

ReFH User Forum

Held at CEH Wallingford on 11 October 2006

A user forum to discuss initial experiences of applying the revitalised FSR/FEH rainfall-runoff (ReFH) method was held by the Centre for Ecology and Hydrology, Wallingford on 11 October 2006. Over 60 delegates attended the meeting, which took the form of a series of presentations followed by questions and open discussion sessions. This document summarises the discussions that took place during the day. Abstracts of the presentations can be found on the ReFH web page (<http://www.ceh.ac.uk/refh>).

Morning session discussion (Chair – Ann Calver, CEH)

Duncan Faulkner (JBA) asked when the results of further research using the additional raingauges in Scotland would be released. **Thomas Kjeldsen (CEH)** replied that the work was ongoing. The aim was to validate the method in Scotland rather than to modify it since there were insufficient additional data to justify changes to the national method.

Commenting on Matthew Scott's presentation, **Adrian Bayliss (CEH)** pointed out that the FEH recommends pooling because growth curves based on a relatively short record can be misleading. However, in ongoing research CEH were considering new ways of weighting pooling-group members. **Matthew Scott (Halcrow)** replied that in the situation that he had described, following the practice recommended in the FEH could lead to a discontinuity in flood frequency estimates. Furthermore, local residents had questioned the validity of the return periods assigned to recent flood events. **Thomas Kjeldsen** reiterated that early results from an ongoing research project suggested that the current method of assigning weights to pooling-group members should be revised to give more weight to at-site data.

Andrew Pepper (ATPEC) reminded **David MacDonald (Black & Veatch)** that in the design of flood storage reservoirs there was a need to estimate flood volumes as well as peaks. **David MacDonald** replied that the ReFH project had had a limited budget and thus it had not been possible to consider every aspect of the method in detail. For example, the emerging results from Lisa Stewart's current work on long period rainfall (funded by Defra) had not been available to the ReFH team. It was possible that the outputs from this research would suggest that rainfall growth curves should be less steep. In the existing FEH rainfall-runoff method, researchers had found that overall percentage runoff did not increase sufficiently with return period, and this raised questions about flood volumes.

Matthew Scott asked whether the ReFH method recommended the analysis of individual flood events in a similar way to the FSR/FEH method. **Thomas Kjeldsen** replied that this would be included in the demonstration of the new ReFH software later in the day.

Commenting on the question of flood volumes and permeable catchments, **John Packman (CEH)** reported that parts of the ReFH model had been developed using a continuous simulation approach, giving good results on pervious catchments. The

inability of ReFH to estimate flood volumes was not a step backwards, as this had not been possible with the preceding FSR/FEH method. It should be possible to estimate flood volumes using the ReFH model in continuous simulation mode and mean daily river flows from the National River Flow Archive as input. John would be happy to provide further information if required.

Commenting on Matthew Scott's presentation, **David MacDonald** observed that it would be unfortunate if the hard work on re-rating the AMAX series were to be unavailable to future researchers. He was concerned that there should be a way to feed this, and other corrections, back into the HiFlows-UK system so that other users could benefit. **Peter Spencer (Environment Agency)** agreed that it was important to incorporate work such as this. Formal procedures were being setup, but for the time being people could send any such information to him at: peter.spencer@environment-agency.gov.uk.

Duncan Reed (Independent Consultant) It is important to be consistent, as ratings based on hydraulic methods tend to give lower flood estimates.

Peter Spencer (Environment Agency) replied that the results of such studies will depend on the nature of the hydraulics. Where previous work had not allowed for backing-up from downstream controls such as bridges, such decreases might be the case. However, other situations might increase flows – for example, better allowance for floodplain flow could produce significant increases in flow.

Commenting on extrapolation to events of high return period, **Paul Webster (Hydro-Logic)** drew attention to the value of the more process-based approach adopted in the development of the ReFH model. However, the fact that the alpha correction factor was needed should be viewed as a warning that something was not quite in balance.

Afternoon discussion session (Chair – Kate Scott, Environment Agency)

Participants were invited to present one or two slides to facilitate the discussion, following which a wider discussion took place.

Eva Kordomenidi on behalf of David Price (Jacobs) presented one slide with five questions:

- *Has ReFH been officially accepted as a replacement for the FSR/FEH rainfall-runoff method?*

Peter Spencer (Environment Agency) replied with a qualified 'Yes'. There might be particular conditions where FSR methods should either still be applied, or applied with the ReFH method.

- *Is there a ReFH module for ISIS?*

Ruth Clarke (Wallingford Software) and **Matthew Scott (Halcrow)** replied that hopefully it would be included in the next release of ISIS but that this was currently under discussion with CEH. **Matt Fry (CEH)** mentioned that discussions had been held with DHI with a view to including the ReFH method in MIKE 11 products, but the decision currently rested with DHI.

- *For what type of catchments does ReFH not perform well and how is performance measured?*

Peter Spencer The presentations today have identified some of the strengths and weaknesses of the method. Thomas Kjeldsen had plotted the ratio of highest ever recorded to QMED, and on this graph particular types of catchments stood out as having extreme values – including chalk, clay and urban catchments. Any general method such as ReFH could be expected to find such catchments difficult. The current discussion would help to identify where ReFH was performing well and in what situations it was less reliable. **Kate Scott** added that the Environment Agency intended to issue implementation Guidance on the ReFH method in the near future.

