USER FORUM
THE REVITALISED FSR/FEH RAINFALL-RUNOFF METHOD

Wednesday 11 October 2006
10 am – 4 pm CEH Wallingford

Abstracts:

Setting the Scene – Background to ReFH
David MacDonald (Black & Veatch)

This introductory talk is intended to help set the new ReFH method in appropriate context. The talk provides a personal perspective on some of the key issues that have stemmed from the studies undertaken for the Flood Estimation Handbook. Reference is also made to research projects currently underway, whose findings are likely to have an impact on the existing version of ReFH.

Applications and limits
Thomas Kjeldsen (Centre for Ecology & Hydrology, Wallingford)

The objective of this presentation is to provide background to the development and calibration of the input parameters used by the revitalised FSR/FEH rainfall-runoff method for generation of design flood events. Through a discussion of the issues and constraints confronted by the development team and by providing details of the chosen solutions, the potential applications and limits of the method will be highlighted.

For the ReFH model to be able to generate design flood events of a specified return period, the design input values were calibrated to align the peak flow of the flood hydrographs with the corresponding estimates of peak flow obtained from the FEH statistical method (pooled analysis). As rainfall frequency curves are generally steeper than the corresponding flood frequency curves in the UK and it was decided that a T-year flood should be generated by a T-year design storm, it was necessary to introduce a correction factor (α_T) in the method. The correction factor depends only on the considered return period and was calibrated to a return period of 150 years..

The added emphasis on seasonality required the development of seasonal design rainfall. The project did not allow for development of two new FORGEX type models for summer and winter maximum rainfall. As an alternative a set of summer and winter seasonal correction factors were developed to be applied in conjunction with the FEH DDF model available on the FEH CD-ROM. Through a functional relationship between the seasonal correction factors and SAAR, seasonal design rainfall can be predicted at for any catchment.

In addition to design rainfall, seasonal design values of initial soil moisture content (C_{ini}) were developed. The design values of C_{ini} correspond to the soil moisture content required to produce a flood hydrograph with a peak flow value corresponding to a 5 year return period. The design values of of C_{ini} were found, generally, to correspond to the upper end of the observed values of C_{ini}.

While the ReFH model is generally believed to perform reasonably well on most catchments, attention is drawn to potential problems with regards to application of the method on urbanised and permeable catchments. Finally, a list of issues is presented where it is believed that further research could potentially improve the overall performance of the model.

Comparison of FEH/ReFH - An Example in Deconstructing Uncertainty
Matthew Scott (Halcrow)

Considering the requirements of providing flood extent mapping for the River Lee, a 1500 km^2 catchment draining into the Thames Estuary, an in-depth assessment of the hydrological methods used for a single gauged 40 km^2 sub-catchment will be presented, with additional reference made to the revitalised rainfall runoff method (ReFH). Particular emphasis will be given to a discussion of how to reconcile conflicting evidence, with a focus on understanding model assumptions and sources of uncertainty. Illustrating study results, the presentation will provide a walk-through of uncertainty associated with: the use of AMAX data; statistical frequency analysis; and rainfall-runoff modelling. Conclusions will be offered that seek to establish a set of principles to be applied in deriving design hydrographs for use in flood mapping studies.

Thoughts after 80 applications of ReFH
Duncan Faulkner (JBA Consulting)

This presentation discusses the performance of ReFH on a variety of catchments, including comparisons with FEH methods, and concludes with two aspects of ReFH, one quite hopeful and the other rather worrying.

Around the time that ReFH was released, JBA was asked by Northern Area of the Environment Agency's Anglian Region to develop guidance on choice of method in flood estimation, including a comparison of results from different methods. We tested ReFH and the various FEH techniques on 27 gauged catchments in Northern Area. The results showed what might be expected: compared with peak flows from pooled analysis, the ReFH method generally gives a much closer agreement than does the FEH rainfall-runoff method. On average, ReFH 100-year flows were a factor of 1.19 larger than the pooled estimate, whereas FEH rainfall-runoff flows were 2.60 times the pooled estimate. At only two sites were the ReFH results higher than the rainfall-runoff estimates. However, ReFH was found to underestimate QMED by a long way (almost a factor of 5) on some permeable catchments.

