



Flood risk mapping in an uncertain world

Water engineering and management

By allowing for uncertainty in flood maps, we enable more robust decision making in flood risk management.

The appraisal of flood risk management options is better informed by reference to probability-depth maps which consider natural variability and uncertainties in our knowledge and natural variability.

Similarly, the use of flood maps to support development control decisions is more dependable where the user has an appreciation of the underlying uncertainties and is able to communicate this to other stakeholders, such as developers.

Our approach

At Halcrow, we enjoy working with our clients to continually drive innovation in flood risk management. Through understanding our client's needs, we have developed practical approaches to flood risk mapping which explicitly allow for uncertainty.

Our flood risk mapping experts are well qualified to recognise and advise on the treatment of uncertainty in flood modelling and mapping. We maintain close relationships with several academic departments across the UK and actively seek to disseminate latest thinking through contributing papers and presentations to relevant journals and conferences.

We also maintain our own research and development programme, which includes projects related to flood risk management, such as our innovative knowledge portal, developed as part of our CanuteDS project.

Our approach is to allow for the treatment and communication of uncertainty in flood risk maps. Keeping client needs in mind, we strive to develop methods that are practical, transparent and robust.

By listening to our clients, we have successfully developed and implemented innovative methods and tools to produce probabilistic flood maps (eg probability-depth grids), facilitating more detailed appraisal of flood risk management (FRM) options.

We have also developed a tiered approach to assessing and communicating uncertainty in flood extents.

Halcrow's areas of flood mapping expertise include:

- flood mapping using one and two-dimensional model outputs
- depth-probability and probability-depth mapping
- using flood maps to appraise FRM options
- mapping residual risk from defence failure
- combining flood maps from different sources
- communicating uncertainty in flood maps
- spatial coherence and joint probability
- tailor-made methods of uncertainty analysis
- application of Monte Carlo and Bayesian methods

Flood mapping and uncertainty: case studies

■ Thames Estuary 2100 – modelling for appraisal

The Environment Agency commissioned Halcrow to refine and apply our innovative and practical probabilistic modelling framework, initially developed as part of an earlier stage of the same project, to support the final appraisal of options for the Thames Estuary 2100 flood risk management plan.

The framework includes an integrated approach to analysing and allowing for uncertainties, providing the client with a better understanding of residual risk for each option. The probabilistic treatment and adjustment of input variables (e.g. model boundaries and defence fragility) is accommodated by the framework. The method of hydraulic modelling includes a new conceptual approach to estimating the combined contribution of flood risk from breaching, overtopping and mechanical failure of flood defences (eg moveable barriers). Water levels are modelled using Halcrow's ISIS software (in the river) and TUFLOW (for the floodplain).

The principal outputs from the study are depth probability grids and water levels. Water levels were then used to calculate direct property damage while the depth-probability grids were applied to calculate social and environmental impacts, as well as annualised risk to life and the number of injuries from flooding. The project was successfully delivered within a very challenging timeframe.

■ Communicating uncertainty in flood maps

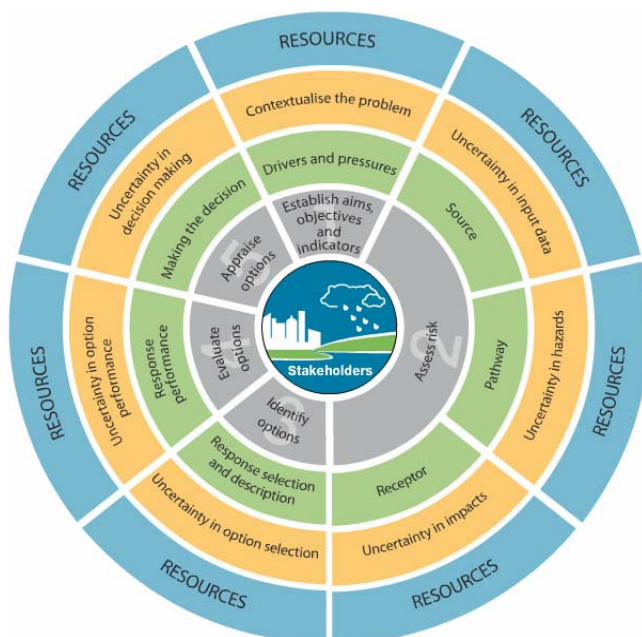
Traditionally, predictive flood mapping has presented a single contour defining the limit of flooding for a particular event. This type of mapping fails to communicate to users the potentially significant uncertainty inherent in those flood limits.

The Office of Public Works in Ireland identified a need to assess and communicate uncertainty in its flood maps. Such assessments are not commonly carried out as there are technical issues associated with estimating the uncertainty, particularly after the flood maps have been produced. There are further issues with how to communicate the uncertainty to stakeholders and users.

Halcrow's flood risk mapping experts used their knowledge of flood risk mapping and uncertainty analysis to work with the client to develop a tiered approach to quantifying uncertainties in its flood maps, and developed simple but effective ways to communicate this.

We developed a sequence of methods, moving from computationally intensive Monte Carlo analysis (tier one), through to a quantitative method, requiring two additional model simulations (tier two) and a much simpler qualitative method (tier three). The tier two and three methods can be calibrated on the method in the tier above. Thus, Monte Carlo Analysis was first applied to a single test site and used to calibrate the tier two quantitative method, which was then applied to a larger number of test sites. The tier three method, along with mapping and visualisation tools, provides a rapid uncertainty mapping method which the client can apply with the minimum of extra modelling effort. Uncertainty in flood extents was communicated using different line styles around the flood extent.

Halcrow's CanuteDS Knowledge Portal



Contact us

- **Luke Lovell** – Swindon
tel +44 (0) 17 9381 6621
email LovellL@halcrow.com
- **Jon Wicks** – Swindon
tel +44 (0) 17 9381 6476
email WicksJM@halcrow.com
- **Jenni Godsland** – Leeds
tel +44 (0) 11 3220 8141
email GodslandJ@halcrow.com
- **Pascal Lardet** – Edinburgh
tel +44 (0) 13 1272 3300
email LardetP@halcrow.com

For details of your nearest Halcrow office, visit our website at halcrow.com