UDG Training Day
Urban pollution management
"Collaborating to improve the environment!"

IET Birmingham: Austin Court

19 February 2013

UPM Environmental Modelling

Estuary and Marine Modelling

A Brief Introduction

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UPM

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Urban Pollution Management (UPM) is defined as:

'the management of wastewater discharges from sewer and sewage treatment systems under wet weather conditions such that the requirements of the receiving water are met in a cost effective way'

Any modelling methodology used must satisfy two criteria:

1. It must be **technically acceptable** - i.e., it must adequately address the technical complexity of the problem; and,
2. It must be **cost-effective** - i.e., the total costs should be as low as possible, consistent with meeting the first criterion.

UPM provides us with a regulated method of approaching water quality problems that is generic and well understood across the UK – uniformity and agreement of approach

UPM WQ Modelling Approach – in summary

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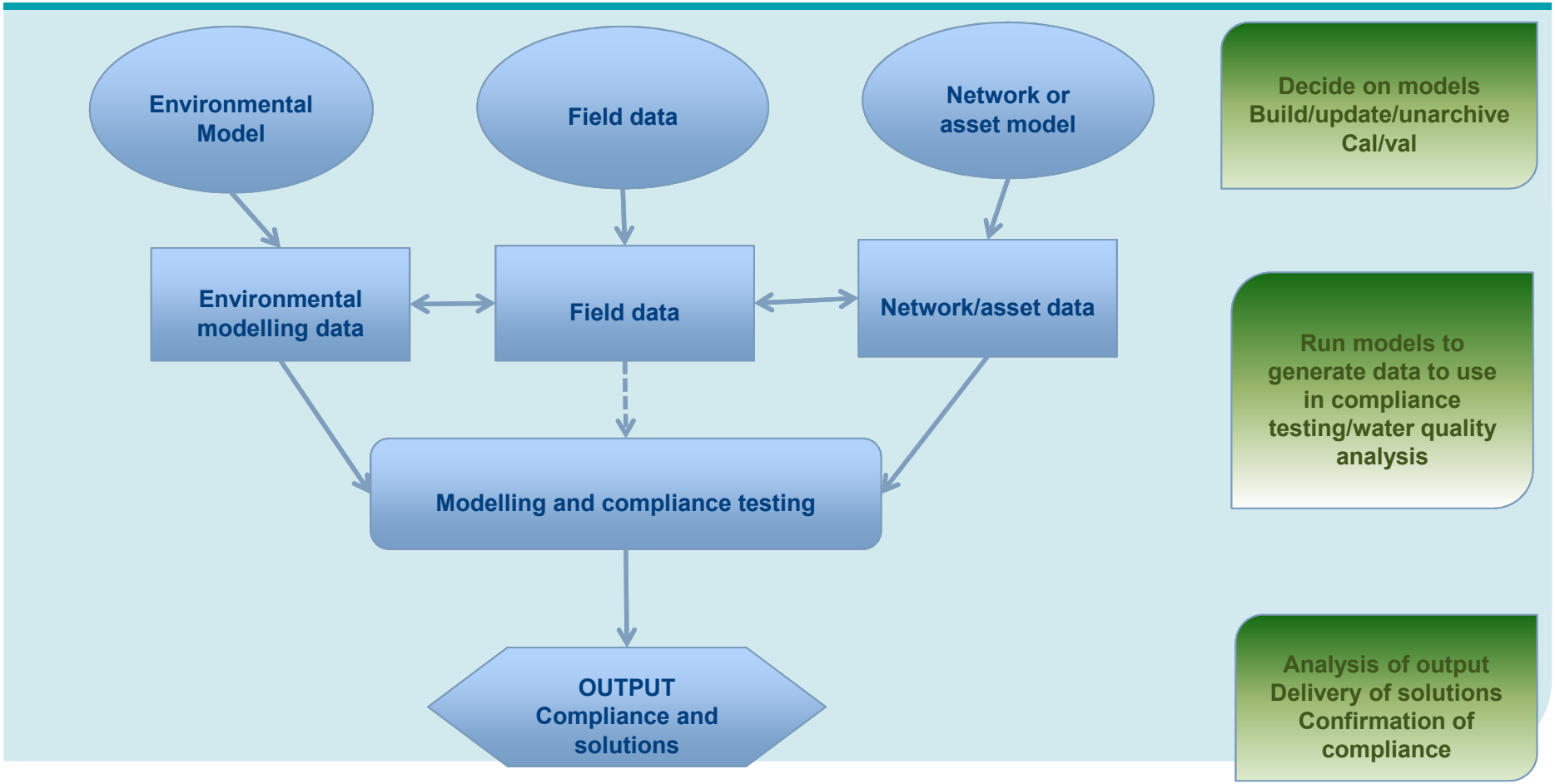

