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book reviews

***Weather Typing-Based Flood Frequency Analysis Verified for Exceptional Historical Events of Past 500 Years Along the Meuse River* [in:] *Water Resources Research*, J. De Niel, G. Demarée, P. Willems, 2017, Belgium, AGU Publication, 16pp.**

Almost a year ago now there appeared this work by a team of Belgian authors from the Department of Civil Engineering of the Catholic University in Leuven, in collaboration with the Brussels-based Royal Meteorological Institute of Belgium. The authors had taken on the challenge of giving effect to guidelines set out in the "EU Floods Directive" (Directive 2007/60/EC on the assessment and management of flood risks). As the authors note on page 1, following the several flood events that have been observed recently across Europe, there can be no doubt as to the need for assessment – via proper mathematical modelling – of common flood hazards and flood risk procedures.

Cause-and-effect assessment has therefore been carried out in relation to the frequency of occurrence of peak high-water events along Belgium's most important river – the Meuse. This is a transit river flowing through France, Belgium and The Netherlands (as the Maas), while parts of the basin are also in Germany. The task involved here has been the collection of data to allow a period extending to 500 years to be considered.

The historical recording provides for the extrapolation of values for annual flow, and hence for assessments of the probability that risks will arise in relation to water levels and flows noted along the river at the three hydrological profiles at Borgharen (on the Belgian-Dutch border), as well as Grave and Lith on the Maas. The immediate aim of the studies carried out was to incorporate meteorological information (on weather type, as represented by a number generator drawing on such varied elements as pressure and precipitation, wind speed and direction, and the types and directions of air mass categorised in relation to 10 circulation types).

A key cognitive element here is the methodological aspect to the research, which allows use to be made of series of differing lengths relating to water levels and maximum daily discharges, with a view to assessing the probability of occurrence of flood risk, in line with accepted threshold probability values for exceedance (in categories 0, 1, 2 or 3) generated digitally.

A major source of interest here is the use made of historical data, e.g. on water levels along the river in the pre-industrial period, as well as in the mid-19th century, thanks to measurement of flows at mills. The outcome takes the form of functions illustrating the dependent relationship between water levels and flows, with periodically-changing consumption curves generated.

Also interesting is presentation in the form of synthetic figures allowing for verification of the distribution of maximal annual discharges over the 500-year period, as well as for an assessment of the sensitivity of the available data within the accessible time framework, with indications as to the probability distribution given, particularly in the diagram's oldest, extrapolated "tail".

It proved possible for the authors to categorise high-water events and maximal flood levels annually in line with meteorological causes giving rise to them, especially in relation to atmospheric circulation from the NW, N, NE, W or E, anticyclones, or else from the SW, S, SE, cyclones; in relation to exceedance probabilities. In the case of the latter, account was taken of four categories of stochastic Q_{maxp} values, by reference to the Bayesian Information Criterion as well as the Generalised Pareto Distribution (GPD). Exceedance probabilities relate to intervals for empirical values of flow along the river ranging from 10^{o} to $!0^{-2}m^{3}/s$.

Different positionings of the aforementioned "tail" as regards the behaviour of variable values for extreme annual discharges were tested in relation to the Grave profile, with use made of GRADE (the **G**enerator of **R**ainfall and **D**ischarge **E**xtremes for the Rhine and Meuse basins),making stochastic calculations to estimate empirical return periods of more than 10 years.

The authors also consider the uncertainty associated with their statistical estimates in line with available data, and their reliability when set against the traditional approach. Assessment of return periods of maximal annual discharges is a complex matter dependent on the precision of empirical data and extrapolation models, as well as methods of determining the probability of exceedance in a random configuration.

A modern, but tried and tested, approach has been used in reconstructing and assessing the position of the "tail" in determining the functions of deterministic/stochastic co-dependence governing maximal discharges in different years in the past, and also in the future.

The research here makes reference to 73 published works appearing between 1703 and 2015 in English, French and Flemish. It should be stressed that most of these offer a rich empirical base of knowledge, as well as insight into the modern methodological approach allowing challenges set to be addressed thanks to the achievements of contemporary statistics, as well as stochastic hydrology. A pity such an accomplished research team did not also seek to illuminate the influence of climate change on the risk of given annual peak-flow events arising throughout the Meuse Basin and its sub-parts. It would anyway be well worth the while of hydrologists and climatologists to acquaint themselves better with the solutions applied here, as they seek to estimate the frequency of occurrence of peak high-water events along other large rivers.

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