In-stream water quality modelling on the River Ouse

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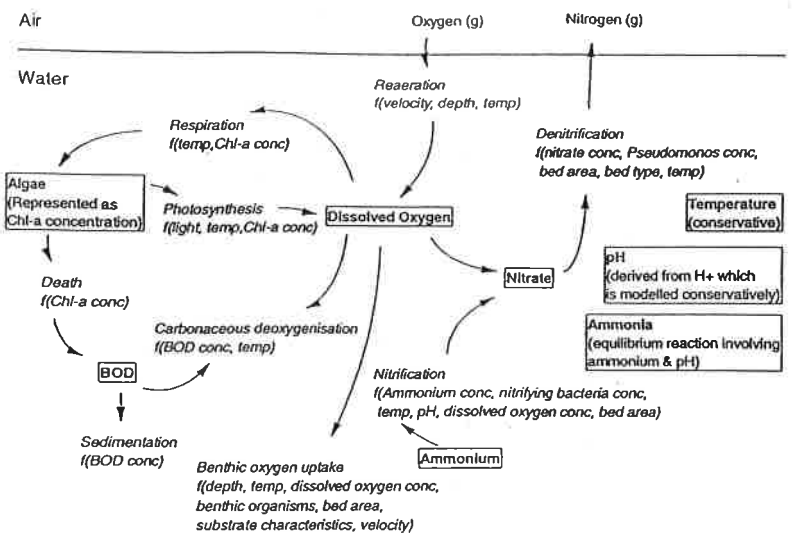
Quantity and quality of water in a river may be affected by natural or anthropogenic impacts. Changes in climate, land-use or land management may result in non-point sources of water pollution. Discharges from industry and sewage treatment works, abstractions for water supply *etc.* will act as point source influences on water quality. In general non-point sources tend to be more important in the agricultural areas of the headwaters and point sources in the more urbanized lowlands.

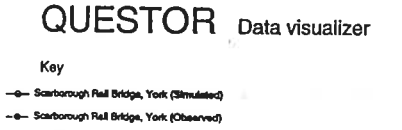
Investigation of possible changes in water quality is facilitated by representing the river catchment within the framework of a model. Non-point sources require a delivery (or catchment) model, while point sources may be represented within an in-stream water quality model. These two types of model are currently being integrated within a single modelling system. QUESTOR (Quality Evaluation and Simulation Tool for River systems) is an in-stream water quality model developed at the Institute of Hydrology as a tool to aid the assessment and management of water quality in river systems. The model can be operated in two modes: a dynamic mode in which pulses of pollutant can be traced downstream at key locations along the river; and a planning mode which is useful for establishing effluent consent conditions given river water quality objectives.

In the model the river is discretised as a series of reaches with reach boundaries at points where there is a change in water quality or flow such as the confluence with a tributary, a sewage treatment discharge, an abstraction or weir. Water quality and flow from point sources (influences) are input into the corresponding reach. Each reach is modelled as a series of well mixed tanks in series. Water quality changes caused by biological and chemical transformations are assumed to follow first order differential equations. The water quality determinands currently modelled, in addition to flow, are: nitrate; dissolved oxygen; biochemical oxygen demand; ammonia; ammonium; temperature; pH; and any conservative pollutant. The model processes for these determinands are illustrated in Figure 1. Several new determinands are currently being added including: heavy metals; silica; phosphorus; sediments; micro-organics; carbon; and an improved representation of algal dynamics.

QUESTOR therefore requires information describing the network and the characteristics of all influences, *i.e.* tributaries, discharges, abstractions and weirs. These data can be abstracted from the National Water Archive and LOIS data bases held at IH and formatted for use in the model. It is then possible to refine the extent of the river network and to select the level of information to be included in any simulation. Data sets for discharges and influences are constructed by transfer from analogue sites, interpolation, and estimation from consent or default values where data are not available. For ungauged tributaries flow and determinand data series are transferred with scaling from nearby sites which are deemed to have similar characteristics. A catchment delivery model is currently being implemented to extend the river network upstream and to simulate non-point sources to provide these inputs. QUESTOR has been applied to the River Ouse in North Yorkshire as part of the LOIS study. Typical output from the model for two different river reaches are shown in Figure 2, time-series for dynamic mode and a distribution plot for planning mode.