UPM Modelling Approach

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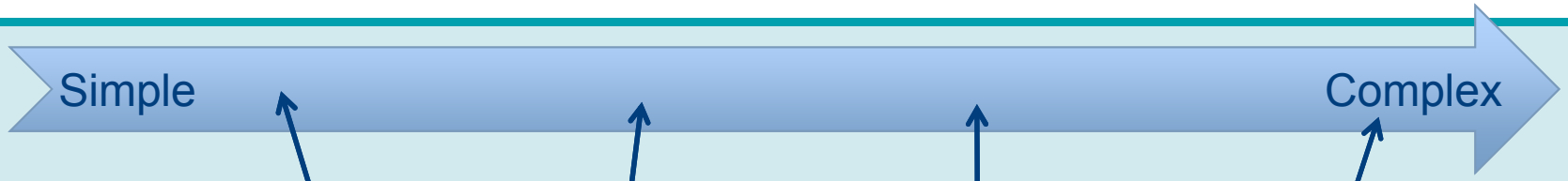

Desk study, to demonstrate correlation or relationship between certain events or actions and measurable consequences

Simple spreadsheet-based approach to simply link, mathematically, events and consequences

Non-dynamic approaches, more complex handling of data

Dynamic estuary or coastal modelling of multiple sources and multiple receivers

Selecting the Modelling Approach

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Whatever approach we choose, we need:

- An **understanding** of the problem and the required **aims**
- An understanding of the **Drivers**
- Sufficient data to **calibrate** the model
- Sufficient data to **validate** the model
- To demonstrate model and approach is **fit for purpose**
- Sufficient data to **characterise** and **represent** sources and the environment
- Deliver output in a clear and meaningful manner:

...**Turn the model into useful data into valuable project information**

How to Decide

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Understanding

If there is one asset, one impacted receiver and no other sources

-we probably don't need a model

If there are two hundred assets, 8 catchments and 10 environmental receivers

- we probably need quite a good model

How to Decide

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Review the data we have, **identify** the information we have, **define** the problem

Define the problem as **simple** (perhaps 1 or 2 discharges, one receiver), or **complex** (multiple sources, receivers and complex compliance criteria)

Identify the **ideal** method of modelling on the basis of our understanding

Agree study **limitations** (cost, timeframe, policy)

On the basis of the above, **agree** the modelling **approach** and define a **scope**

Examples

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Simple

Continuous discharge from minewater

single source, near-field compliance requirements

spreadsheet-based approach more than adequate

Bathing water compliance issues, few discharges, intermittent

Extensive datasets available, including asset and meteorological

Desk study data analysis adequate to determine significance

Complex

Bathing Water and Shellfish Water quality studies, multiple discharges, multiple receivers, large investment potentially required, value not clear

Impact understanding required to determine value of investment, and investment sites

