



Flood estimation: technical guidance

Reference number: GN008

Document Owner: Flood Risk Management Board

Beth sydd yn y ddogfen?

Mae'r ddogfen hon yn amlinellu argymhellion Cyfoeth Naturiol Cymru (CNC) ar fethodoleg briodol amcangyfrif amlder llifogydd yng Nghymru, yn enwedig o ran perygl llifogydd sy'n gysylltiedig â chynigion datblygu ac amcangyfrif hydroleg llifogydd ar gyfer modelu/mapio perygl llifogydd. Daw pob amcangyfrif llifogydd gydag ychydig o ansicrwydd a'r dadansoddwr sydd â'r cyfrifoldeb am sicrhau bod y llif yn addas ar gyfer y diben a fwriadwyd, yn seiliedig ar y data sydd ar gael, y wybodaeth a'r ansicrwydd.

Fe seilir yr argymhellion ar wybodaeth oedd ar gael ar ddyddiad y cyhoeddi ac efallai bydd yn cael ei ddisodli wrth i ymchwil a chanllawiau ymhellach gael eu cyhoeddi.

What is this document about?

This document outlines Natural Resources Wales (NRW) recommendations on appropriate methodologies for flood frequency estimation in Wales, particularly in respect of flood risk associated with development proposals and flood hydrology calculation for flood risk mapping/modelling. All flood estimation comes with a degree of uncertainty and the responsibility to ensure that the estimated flows are fit for the intended purpose remains that of the analyst, based on a consideration of the available data, information and uncertainty.

These recommendations are based on information available to us at the date of the publication and may be superseded as further research and guidance are published.

Who is this document for?

- Hydrology teams
- Flood Risk Analysis teams
- Development Planning teams
- External organisations e.g. councils, contractors

Contact for queries and feedback

If you have any questions regarding this guidance please contact us via email.

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Croesewir gohebiaeth yn y Gymraeg a'r Saesneg / Correspondence welcomed in both Welsh and English.

Version History

Document Version	Date Published	Summary of Changes
1.0	December 2017	Published, superseding Flood Estimation Good Practice Guide (GPG102)
Review Date: December 2019		

Spotted a problem? Let us know at
guidance.development@cyfoethnaturiolcymru.gov.uk

Background

The Flood Estimation Handbook (FEH) is the industry standard methodology for flood frequency estimation in the UK. The two principle techniques detailed in the FEH (and supplementary reports) are the Statistical method and the Revitalised Flood Hydrograph method (ReFH).

During the past two years, there have been several updates to flood estimation methodologies, through new versions of the recognised software and published research. These are summarised below:

- Wallingford HydroSolutions released an updated version of the ReFH method in 2016, called ReFH2. The latest version of the software is ReFH2.2 and it incorporates improved science and supports use of the new FEH2013 rainfall model, developed by the Centre for Ecology and Hydrology (CEH).
- The research project *Making better use of local and historic data, and estimating uncertainty in FEH design flood estimation (FEH Local)*, SC130009¹ output was published in February 2017. It includes a number of supplementary methods to improve the standard Statistical and Rainfall Runoff approaches.
- Wallingford HydroSolutions recently released an updated version of the software used for the Statistical method, called WINFAP-FEH version 4 (WINFAP4). This includes a number of changes to the estimation process, including some of the recommendations from the research project *Making better use of local and historical data in flood frequency estimation (FEH Local) SC130009*. A summary of the updates in WINFAP4 can be found on the Wallingford HydroSolutions website².

We have reviewed the new methodologies and have a number of recommendations regarding their use in Wales. This provides a timely opportunity to clarify our general position on flood peak estimation methodologies and how both pieces of new software fit in. These recommendations should be used in conjunction with the most recent version of the Environment Agency (EA) Flood Estimation Guidelines and the 'FEH Local' technical guidance *Using Local Data to Reduce Uncertainty in Flood Frequency Estimation*³.

Recommendations

Method selection

Our preferred approach for estimating peak flows up to and including the 100 year return period is the FEH Statistical method, using the latest methodologies.

Peak flows for longer return periods should be estimated using the "ratio" method, whereby the flood growth curve from ReFH2.2⁴ is applied to the 100 year estimate from the FEH

¹Summary and report are available to download here: <https://www.gov.uk/government/publications/making-better-use-of-local-data-in-flood-frequency-estimation> and Technical Guidance is available from enquiries@environment-agency.gov.uk

² <http://www.hydrosolutions.co.uk/products.asp?categoryID=10838>

³ Both available from enquiries@environment-agency.gov.uk

⁴ Wherever ReFH2.2 is referred to in this document, it should be read as 'ReFH2.2 and later software versions which use the same methodology'.

Statistical method. For example, to derive the 1000 year estimate, the ratio of the 1000 year to 100 year ReFH2.2 estimates, is multiplied by the 100 year estimate from the FEH Statistical method. The resulting flow estimates should be compared to absolute values calculated by Statistical and ReFH2.2. ReFH2.2 should be used with the FEH2013 rainfall model, not the FEH1999 rainfall model.

