

Environmental Impact of Combined Sewer Overflows and Riverine Inputs on Urban Water Bodies

Objectives

The main goal of this project is to predict microbiological water quality of direct relevance to recreational activities. The project aims to:

- quantify existing disease burden levels attributable to combined sewer overflows and riverine discharges into urban freshwater bodies and to determine the impact on recreational opportunities
- quantify the 'health gain' of possible treatment and/or management strategies of waste water discharges into urban water bodies
- link urban storm water discharge models to 2-D and 3-D hydrodynamic and water quality models using plume based near field models
- link water quality and epidemiological models to establish 'health gain' and risk levels, ie in time and space, in urban water bodies
- develop and propose design strategies to maximise recreational opportunities in urban water bodies.

Location

South Wales

Approach

One of the main tasks of this project is to integrate a storm sewer design and analysis software tool with a 2-D and 3-D model for predicting hydrodynamic processes and water quality indicator distributions in urban water bodies. This integrated modelling approach is, initially, being set-up and validated for the Fylde Coast, at Blackpool. Because of the extensive data available for the region and the various hydrodynamic inputs to the coastal waters, this is an ideal site for model calibration and verification.

In parallel with this, the model is being extended to include an epidemiological model, to provide health risk and health gain assessments for various scenarios. The linked component model will then be applied to a range of input and meteorological scenarios for Cardiff Bay, and possibly the Tawe Barrage. This site specific example will investigate the impact of various combinations of rainfall, weather conditions (eg cloud cover and wind), and riverine flow and tidal conditions to establish the impact of these parameters on the health risk probability within the urban water body.

Start Date/Duration

October 1997 Three years

Lead Organisations

University of Leeds

Deliverables

This project will provide software tools and water management guidelines for quantifying the health risks and enhancing the 'health gain' in urban water bodies.

Users

Agencies responsible for standards design
Water and effluent disposal companies
OFWAT
Environment Agency
Medical public health services
Local environmental health professionals
Central and local government
Trans-national environmental standards agencies

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Sediment Dynamics In Urban Systems - An Holistic Approach To Surface, Drain And Riverine Particulate Transport

Objectives

The aim of this research project is to quantify and provide an improved understanding of the movements of particulate materials through urban systems. The project includes:

- identifying sediment sources
- assessing opportunities for storage
- flow generation and routing, including travel times, through urban systems
- measuring sediment outputs
- applying hydrological and sediment transport models, eg Hydroworks and MOUSETRAP, to assess and integrate existing models with regard to operation over the full range of flows.

Location

Bradford

Approach

Archive data, field observations and integrated modelling are being used in collaboration with Unilever, the Environment Agency and Yorkshire Water. The project has an holistic approach to particulate transfers through the urban environment, from entrainment at source to eventual deposition within and beyond the immediate town or city. This broad approach is providing a means of focusing on important interfaces between urban and rural systems.

The project is closely linked to a Urban Pollution Management survey of Bradford, Yorkshire and it is complementary to other large scale research.

Start date/duration

October 1998

Three years

Lead Organisations

CEH Wallingford
University of Sheffield

Deliverables

- an improved understanding of urban sediment pathways, times of travel and pollutant loads
- support for waste disposal strategies and remediation techniques to reduce pollution.

Users

Environment Agency
Water Companies
Local Authorities
Water users

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Depth And Extent of Penetration of Urban Recharge and Contamination Into UK Aquifers

Objectives

This project is establishing the depth and extent to which the aquifers beneath the conurbations of Birmingham and Nottingham are contaminated, the buffering capacity of the aquifers, and the degree to which shallow industrial abstractions are removing contaminants, thus protecting the deeper aquifer.

Location

West Midlands/Nottingham

Approach

To address these issues, the approach is to:

- install a network of open, fully penetrating boreholes distributed in the conurbations, lined to prevent mixing when not in use (initial sampling is being carried out during installation)
- log the boreholes to locate high flow zones
- undertake hydraulic tests as requested by Severn Trent Water plc
- take samples from the boreholes using the Bradford on-line packer system over a period of two years to establish variations in organic and inorganic species with depth and time
- compare the relative penetration of reactive and non-reactive species to establish aquifer buffering
- interpret this data to establish the viability of sustainable high quality abstractions.