- *Can real events be simulated using ReFH?*

The ReFH software as demonstrated by **Matt Fry** would enable the simulation of observed events.

- *Have seasonal issues been experienced when unquestioning acceptance of winter conditions for rural design floods is thought to be wrong?*

Peter Spencer suggested that at present users should follow the guidance in the FD1913 final report about using winter conditions for rural catchments. At present, it was thought there was not enough information for the method to be applied to urban catchments with summer rainfalls. The strict split between the two conditions (rural and urban) had been discussed at some length. One option considered had been to apply both winter and summer conditions, but experience to date suggested that winter always gave the larger flood peak, so that there was little advantage in such an approach. He added that he had applied summer and winter conditions to rural catchments which had experienced famous summer floods, but ReFH winter still gave higher peaks. **John Packman** added that it was unfortunate that the dataset had contained too few summer-critical catchments to gain enough information. **Thomas Kjeldsen** warned of the danger of misinterpreting the significance of the seasonal design inputs and reminded users that the seasonality of individual catchments was determined on the basis of the urbanisation index, URBEXT. **David MacDonald** suggested that the problem of seasonality may be partly addressed by the seasonal rainfall analysis being carried out by Lisa Stewart's team at CEH. **Duncan Faulkner** also advised users to be cautious when using ReFH on urban catchments.

Issues to be addressed in future research

A general discussion formulated a list of issues to be addressed in future research and software as follows:

1. Seasonality of floods
2. Catchment data (with an emphasis on urban catchments)
3. Urban component in model
4. Diagnostics in the ReFH Software such as PR
5. Variable Baseflow Recharge for long events
6. Local data (donor/analogue)
7. Calibration of flood volumes
8. User access to data (both rainfall and flow data)
9. Discontinuity in PROPWET
10. Explore ReFH for high return periods
11. Retain SPRHOST

2. Catchment data

David MacDonald highlighted the need to increase the data we have for urban catchments and suggested that use could be made of data from level stations and results from hydraulic modelling studies.

4. Software diagnostics

Duncan Reed asked whether percentage runoff could be included in the reporting section of the software.

John Packman warned that within ReFH, PR is different to the FEH SPR-based PR as the ReFH rainfall–runoff model includes a larger baseflow component. He added that the reason for PR exceeding rainfall in the model at long durations is that the BR parameter is fixed for all durations, but should ideally be more flexible.

A questioner asked for clarification on what should be considered a ‘long’ or ‘short’ event. This should be defined relative to the normal critical duration for the catchment.

5. Variable BR for long events

John Packman pointed out that it was not ideal that BL and BR should be specified *a priori* but that this had arisen due to the short recessions available during the analysis of events.

6. Local data

Thomas Kjeldsen pointed out that as a user he would like to see guidance for a framework for using donor/analogue catchments.

8. Access to data

Rob Sweet (Scott Wilson) asked about the availability of rainfall data for use in the ReFH software.

Peter Spencer suggested contacting the relevant EA hydrometric teams however he warned that the hydrometric groups should not be swamped by requests for data. There is no method for holding these data within HiFlows-UK at present.

Kate Scott added that developments of the Wiski–Web may enable access but that it was an Agency water resources issue.

Duncan Reed and **Tom Baker (Environment Agency)** noted that rainfall data were freely available in some countries/organisations such as NMI (Norway) and USGS (USA).

9. PROPWET

David MacDonald asked whether the problems of the discontinuity in the PROPWET dataset could be overcome by using alternate dataset such as MOSES.

Adrian Bayliss agreed this was possible but issues of licensing and cost would have to be examined.

Duncan Faulkner reiterated that the issues with PROPWET were a concern because it appears in all of the catchment descriptor equations, but acknowledged that the example (in the Pennines) presented earlier was an extreme case.

10. Testing of ReFH for very extreme events

Lisa Stewart (CEH) highlighted a need to assess ReFH in light of the reservoir safety study which requires design estimates at return periods far higher than 150 yrs.

11. SPRHOST

John Packman pointed out that SPRHOST was not included in the catchment descriptor equations as BFIHOST was derived from a larger dataset and outperformed SPRHOST in the analysis.

Other comments and questions from the session

Matt Fry confirmed that the cost of the ReFH software will be between £750 - £950 for a perpetual licence, with other pricing options available for leasing and support.

John Packman suggested that the continuous simulation approach may provide a basis for examining the effects of land use change.

There was a reminder for users to take the opportunity to feed comments to **Duncan Faulkner** and colleagues at JBA who are preparing guidance on the use of the ReFH method on behalf of the Agency. Users are encouraged to contact Duncan via email.

David MacDonald noted that permeable catchments behave like saturated ones at high return periods, as had been demonstrated in Duncan Faulkner's presentation.

Duncan Reed asked Duncan Faulkner which pooling-group method had been used in his comparison of ReFH and FEH. Duncan confirmed that the WNFAP-FEH method had been used.

Carl Ishemo (BWB Consulting) asked how modelling of large catchments should be disaggregated – i.e. what value of C_{\max} should be used. **Peter Spencer** replied that it is still sensible to identify major geological or land use splits. **Duncan Faulkner** added that the catchment can be split where there is natural inflow, e.g. at a reservoir. He pointed out that the method was not calibrated on catchment areas larger than 500 km² and suggested that the method should be used with caution on catchment areas in excess of this.