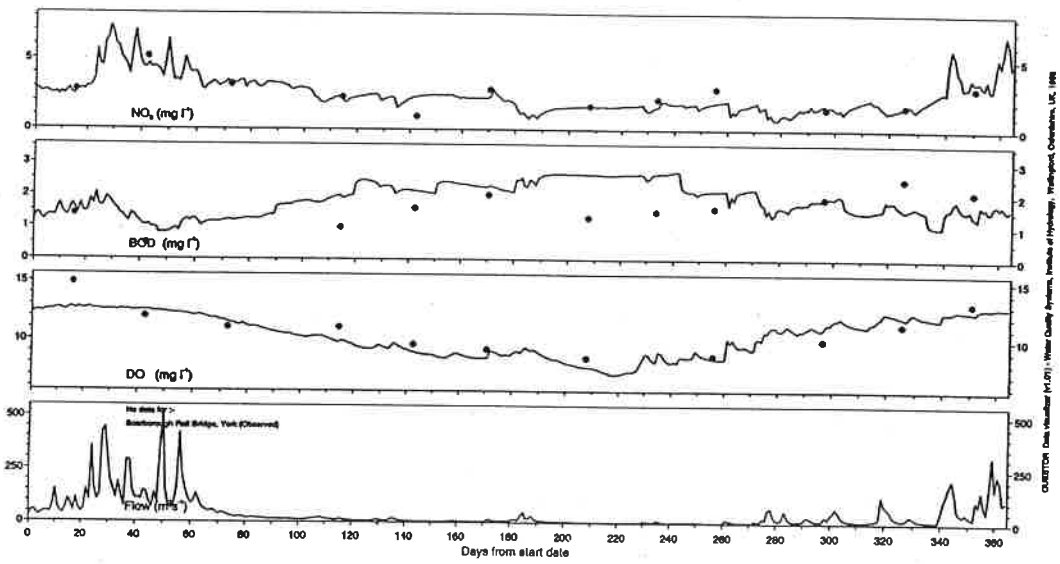
Figure 1.

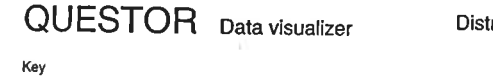




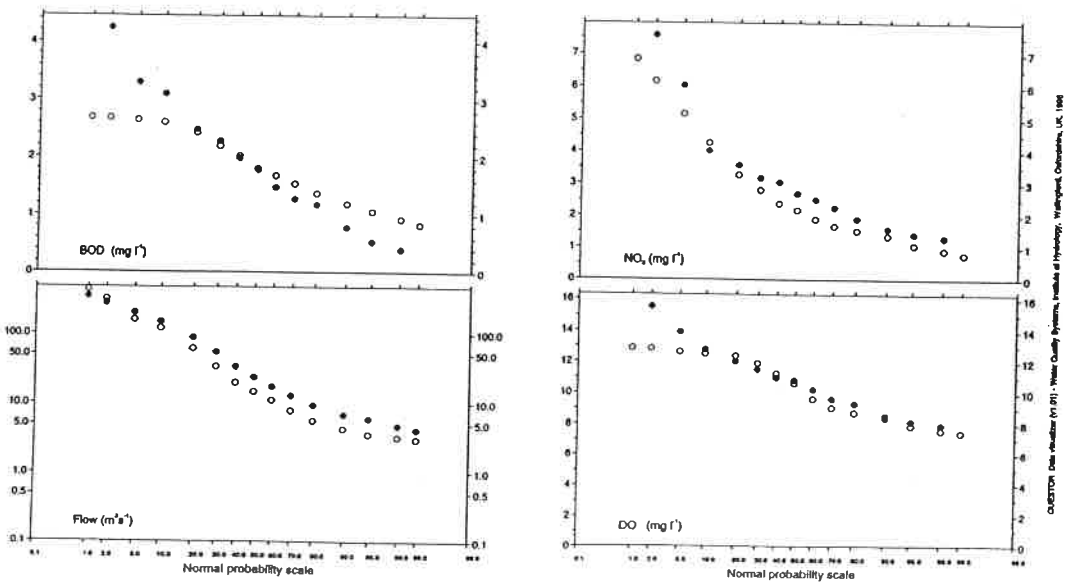
Time series display
Determinand: See line/panel labels
Location: See line or panel labels
Model/data: Model output from QUASAR v2
Network: Ouse (inc. Swale, Ure, Nidd)
Scenario: Existing conditions
Date/time: 1-Jan-1990 to 1-Jan-1991

Figure 2.





Distribution display
Determinand: See line/panel labels
Location: See line or panel labels
Model/data: Model output from QUASAR v2
Network: Ouse (inc. Swale, Ure, Nidd)
Scenario: Existing conditions
Date/time: 1-Jun-1990 at 00.00
Distribution: As percentiles
Source: Fitted



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