Start date/duration

October 1997 - four years

Lead Organisations

University of Sheffield
University of Surrey
University of Bradford

Deliverables

The deliverables of this project include an inception report, biannual reports, a final report and published papers on the scientific results. This information will include rates of penetration of urban recharge and contaminants, and the factors which control this penetration. There will also be a database of detailed information on groundwater quality variations with depth and hydrogeological property variations. The information will be a significant tool for management strategies on the sustainable use of urban aquifers. It will be available for industry, the Environment Agency and Severn Trent Water plc.

Users

Environment Agency
Seven Trent Water plc

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Using Urban Aquifers: Sustainability at Different Space and Time Scales

Objectives

Using Birmingham as an example, this project is testing the suggestion that it should be possible to abstract potable quality water from several of the UK urban aquifers on a sustainable basis. The project is concentrating on the Triassic sandstone aquifer of the West Midlands. The main issues are related to the heterogeneity of pollutant sources, and the effects of geochemical, hydrochemical and hydraulic layering at regional, sub-regional and local scales. The project is developing and applying tools which take these issues into account.

Location

West Midlands

Approach

The project is addressing three main areas: evaluation of solute source fluxes; evaluation of advective transport of solutes; and evaluation of the effect of reactive interactions. Three scales are being considered:

- urban-scale, where the aquifer is considered as one unit
- suburban-scale, where solute transfers from one part of the aquifer to another are considered
- borehole-scale, where solute fate in the immediate vicinity of the borehole is considered.

Start date/duration

November 1997 - four years

Lead Organisation

University of Birmingham

Deliverables

- an assessment of the researchers' hypothesis in the context of the Birmingham system, including GIS databases, models at three scales with the incorporation of geochemical issues for the first time
- a general methodology for assessing urban aquifer exploitation, incorporating a GIS-based system for urban risk assessment, a general reactive solute transport model that will allow the influence of water levels on hydrochemistry to be explored, and a borehole model for use in detailed well catchment/protection zone mapping.

Users

Environment Agency
Severn Trent Water Plc
Birmingham City Council

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A General Model For Prediction Of Changes In Fluxes To And From Contaminated Sediments In Response To Changes In Water Quality

Objectives

This project has two closely associated aims.

The pollution impacts of sediments vary qualitatively and quantitatively dependent on the contemporary chemistry of the water column. This water chemistry varies both naturally - seasonally, diurnally and with variations in plankton density - and as the pollutant loading is decreased or remedial actions such as oxygen injection are made. One aim of the project is to develop a model that is able to predict changes in oxygen and metal fluxes in response to these changes in overlying water quality. To achieve this, the objectives are to:

- monitor the interaction between soluble and solid phases within the sediment
- monitor in-situ fluxes across the sediment water interface.

Pollution impacts of sediments may also be altered by dredging, which removes the sediment water interface and replaces it with a previously buried surface. The other aim of the project is to identify sediment that has become refractory, no longer oxidisable or only oxidisable at a slow rate. Recognition of the depth at which this occurs will be required to guide the depth to which any dredging may be necessary at a specific site, whilst the ability to recognise such a change will be generic. The objectives to meet this aim are to:

- devise appropriate measurements of sediment oxygen demand
- identify marker compounds or suites of compounds indicative of a refractory horizon.

Location

Greater Manchester

Approach

The approach will be to devise an initial model primarily from existing theory, whilst collecting field data. As the field data is collected, it will be used to calibrate the model and, subsequent to calibration failures, to refine the abstractions and assumptions of the initial model. A full sampling and monitoring programme will be undertaken at a site in the turning basin of the Manchester Ship Canal (MSC) and the largest of the Salford Quays, as these provide the best opportunity for generic and specific research. A site in the lower reaches of the MSC, towards Liverpool, and a canal site in central Birmingham will each be sampled three times during the project and monitored throughout.