Dynamic modelling and compliance assessment required

Data Requirements

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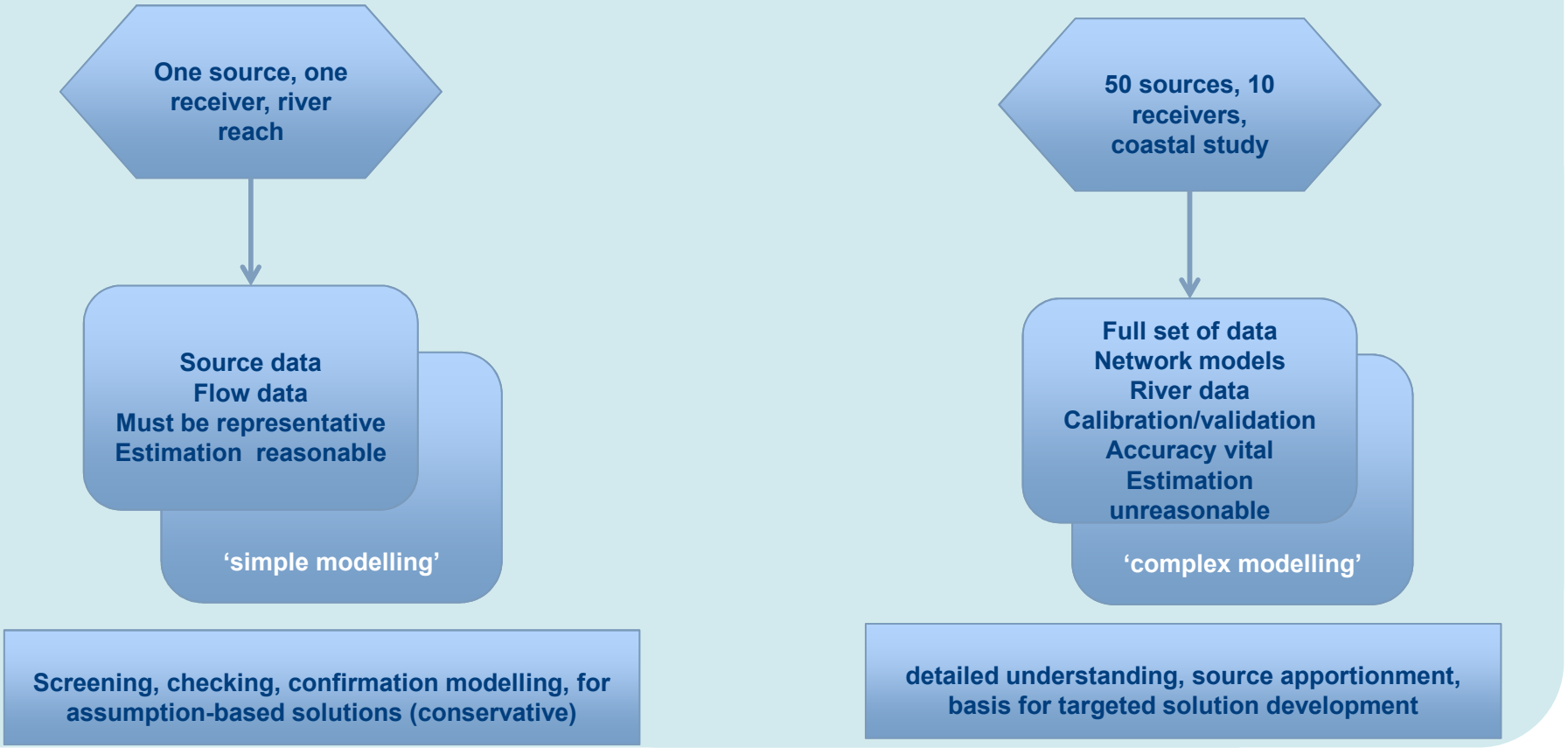

Considerations for Data Requirements

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Asset data:

- location
- performance (flow and quality)

Receiving water:

- Flow and tidal data
- Bathymetry
- Existing quality

Environmental Data:

- Rainfall
- Wind data
- Background/other/diffuse sources

Amount of Data?

