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Overcoming complexities for consistent, continental-scale flood mapping

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The EU Floods Directive requires all member states to produce flood hazard maps by 2013. Although flood mapping practices are well developed in Europe, there are huge variations in the scale and resolution of the maps between individual countries. Since extreme flood events are rarely confined to a single country, this is problematic, particularly for the re/insurance industry whose exposures often extend beyond country boundaries. Here, we discuss the challenges of large-scale hydrological and hydraulic modelling, using our experience of developing a 12-country model and set of maps, to illustrate how consistent, high-resolution river flood maps across Europe can be produced. The main challenges addressed include: data acquisition; manipulating the vast quantities of high-resolution data; and computational resources.

Our starting point was to develop robust flood-frequency models that are suitable for estimating peak flows for a range of design flood return periods. We used the index flood approach, based on a statistical analysis of historic river flow data pooled on the basis of catchment characteristics. Historical flow data were therefore sourced for each country and collated into a large pan-European database. After a lengthy validation these data were collated into 21 separate analysis zones or regions, grouping smaller river basins according to their physical and climatic characteristics. The very large continental scale basins were each modelled separately on account of their size (e.g. Danube, Elbe, Drava and Rhine). Our methodology allows the design flood hydrograph to be predicted at any point on the river network for a range of return periods.

Using JFlow+, JBA's proprietary 2D hydraulic hydrodynamic model, the calculated out-of-bank flows for all watercourses with an upstream drainage area exceeding 50km2 were routed across two different Digital Terrain Models in order to map the extent and depth of floodplain inundation. This generated modelling for a total river length of approximately 250,000km. Such a large-scale, high-resolution modelling exercise is extremely demanding on computational resources and would have been unfeasible without the use of Graphics Processing Units on a network of standard specification gaming computers. Our GPU grid is the world's largest flood-dedicated computer grid. The European river basins were split out into approximately 100 separate hydraulic models and managed individually, although care was taken to ensure flow continuity was maintained between models.

The flood hazard maps from the modelling were pieced together using GIS techniques, to provide flood depth and extent information across Europe to a consistent scale and standard.

After discussing the methodological challenges, we shall present our flood hazard maps and, from extensive validation work, compare these against historical flow records and observed flood extents.