Start date/duration

October 1998 Two years

Lead Organisation

University of Manchester
Manchester Metropolitan University

Deliverables

This project will produce a general model to predict the changes in fluxes to and from contaminated sediments in response to changes in water quality. The findings will be published in major international journals and at an international geochemistry conference. The research material may also be incorporated in computer aided learning packages, some of which may be aimed at schools. Display material will also be produced for use in the Salford Quays Visitor Centre.

Users

Bodies and companies responsible for urban redevelopment
Earth Science Courseware Consortium

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Modelling River Corridors: The Scientific Basis for Rehabilitation of Urban Rivers

Objectives

This project is examining the dependence of urban river ecosystems on flow, water quality and physical habitat. The precise nature of the dependence upon these boundary conditions is far from clear and may vary throughout the river system. The contention is that even in highly polluted urban river systems, the flow regime and the nature and diversity of the physical habitat also significantly influence the river ecosystem. Therefore, all three boundary conditions and their interactions are being investigated. There are five principle research tasks:

- Development of a rainfall run-off procedure linked with the Urban Pollution Modelling (UPM) procedure.
- Development of modelling procedures for urban solute and sediment transport processes.
- Development of a hydro-ecological classification of urban rivers.
- Development of a bio-assessment method for urban rivers.
- Development of a hydro-ecological model to explore the effects of changes in water quality, flow regime and physical habitat for urban rivers in evaluating restoration strategies.

Location

West Midlands

Approach

The studies are being focused on the River Tame, upstream of Water Orton (407 km²) which drains substantial portions of Birmingham, Sandwell, Walsall and Wolverhampton.

Tasks 1 and 2 will produce flow, water depth, shear stress and water quality time series (based on observed data and some output from Task 3) for representative channel reaches for historic and current conditions. Task 3 will provide a physical classification to meso-habitat level that is suitable for urban rivers by using observed data and output from Task 1.

Task 4 will provide information on the invertebrate fauna associated with the defined physical classes (from Task 3) in combination with summary water quality indices (from Task 2), to define sensitive physical and chemical habitat relationships for invertebrates in urban rivers. Task 5 will lead to the development of a predictive model that reflects the relative importance of the boundary conditions upon the river ecosystem.

Start date/duration

January 1998 four years

Lead Organisation

University of Birmingham
CEH Wallingford

Deliverables

The main deliverables of the project will be a generic methodology appropriate for urban areas for:

- integrated hydrological and water quality modelling
- hydro-ecological classification for river corridors
- bio-assessment method for urban streams
- hydro-ecological model extending PHABSIM to urban channels
- inclusion of ecological factors into the UPM methodology.

Users

Environment Agency
Severn Trent Water
WRc plc
Sandwell Metropolitan Borough Council
Birmingham City Council
Walsall Metropolitan Borough Council

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Direct Toxicity Assessment and Mapping of Urban Groundwater Pollution

Objectives

Expanding on the Environment Agency's current plans to regulate surface water toxicity through Direct Toxicity Assessment, this project aims to:

- evaluate the use of established and novel ecotoxicity test procedures for identifying the sources, pathways and fluxes of pollutants in groundwaters
- analyse the data from these toxicity tests using statistical techniques novel to the field of ecotoxicology
- produce a 3-D groundwater pollutant map, based on the chemical and toxicological information, for a conurbation with a highly complex history of contamination sources and types - this will allow the diagnosis and characterisation of problems in relation to natural backgrounds
- develop Toxicity Identification and Evaluation (TIE) procedures to identify classes of chemicals that pose the greatest ecotoxicological hazard at specific sites
- develop generic guidance for the use of ecotoxicity testing and TIE techniques in monitoring contaminated groundwaters in the UK and to prescribe appropriate toxicity-based standards.

All data collection will be quality controlled and all aspects of the project will be quality assured within a Quality Management System.

