

# Revitalisation of the FSR/FEH rainfall-runoff model

Technical Summary: FD1913

## Joint Defra / EA Flood and Coastal Erosion Risk Management R&D programme

### Background to R&D project

The FSR/FEH rainfall-runoff method is a widely used tool for design flood estimation in the UK. The method was first documented in the Flood Studies Report (FSR) in 1975, and since then numerous studies have updated and improved the method. The latest revision was the technical restatement of the method published in Volume 4 of the Flood Estimation Handbook (FEH) in 1999. Despite these improvements, the basic model structure and the design estimation package have remained unchanged since the first FSR version. The widespread use of the method has prompted valuable feedback from the user community, including critical observations about existing procedures and areas in need of improvement. The aim of this project was to make improvements to the key components of the FSR/FEH rainfall-runoff method taking advantage of new data, updated analytical techniques and recent advances in computation.

### Results of R&D project

The outcome of the project is a revitalised and improved method for event-based flood modelling in the UK. The modifications include, improved rainfall-runoff modelling techniques and a method for generating design flood events with added emphasis on quantifying the underlying physical flood-generating mechanisms. To improve confidence in the performance of the method, especially at high return periods, extra hydrological data from recent large flood events were collected from catchments throughout the UK and added to the existing flood event archive.

A key part of the project was the development of a new physically-based conceptual rainfall-runoff model, the Revitalised Flood Hydrograph (ReFH) model, for the modelling of flood events. The ReFH model is based on robust hydrological modelling techniques and is considered to be a significant improvement over the existing FSR/FEH model. The ReFH model allows a more direct and transparent quantification of flood-generating mechanisms, and the concept of seasonal variation in soil moisture content and design rainfall is introduced. Based on the results obtained from applying the ReFH model to observed flood events from 101 catchments located throughout the UK, a set of equations was developed allowing users to estimate the model parameters for any catchment in the UK larger than 0.5 km<sup>2</sup>.



Based on the ReFH model, a design method has been developed which allows for the generation of design flood hydrographs through the specification of initial soil moisture content, design rainfall and required return period. Both soil moisture and rainfall are specified on a seasonal basis depending on the degree of urbanisation of the catchment under consideration (summer conditions for urbanised catchments and winter conditions for rural catchments). Validation of the design method confirmed that the method for most catchments is within  $\pm 10\%$  of the peak flow estimates obtained from a statistical analysis of annual maximum peak flow data on the same catchments.

## R&D Outputs and their Use

The Revitalised rainfall-runoff method developed in this study is intended to replace the existing FSR/FEH rainfall-runoff method as detailed in the Flood Estimation Handbook (FEH) Vol. 4, enabling the estimation of design hydrographs for use in hydraulic engineering and flood management. It is anticipated that users of the existing FSR/FEH method, including the Environment Agency, local authorities and consulting engineers, will adopt the ReFH method.

To support the dissemination of the results, a user-friendly spreadsheet implementation of the design method has been developed and will be made available to users via the FEH homepage free of charge. In addition, the Environment Agency has funded a follow-on project to develop a more comprehensive software package, which will allow users to analyse data from observed flood events as well as to conduct reservoir routing studies.

The benefits to Defra/Environment Agency are a framework for event-based flood modelling founded on a more physical consideration of the catchment flood hydrology, and an improved design method. The method will enable more detailed studies of flood hydrology and the underlying flood-generating mechanisms, thereby enhancing flood management on a national basis.

This R&D Technical Summary relates to R&D Project FD1913 and the following R&D output:

- **R&D Technical Report FD1913/TR – Revitalisation of the FSR/FEH Rainfall-Runoff model.** Published January 2006.

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The above outputs may be downloaded from the Defra/EA Joint R&D FCERM Programme website ([www.defra.gov.uk/enviro/fcd/research](http://www.defra.gov.uk/enviro/fcd/research)). Copies are also available via the Environment Agency's science publications catalogue (<http://publications.environment-agency.gov.uk/epages/eapublications.storefront>) on a print-on-demand basis.

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