


Calibrating mathematical models using dye tracer data: a users perspective

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Environmental Design and Risk Management

Overview

Introduction

1. Use of Models
2. Calibration / Validation Process
3. Case Studies
4. Considerations / Recommendations

Questions




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Introduction to Metoc plc

Metoc is a marine environmental consultancy operating in a range of sectors: water, oil & gas, renewables, cables.


We provide modelling services for a range of clients, particularly in coastal, estuarine and riverine environments.

Metoc advises clients on their Environmental Design and Risk Management (EDRM) strategies



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1. Coastal Modelling




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Why use a model?

Numerical models provide us with accurate, flexible and effective assessment and planning tools

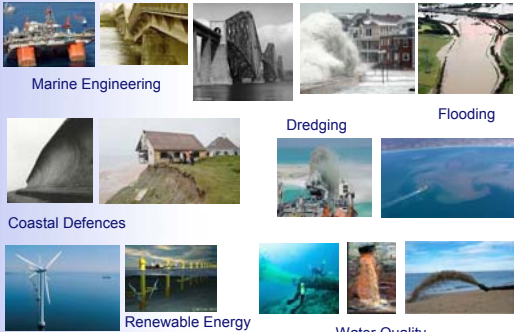
These give us the ability to predict impacts and consequences and optimise environmental design solutions

Key Note: Modelling is fundamental to Environmental Design and Risk Management



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Typical uses of models



Marine Engineering


Coastal Defences

Renewable Energy

Dredging

Flooding

Water Quality



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Water Quality Modelling - Objectives

- Identify receivers at risk of failing relevant compliance standards
- Identify key sources contributing to failures
- Develop optimum solutions to reduce risk:
 - Reduce spills from CSOs (storage)
 - Improve treatment at WwTW (UV)

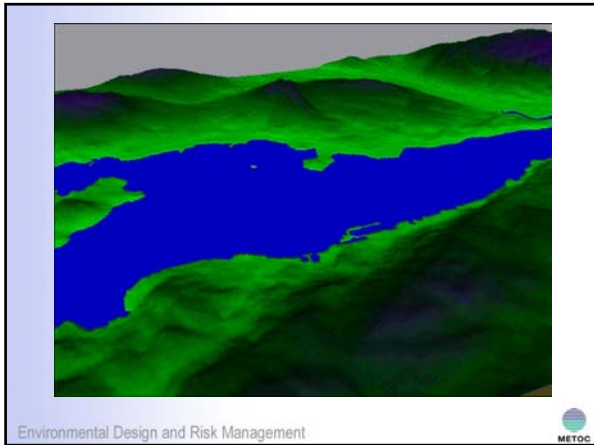
Key Note: Models used to assess many different conditions and predict future scenarios



Water Quality Modelling - Approach

- Pollutant discharges (sewage outfalls) modelled to determine the impact in the environment
- Important to simulate plumes accurately
- Advection *AND* dispersion are both important - under/over-predicted impacts could lead to inappropriate solutions

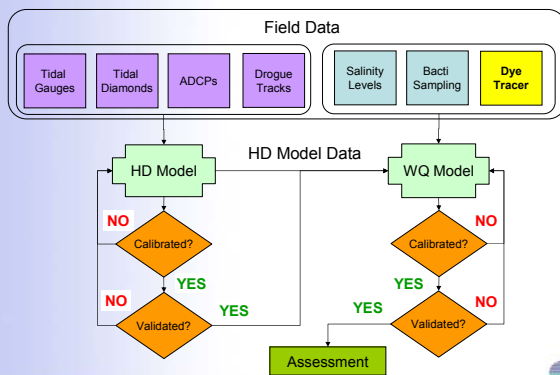
Key Note: Dye used to measure the advective and dispersive nature of the environment



2. Calibrating / Validating models



Calibration / Validation Process



WQ Calibration – dye tracer

Dye surveys provide information on the characteristics of the receiving environment:

- Advection
- Dispersion

The behaviour of the dye under different tidal conditions is measured

Key Note: Dye patches represent specific local conditions at time of survey



Model Calibration – dye tracer

WQ model simulates the behaviour of the dye:

- survey conditions reproduced
- conservative tracer of same mass as dye is introduced into model at same time / location
- PT or AD modelling technique used

Key Note: Modelling limitations include grid resolution, short-term variability, localised influences



3. Case Studies



Case Studies

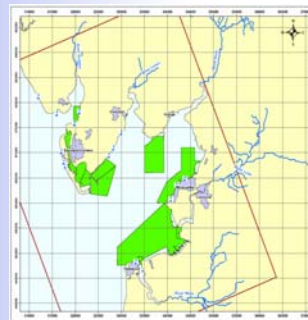
1. Morecambe Bay Modelling System - United Utilities



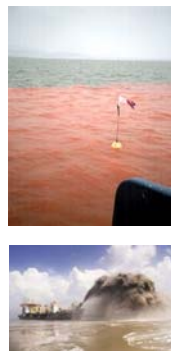
2. Northumbrian Coastal Modelling System - Northumbrian Water Limited



Case Study 1 - MBMS



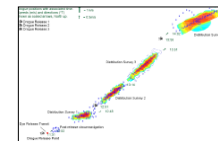
- Silecroft to Fleetwood
- Very dynamic – large drying area, moving channels
- 5 major estuaries + Walney channel



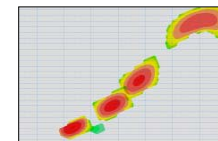
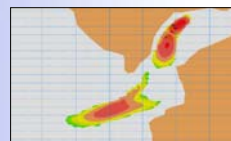
Examples of Dye Patches - MBMS

Lune Estuary - HW

Duddon Estuary - LW




Measured




Modelled





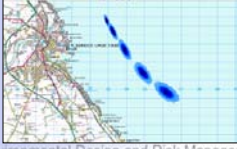

Case Study 2 - NCMS




- Dunbar to Whitby
- Relatively simple compared to MBMS
- Regional model – 450m
- 2 x Area models – 150m
- 2 x Fine models – 50m


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Examples of Dye Patches - NCMS

| | Berwick - HW | Cambois - LW | |
|----------|--|---|--|
| Measured |  |  | |
| Modelled |  |  | |

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4. Considerations / Recommendations

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Considerations – surveyed dye

- Measured data can be noisy – ‘hot spots’
- Inaccuracies: release time, location & concentration
- vessel drift, duration of each patch (not snapshot)
- Interpolation issues, measurement units provided
- Unknown or ‘un-modellable’ influences

Key Note: Confidence in measured dye data unknown

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Considerations - environment


Local influences hard to simulate

- Short-term, localised variable wind effects
- Antecedent winds
- 3D currents (if using 2D model)

Supply of measured data

- Usually sent as graphics – hard to utilise
- Raw data in electronic format required
- Prevailing conditions needed


Key Note: Supply of survey data including prevailing conditions important

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Recommendations

- Take account of prevailing *and* preceding conditions – postpone surveys if necessary (if possible)
- Record all prevailing conditions accurately
- Provide all relevant information
- Industry-standard method for measurement, including units
- Provide all data (raw and interpolated) in electronic format

Key Note: The more information provided with the data the more useful it is

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Any Questions?

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