

R&D Technical Summary W5A-057/TS/2 Reducing uncertainty in river flood conveyance - New UK Conveyance Estimation System (CES)

Background to R&D project

Uncertainty and poor accuracy in flood water level estimation increases the cost and risks in flood management. Water level estimation feeds into most sectors of flood risk management – strategic planning; flood forecasting and warning; design of improvement works and new schemes; operations and maintenance; planning and control of development. Scoping work in 2001 on current design and operational practice related to flood level estimation showed that advances in understanding of flood hydraulics have not fed through into the software that supports the design/planning process, that there was an undue dependency on outdated methods, and that it would be beneficial to carry out a targeted programme of R&D to develop improved tools for conveyance estimation. Technical Summary W5A-057/1/TS summarises the results of that scoping study, which involved a wide range of researchers, software developers and end users.

The Joint Defra / Environment Agency R&D Programme therefore promoted a UK research initiative to develop an improved decision-support system for conveyance estimation to calculate the flow / depth / slope relationship in river channel and flood plain systems. (Conveyance (K) is a function of flow cross-section, flow depth, and hydraulic roughness (e.g. Manning “n”). The parameter enables flood level and/or flow depth to be calculated for given flood discharge in the river channel and flood plain.) The Scottish Executive and Rivers Agency, Northern Ireland supported the project in order to secure UK ownership and relevance.

The project to produce the new Conveyance Estimation System (CES) was carried out from early 2001 to mid 2004. It has been closely co-ordinated with a parallel project aimed at improved estimation of afflux at bridges and culverts through an Afflux Estimation System.

Results of R&D project

A key objective of the R&D has been to make the tasks of assembling information and estimating hydraulic roughness and conveyance as logical and practical as possible for the user. The way that conveyance estimation is configured therefore had to be considered from a number of different viewpoints, and these are reflected in the outputs (see R&D Outputs and their Use overleaf):

- **For scheme or channel design**, the new system had to be able to be embedded into currently used commercial 1-D hydrodynamic modelling software such as iSIS flow, MIKE11 or HECRAS.
- **For channel maintenance**, the operations engineer wanted a simple stand-alone tool that was able to indicate the effects of reprofiling the channel (for example by dredging and/or cutting vegetation) on either the channel rating curve (i.e. the depth / flow relationship) or a simple backwater curve for given channel cross section and slope.
- **For bespoke application**, such as use in a flood warning system, the basic conveyance estimation tool had to be available for incorporation into the products of other software engineers and system designers.

The CES has been developed with three main components:

1. The **Roughness Advisor** for estimation of local hydraulic roughness due to surface material, vegetation or irregularities. This includes a major database of vegetation roughness compiled by the Centre for Ecology and Hydrology and not previously made available for flood management. The database also links into the UK River Habitat Survey and will help to link flood risk management with river ecosystem management under the Water Framework Directive.
2. The **Conveyance Generator** for improved calculation of flow conveyance. This makes significant advances in taking account of the complexities of real rivers – for example, shape and sinuosity, and dealing with the separate flood plain and main channel components of flow. The new approach is well suited for modern data management and computing systems.
3. An **Uncertainty Advisor** which provides a measure of confidence in the estimation.

R&D Outputs and their Use

The user products are being delivered as software by agreement with commercial software companies:

1. **CES as a stand-alone software package** through Wallingford Software to solve simple types of conveyance assessment (e.g. for maintenance operations, including backwater calculation module) and to support parameter selection in hydraulic models;
2. **CES currently implemented within iSIS flow and other 1-D hydrodynamic river modelling software**

These are supported by:

3. **Conveyance manual** (R&D Technical Report W5A-057/TR/6) available either as a paper report or for web reference or downloading as a pdf file. The manual will also be available as hypertext in the software packages.
4. **Training material** in the use of the software.

A comprehensive series of Technical Reports has been produced to document and discuss the underpinning science. These reports and other project records are available on the project web site at www.river-conveyance.net as pdf files. Paper copies of these reports are not being produced. They are further supported by the refereed technical papers that have been produced (see list on the project web site).

5. **Inception report** - (R&D Technical Report W5A-057/TR/2)
6. **Data mining - Interim report 1** (R&D Technical Report W5A-057/TR/3)
7. **Review of methods for estimating conveyance - Interim report 2**, including 4 appendices (R&D Technical Report W5A-057/TR/4)
8. **Roughness review** (R&D Technical Report W5A-057/TR/5)
9. **Testing of preferred 1D model - Interim Report 3** (R&D Technical Report W5A-057/TR/7)

Algorithms for the **open source code** (10) for the CES will be available under licence either to bona fide researchers for further development or to software developers for incorporation into commercial river modelling software.

Details of the availability of software and source code will be posted in a further Technical Summary (W5A-059/TS/3). The software will be further upgraded in 2005 to incorporate the Afflux Estimation System.

This R&D Technical Summary relates to R&D Project W5A-057, Phase 2 – Targeted Programme.

The lead funder for this collaborative project was the Defra / EA Joint Flood and Coastal Defence R&D Programme Environment. Scottish Executive, Rivers Agency – Northern Ireland, and the Natural Environment Research Council also contributed funding. Wallingford Software supported the development of new software.

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The above outputs are being made available through different implementation routes. Details of availability of software and open code (Items 1 – 4 and 10 for practitioners and software companies) will be summarised under Technical Summary W5A-057/TS/3. Summary information is posted under R&D Project W5A-057 under the Engineering Theme on the Defra / Environment Agency webpages for the Joint Flood and Coastal Defence R&D Programme (www.environment-agency.gov.uk/floodresearch). Record copies of supporting reports are held by EA Information Centres but otherwise outputs are only available electronically (unless stated otherwise). All the reports and other project records are also available on the project web site at www.river-conveyance.net as pdf files.

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