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ScienceDirect
Science of the Total Environment 373 (2007) 1 – 12
Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Humankind
www.elsevier.com/locate/scitotenv

Evaluating alternative river management options in the tidal Ouse using the QUESTS1D model

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Received 30 May 2006; received in revised form 29 October 2006; accepted 30 October 2006
Available online 22 December 2006

Abstract

The tidal Ouse forms a significant part of the Humber river system in Eastern England, which provides the largest UK fresh water source to the North Sea and a valuable habitat for fish. However it suffers from dissolved oxygen (DO) sag in summer, exacerbated by the industrial effluent discharged at Selby. A one-dimensional water quality model, QUESTS1D, as utilized by the Environment Agency (EA) has been used to evaluate the effectiveness of management options based on exploiting spatial distribution of the assimilative capacity of the river as an alternative to implementing more stringent effluent consents. Significant improvements in water quality of the tidal Ouse are predicted compared to the effects of tightening effluent consents. A system of water quality functions is derived in this paper for quicker and more direct predictions of water quality, which will be useful in future research when combined with other analyses. Taking account the assimilative capacity in policy making, this paper suggests that a combined water management framework should be applied to ensure the required water quality.

Keywords: Effluent discharges; Water abstraction; Water quality model; Water quality functions; Integrated river policy

1. Introduction

As shown by Fig. 1, the tidal Ouse forms a significant part of the Humber drainage basin, which is the largest catchment in England, draining one fifth of the land area of England (Edwards et al., 1997; Jarvie et al., 1997). The sea spurn of the Humber makes the biggest freshwater contribution to the North Sea from the UK, approximately 250 m^3 s^{-1} (National Rivers Authority, 1993). The tidal Ouse is an upper section of the tidal Humber system, stretching from Naburn to Trent Falls. It includes four tributaries, the Wharfe, Derwent, Aire and Don. The tidal Ouse remains one of the most polluted river reaches in the tidal section of the Humber system. One result of the poor water quality in the tidal Ouse during the warm summer months is the low DO saturation (DO%) or DO sag, a common phenomenon of estuaries.

The spatial variations in the mean DO% levels of the Ouse–Humber system in summer during the last three decades are shown in Fig. 2. As a result of the DO sag, water quality in the tidal Ouse is too low to support the return of spawning salmon, an important indicator of ecological health of an estuarine river. The most severe DO sag in the summer persists in the upper reaches of the river between the Environment Agency (EA) water quality monitoring (WQM) sites at Selby

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doi:10.1016/j.scitotenv.2006.10.045

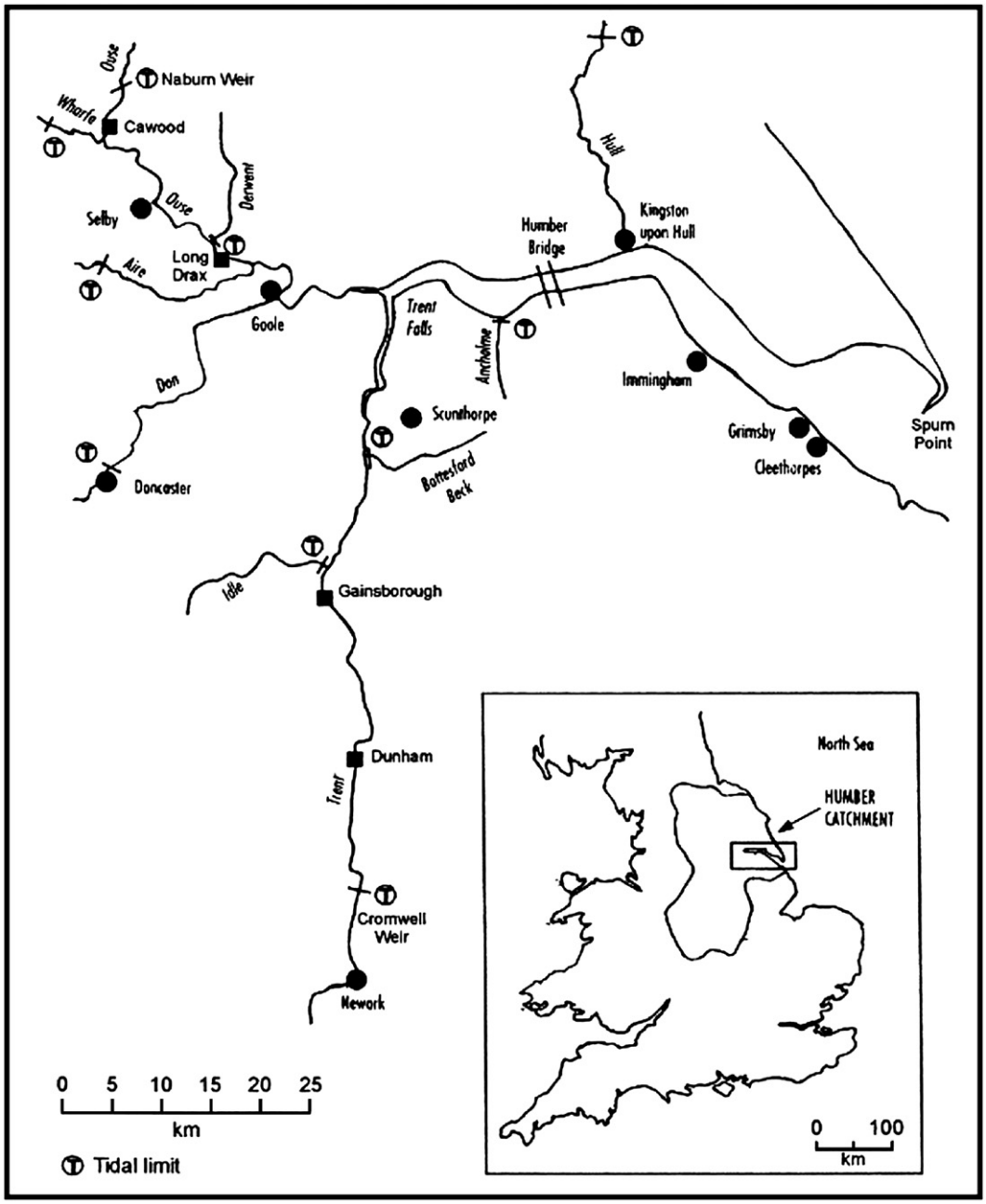

Fig. 1. The tidal section of Humber, Trent and Ouse system and main tributaries. The rivers Trent and Ouse are the two main sources of freshwater to the Humber Estuary, draining approximately one-fifth of England. Reprinted from Science of The Total Environment 314–316, issue 1–3, Tappin et al. (2003), The fluxes and transformations of suspended particles, carbon and nitrogen in the Humber estuarine system (UK) from 1994 to 1996: results from an integrated observation and modelling study, 665–713, with permission from Elsevier.

and Long Drax. Although the DO levels in summer in the Ouse–Humber system have shown sustained improvements since the 1970s, the mean levels of DO do not fully reveal the DO problem. The EA uses 5%ile values to assess the water quality in the Ouse–Humber system. Values were still worrying between Selby and Long Drax, especially during dry summers such as those in 1995 and 2003. The EA therefore proposed tightening effluent discharge consents to improve water quality. However, other factors should also be considered. The water in the tidal Ouse is also heavily influenced by the rivers Aire and Don, draining from major urban centres