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- Will be dependent on study requirements and convention or policy
- Bathing waters studies are taken to deliver an ‘average’ over ten bathing seasons
  - need enough data to be able to support this
- Typically for environmental studies, network models will produce output for ten years rainfall – but this may be changing to reflect better knowledge, data and processing power
- Think about the resolution of the study – trying to interpolate/extrapolate 1000 data points from 20 data points may not be all that accurate

BUT IT IS IN THESE CASES THAT MODELS ARE VITAL

They fill in the data that cannot be collected – so there is a balance to be struck

Calibration

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The precise details of calibration will depend on the model or tool being used.

The data used to drive the model is sufficient to make it stable, and to produce data.

Calibration data then tunes the model in order to represent reality.

For hydrodynamics, bathymetry and bed roughness are two key parameters. The boundary conditions are also critical to a successful model

For water quality, the dispersion in the model is the key factor is controlling pollutant transport (assuming advection has been sorted by getting the hydrodynamics right)

Validation

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The calibrated model should be representing reality to the required criteria.

An independent set of data is then used to test the model. Model output is compared to field data, against the given criterion. For example:

Hydrodynamic –	neap tide data	= calibration
	spring tide data	= validation
Water quality –	one dye tracer release	= calibration
	independent release	= validation

Calibration and Validation - standards

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Example of standards

Coastal model criteria for acceptance

1993 report for the National Rivers Authority by FWR. For example:

Current direction, current speed, tidal phasing, tidal elevation (hydrodynamics)

dispersion co-efficients (water quality)

The point being:

Fitness for purpose is a process of showing that that the model achieves a certain accuracy to a certain tolerance

Some criteria have to be subjective, and agreed. To be black and white regarding all criteria would not allow the development of models successfully

Approaches and methodologies

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We have selected a model, and verified is at fit for purpose

We have the input data we need, both for asset and environment

How do we go about using the models to best effect?

Again, we need to identify what we are trying to get out of the model

Approaches and methodologies

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If we are trying to determine the likelihood of a discharge to impact on a receiver, we use a fairly simple approach.

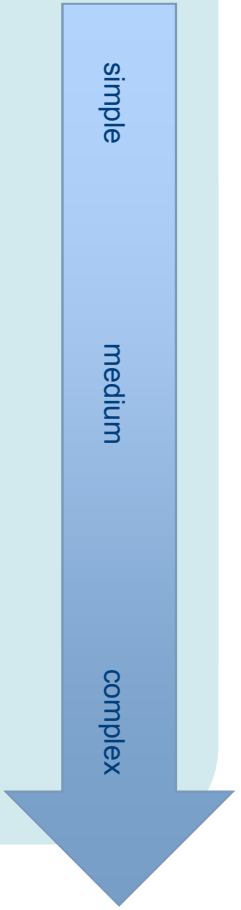
Undertake demonstrative or representative runs, with representative loads, to determine whether or not the discharge reaches the receiver.

If we are trying to determine significance, perhaps by exceedance of a threshold value, then a similar approach but using measured data

because we are trying to understand the fate of the discharge as it would be in reality, but not understand compliance in statistical terms

If we are trying to determine compliance to a given standard, then a more complex approach with accurate data and an understanding of magnitude and frequency of impact

because we are trying to understand impact in compliance terms, which will involve thresholds and a given allowed duration and/or frequency of exceedance