There may be occasions when it is appropriate to use either the FEH Statistical method or ReFH2.2 method for all return periods. In such cases, the onus will be on the analyst to justify which is the more appropriate method. Choosing one methodology over another simply because it provides higher or lower estimates is not appropriate.

Local and/or historical flood data should be used where available to improve estimates. For the highest risk developments, flood history research should be extended to include Paleofloods. Further information can be found in other documents such as the FEH, the EA Flood Estimation Guidelines and the 'FEH Local' report and guidance.

Adjusting the median annual flood (QMED) using local data

When adjusting catchment descriptor QMED using data from donor gauging stations, WINFAP4 defaults to using six stations, as recommended in the latest research (Kjeldsen et al, 2014)¹.

The selection of the six stations is based purely on geographical distance from the subject site and takes no account of catchment similarity (as set out in the FEH) or other factors. Therefore, it is important that analysts review and amend the stations selected, accounting for catchment characteristics, hydrological similarity, river network, data quality and record length. In addition, it is noted that there is no requirement for six stations to be used and in most cases just one or two stations will be of sufficient similarity and proximity to the subject site to be preferred.

In WINFAP4 the catchment descriptor QMED can be adjusted using urbanised donor stations by de-urbanising the gauged QMED. Whilst it is preferable to use rural stations as QMED donors, there will be some locations where it is appropriate to adjust the QMED using more local urban donors rather than more distant or less similar rural donors.

Flood Growth Curve Estimation

WINFAP4 allows analysts to include urbanised stations in pooling groups and enhanced single site analysis (ESS), by de-urbanising flood growth curves. As this increases the number of stations from which the pooling and ESS groups are drawn, it will result in a pooling group which (apart from urbanisation) is more similar to the subject site.

Analysts should change the pooling group urban threshold from the default value of 0.03 to 0.3 (even if the subject site is not urbanised): This will mean the pooling group will include all but the most urbanised stations (where the uncertainty in the effects of urbanisation are higher, due to the small sample size and greater potential for effects of local features). As with other catchment characteristics, it is possible that the urban catchments will have local features which mean it is not appropriate to use them in pooling or ESS groups, so as

¹ Kjeldsen, T. R., D. A. Jones, and D. G. Morris (2014), Using multiple donor sites for enhanced flood estimation in ungauged catchments, *Water Resources. Res.*, 50, 6646–6657, doi:10.1002/2013WR015203.

always, the pooling group should be reviewed with reference to the National River flow Archive (NRFA)¹.

Urban Catchments

ReFH2 methodology improves on ReFH1 methodology for flood estimation in urban catchments, with the urban and rural components of the hydrograph being calculated separately. There is currently insufficient evidence to determine whether ReFH2 or the Statistical method is the most robust method of flood estimation in urban catchments.

For the time being, it is recommended that peak flows in urban catchments are estimated using both the Statistical and ReFH2 methods (using local data where available) and the results compared. If the results are not in broad comparison then the analyst should apply professional judgement to determine which method is considered to be most appropriate.

Changes have been made to the QMED urban adjustment process in WINFAP4 which improve upon the previous method, especially in permeable catchments.

Plot-scale runoff calculations

The Statistical, ReFH2 and the IH124 methods are identified in the SuDs Manual (CIRIA 2015)² as appropriate to use for estimating plot-scale runoff:

- Greenfield runoff rates - Statistical method or ReFH2 (NRW prefer use of the Statistical method, due to its direct use of gauged flow data)
- Pre-developed runoff rates - ReFH2 or IH124

Further information on surface water management can also be found in the document *Recommended non-statutory standards for sustainable drainage (SUDS) in Wales* (Welsh Government, 2016)³.

Flood estimation calculation record

When submitting fluvial flood estimates to us for review, they must be presented in a clear and auditable format. We recommend use of our Flood Estimation Calculation Record⁴.

Software Versions

We recommend that new analyses use:

- WINFAP4 for the Statistical method, so that the new features and outputs from the 'FEH Local' project can be easily applied.
- ReFH2.2 with the updated FEH2013 rainfall model. We may not approve estimates that utilise ReFH1, or earlier versions of ReFH2 with the FEH1999 rainfall model.

Ongoing Research

The advice and recommendations presented in this document may be superseded by the results of ongoing research, which includes a project by Joint Flood and Coastal Erosion

¹ <http://nrfa.ceh.ac.uk/data/search>

² https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

³ <http://gov.wales/topics/environmentcountryside/epq/flooding/drainage/?lang=en>

⁴ GN008 FORM 1: Flood Estimation Calculation Record. Available from our website or from datadistribution@cyfoethnaturiolcymru.gov.uk

Risk Management Research and Development Programme¹, *Estimating flood peaks and hydrographs for small catchments (Phase 2) SC090031*.

¹ <http://evidence.environment-agency.gov.uk/fcerm>