Location

London

Approach

There are three phases to the project. The main objective of Phase 1 is to compile an extensive database on groundwater toxicity in the London Borough of Hounslow. Existing information indicates that groundwater in certain areas contains high concentrations of contaminants, particularly metals and polyaromatic hydrocarbons. However, the toxicological significance of the contaminant mixtures remains unknown. Groundwater samples will be taken from the network of over 600 boreholes which have already been drilled in the Borough and at Heathrow Airport, and from 50 boreholes which will be drilled as part of this project.

In Phase 2, novel sublethal ecotoxicity tests will be used alongside standard suite tests to investigate the effect of groundwater samples on biomarkers in *Daphnia*. This will allow the measurement of much lower levels of toxic effect than possible in Phase 1 and hence, refine the map of the spatial distribution of pollution near hotspots. It will also help to identify some of the major classes of chemicals that may be responsible for this pollution.

Once repeatable measurements of lethal or sublethal toxicity have been found through time at particular sampling sites, chemical fractionation techniques and toxicity testing (known as TIE) will be used in Phase 3 to help identify still further the toxic components of the groundwater samples. TIE is a technique only recently introduced in Europe and consists of the manipulation of environmental samples to identify the physical and chemical nature of the substances causing toxic effects.

Start date/duration

October 1998 Three years

Lead Organisations

University of London
University of Reading

Deliverables

The outputs of the project will include user-friendly manuals, generic monitoring strategies and peer-reviewed scientific papers.

Users

Hounslow Borough Council
British Airports Authority
Environment Agency
WS Atkins Environment

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Rehabilitation of Urban Rivers: Modelling the Ecological Risks of River Sediments

Objectives

This project is a development of another URGENT Project on the River Thames - Modelling River Corridors: the scientific basis for rehabilitation of urban rivers (MRC) - addressing an additional boundary condition for river rehabilitation, the mobilisation and bio-availability of sediment-associated contaminants in relation to flow, water quality and channel structure. The project comprises three research tasks:

1. Measurement and modelling of sediment-associated contaminant fluxes

Fine particulate sediments are important in controlling the flux of nutrients and contaminants in rivers. However there is currently a paucity of field based information on the dynamics of contaminant transfer between the sediments and the water column.

2. Measurement and modelling of the role of biota on sediment-water chemical fluxes

A range of organisms associated with sediments, both interstitial and surface dwellers, play a major part in locking up and mobilising contaminants. Algal biofilms moderate the sediment water exchange and are variable in species composition spatially and temporally. The overall role of biota in sediment water processes is little known at present.

3. Development of a module to assess the ecological risk of urban river sediments

This part of the project aims to integrate the data from parts 1 and 2 into a module providing an analysis of sediment associated pollutant dynamics.

The primary scientific objective is to model the ecological risks associated with urban river sediments.

Location

West Midlands

Approach

Measurement and modelling of sediment-associated contaminant fluxes

Field data obtained from selected reaches of the River Thames will be combined with laboratory data and data from other sources/monitoring programmes. The data will be used to obtain information on, sediment-water partitioning of contaminants, particle size and chemical speciation, particulate movement, timing of resuspension events and calculation of loads and fluxes.

Measurement and modelling of the role of biota on sediment-water chemical fluxes

Fluxes of the selected contaminants will be investigated on different sediment types in fluvial and mesocosms. Studies will include the influence of burrowers and sediment surface grazers.

Development of a module to assess the ecological risk of urban river sediments

Data from tasks 1 and 2 will be integrated to provide an analysis of sediment associated pollutant dynamics.

Start date/duration

October 1999 Three years

Lead Organisations

University of Birmingham
University of Coventry

Deliverables

- A reach scale model of sediment-associated contaminant fluxes
- Provide new data to be incorporated into a generic methodology being developed by the URGENT MRC project to inform decision makers about ecological risks of contaminated sediments
- Produce results for use in the long-term restoration programme
- Provide information on benefits and improvements in discharges from Minworth in time for the reduced limits for BOD(ATU), suspended solids and ammonia
- Contribute to the debate on the long-term future operation of Lea Marston Lakes.
- Presentations and publication in the Scientific Journals to disseminate new findings

Users

URGENT
Environment Agency

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