Approaches and methodologies

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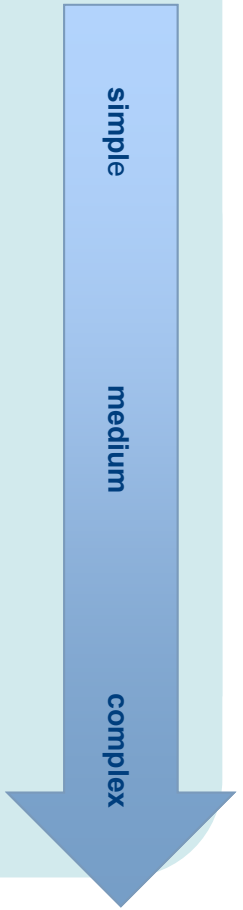
Example Approach	Example Application
Spreadsheet/data analysis Spreading slab model initial dilution model	Screening study Sphere of influence identification
SIMCAT CORMIX spreadsheet models/box models	Screening study Limited discharges/receivers Near field studies Prescribed thresholds
MIKE21/3 Delft3D Telemac Catchment models MIKE11	Strategic studies Detailed compliance studies Solution development Statistical thresholds & multiple receivers



Approaches and Methodologies

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Delivering a Scope

- Environmental Regulator and Water company need to agree Scope
- Scope should clearly identify aims, and consequently identify best available approach
- Scope should provide data to satisfy Regulator policy
- Scope should deliver data sufficient to meet statutory requirements
- Scope should clearly show an understanding of available timeframe and budget
- Scope should identify verification criteria
- Scope should be signed off – avoid ‘mission creep’

Example

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Yorkshire Water Regional Bathing Waters Assessment

- Most comprehensive UK bathing water study to date
- Integrated comprehensive field data and modelling exercise
- Developed a good understanding of the revised Bathing Waters Directive
- Independent research is highlighting the importance of well thought out modelling approaches to the rBWD, especially with regard to ongoing management of UK bathing water quality
- Demonstrates that the considered implementation of a modelling study has high value, develops understanding of compliance, and allows sensible investment decisions to be made

YWS Scope and Approach

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Yorkshire Water chose a detailed, model-based predictive approach

This was supported by the Environment Agency

Intertek were brought in as an AMP5 Partner for water quality modelling.

Yorkshire Water network modelling partners delivered the network models

Yorkshire Water supported the modelling exercise with a comprehensive field survey exercise, delivered by Professor David Kay and CREH.

data collection > network models > environmental models > bathing waters > solutions

YWS Scope and Approach

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Environmental modelling based on the Yorkshire Coastal Model:

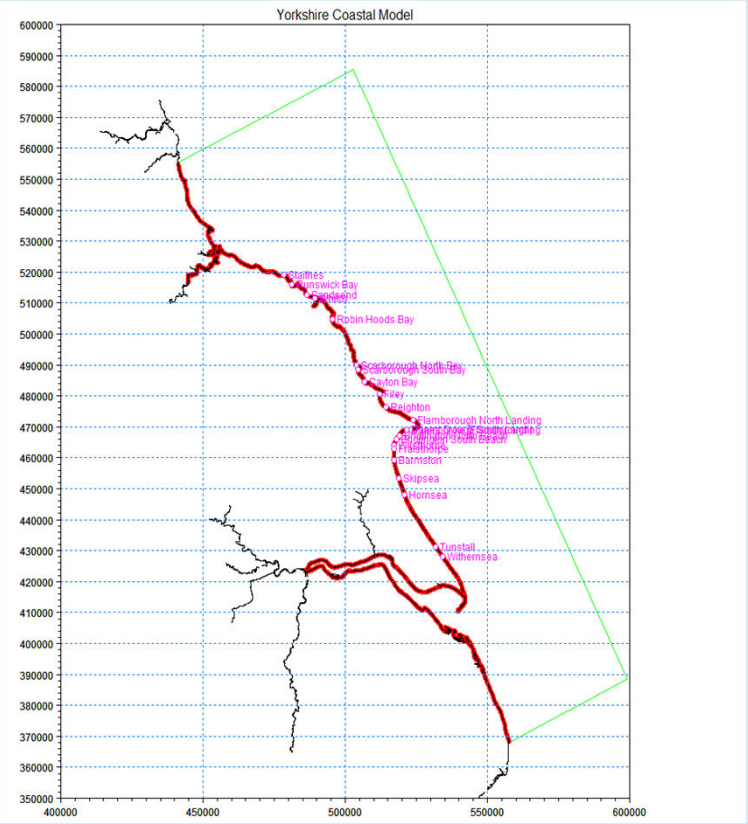
Custom-built for Yorkshire Water to deliver water quality studies.