A similar comparison has been carried out at 60 other locations across England and Wales. Averaging over all the locations where we have compared ReFH with other methods, 100-year flows from ReFH have been found to be a factor of 1.39 larger than FEH pooled estimates (all derived from detailed studies). The minimum ratio was 0.58 and the maximum 3.22. The range of ratios for QMED was rather larger, from 0.22 to 3.80, with a mean of 1.30. These findings are generally encouraging, although some appear to contradict validation results from the ReFH research, which show that the 100-year flow from ReFH was within 10% of that from pooled analysis at the majority of sites. This discrepancy should be investigated further.

Most of the above results from ReFH were derived solely from catchment descriptors, although model parameters for some gauged catchments were taken from Appendix F of the ReFH R&D report. In some locations, we decided to alter the time to peak using data from a nearby water level recorder. Although this is non-standard practice (in two senses), we judged that it would give improved results on a steep urbanised watercourse.

One important area of flood estimation where the ReFH method appears to have promise is for long return periods. In particular, there is a demand for 1000-year flood estimates for flood mapping and flood warning studies. The ReFH design procedure was not calibrated for such long return periods, but neither were the FEH methods (how could they have been?) There are reasons for preferring rainfall-runoff approaches when estimating extreme events, and the presentation shows some example results from ReFH which appear sensible.

One area where ReFH is likely to be applied widely is in semi-distributed modelling, i.e. generating inflows from subcatchments feeding into catchment-wide models. This often requires applying a relatively long design storm to several small subcatchments to generate the design event at the downstream end of the catchment. The presentation concludes with some example results for Pennine catchments which show that this technique can lead to overestimation of design flows, particularly on impermeable wet catchments. This appears to be due to the absence of a water balance check within the ReFH model.

ReFH - Dissemination
Matt Fry (Centre for Ecology & Hydrology, Wallingford)

Dissemination of project outputs has been considered an important part of the FD1913 project since initiation. The Environment Agency has funded a separate dissemination project in order to maximise the uptake of the method, and to provide a clear path for delivery of the science. This dissemination is taking place in four ways. Firstly, a technical report from the project has been published and is available from the Defra website. This explains in detail the work undertaken within the research project, including: updating of the flood event dataset; development of the ReFH model; analysis of events; modifications to the design rain inputs; development of the design procedures; and validation. Secondly, a supplementary report to the Flood Estimation Handbook is being created which will provide assistance to the user on application of the method through worked examples. Thirdly, a freely available spreadsheet implementation of the design method has been created by CEH, and has been distributed via the CEH website. This allows users to import FEH CD-ROM catchment descriptors, enter design rainfall parameters, such as event return period, view the default design model parameters and override these if desired, and display results as tables of data and graphs. A print-quality report can be created from the spreadsheet, including a full audit-trail of inputs to the model run. The spreadsheet has been downloaded by over 675 users in the first 9 months of availability. Lastly a full software implementation of the revitalised FSR / FEH rainfall runoff method has been created. In addition to the design aspects of the spreadsheet, this software allows model parameters to be calibrated through baseflow recession analysis and optimisation against observed events. Other additions include antecedent soil moisture modelling, reservoir routing and the capacity to store observed and modelled event data within a database archive. The software runs on Windows with full graphing and reporting functionality. The ReFH Flood Modelling Package will be distributed through Wallingford HydroSolutions, a NERC technology transfer company, which will have the remit to market, sell and support the software. This method of delivery will allow the software to be sustainable, will provide high quality IT and hydrological support, and will encourage the rapid incorporation of future science outputs. The focal point for dissemination of these project outputs is the CEH ReFH webpages: www.ceh.ac.uk\ReFH.