2D model

Varying resolution for run-time efficiency

Covered all bathing waters

Calibrated and validated, signed off by the Agency



YWS Outputs

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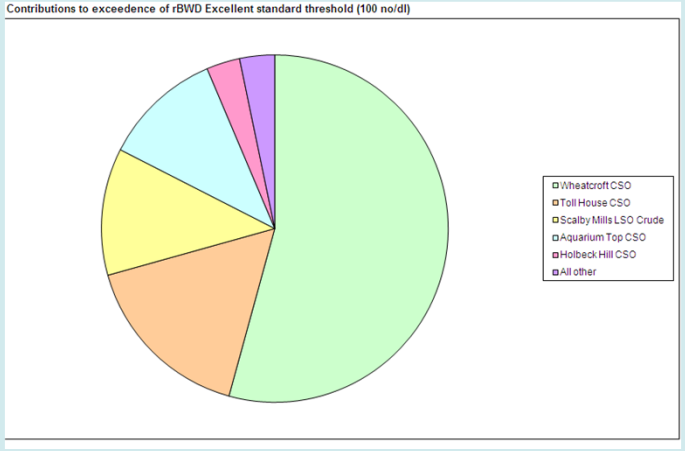
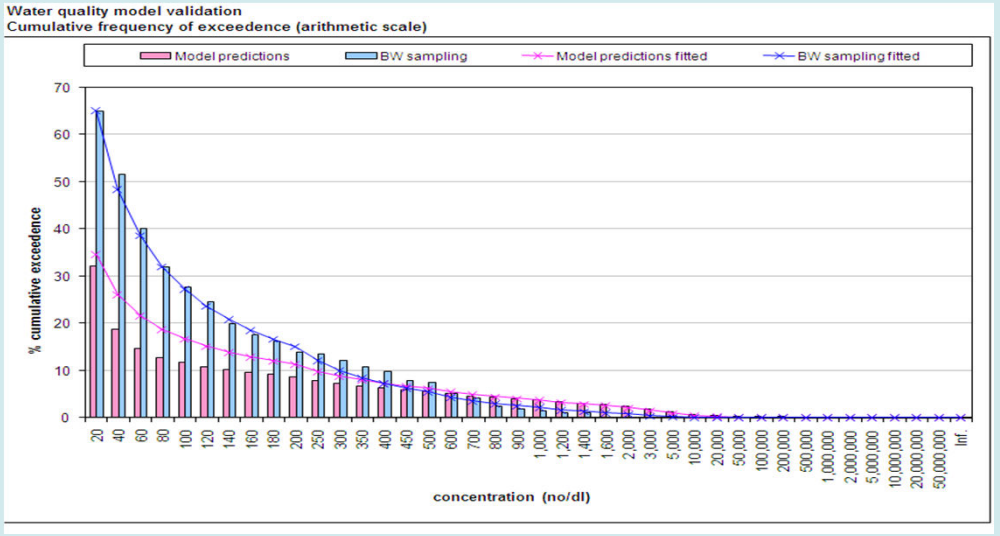
Compliance modelling provides source apportionment



Results compared to historical data



This allowed solutions or mitigation to be targeted at significant sources

RESULTS: understanding of 'Excellent' compliance, targeted investment, information & understanding

In Summary

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Coastal and Estuary modelling is a key part of UPM modelling

Scoping, Data acquisition and methodology agreement are vital

Successful application depends on selecting the right modelling approach

Model selection depends on understanding the issues and the drivers

Coastal integrated with river and catchment approaches to deliver ‘WFD’ studies

Coastal Modelling delivers compliance, sustainability and cost-effective solutions

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