Flood Modeller Pro

Case Study

Developing a national surface water flood map for Scotland, UK

The Scottish Environment Protection Agency (SEPA) has used the 2D FAST solver to produce, for the first time, a national surface water flood map to cover the whole of Scotland (78,000 km^2). This is referred to as the national pluvial flood map for Scotland and is one component of a programme of work by SEPA to respond to the 2009 Flood Risk Management (Scotland) Act.

The national pluvial flood map complements the fluvial and coastal national maps already available to SEPA to inform the preliminary Flood Risk Assessment, which will in turn enable determination of the areas at significant flood risk, and inform the requirements for future detailed flood risk mapping.

The project was delivered in two phases. The first phase involved data collection and method development together with trial application to a pilot area. The second phase involved application of the method to the whole of Scotland and reporting on this.

Overview of flood mapping approach

During phase 1 of the project, a range of calculation methods and data options were assessed for a pilot area which covered Glasgow and the Clyde and Loch Lomond catchments (total area: 3917 km^2) in western and central Scotland. The selected method consisted of 4 calculation blocks:

- Preparation of the Digital Terrain Model
- Preparation of rainfall data
- Flood spreading using the 2D FAST solver
- Processing of results

Preparation of the Digital Terrain Model (DTM)

The NextMap SAR (Synthetic Aperture Radar) DTM was the most accurate readily available national terrain data set and therefore was used. The data provides a representation of the 'bare earth' (i.e. without buildings and vegetation canopy) ground levels on a 5m grid resolution. During the DTM preparation the dataset was modified based on OS Vector Map to include an approximate representation of building thresholds by increasing ground levels by 0.3m within building footprints.

Preparation of the rainfall data

Representation of rainfall is based on the Depth-Duration-Frequency (DDF) model of the Flood Estimation Handbook (FEH). Rainfall was processed using a 100m resolution urban/rural classification of the country to generate a 100m grid of effective rainfall. Based on trials on the pilot region and literature survey, rainfall data was prepared for three rainfall scenarios: 30 year rainfall return period, a 200 year rainfall return period, and a 200 year rainfall return period with 20% increase for climate change.

Flood Modeller Pro can be used for a range of applications, including:

- 1D and 2D floodplain modelling
- Floodplain mapping
- Flood forecasting
- Hydrological analysis
- Embankment/levee failure
- Dam-breach analysis
- Options' appraisal
- Detailed design
- Structure blockage

Contact us

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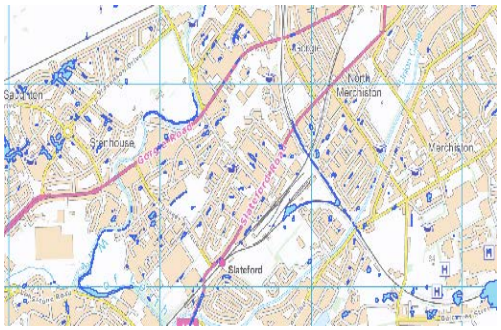
With a legacy stretching back 40 years, Flood Modeller allows users to model rivers, floodplains and urban areas, using our powerful 1D and 2D solvers.



Example pluvial flood map (Ordnance Survey data © Crown copyright and database right 2010)

The above image shows a street in Glasgow where predicted pluvial flooding shows good agreement with the post event flood report data (which identified Loch Achray Street as having been subjected to extensive internal and external flooding).

Under each of these scenarios, a further distinction was made for urban and rural areas taking into account representative percentage runoff, storm duration and sewer capacity for each land use.

Flood spreading using the 2D FAST solver

The use of the 2D FAST solver to simulate the pluvial flood spreading process is a core component of the method. The 2D FAST solver uses simplified hydraulics to spread water over a DTM. Its high computational efficiency, robustness (numerical stability), and volume conservative approach (which focuses on identifying ponded areas) makes it suitable to identify risk of flooding from pluvial sources.

Flood spreading was carried out using a set of about 4,000 models per rainfall scenario (each model representing a hydrological catchment). The total simulation run time for the whole of Scotland is under 48 hours per rainfall scenario.

Processing of results

The simulation for each rainfall scenario produced a GIS file (raster grid) of pluvial flood depths for each catchment at a 5m grid resolution. These results were then processed to remove small ponded areas (<200 m2), apply flood depth thresholds of 0.1m and 0.3m, and generate polygon GIS files of flooded areas for the two depth thresholds aggregated for the whole of Scotland.

Results

The project deliverables consist of six sets of GIS polygon ‘shapefiles’ identifying the areas predicted to be susceptible to pluvial flooding for the three rainfall scenarios with depth thresholds set at 0.1m and 0.3m. In addition, GIS raster grids of simulated pluvial flood depth at a resolution of the 5m x 5m cells (consistent with the DTM data) were delivered thresholded at 0.1m and 0.3m. Validation of the simulated pluvial flood outputs was undertaken using three approaches:

- Comparison with historical observed pluvial flooding data
- Comparison with results generated by other, more detailed, methods
- ‘Sensibility’ checks, for example to identify non-physical behaviour

The comparison data sets identified during the project that were relevant, reliable and available for use included the following information: (a) post flood event report on Glasgow East End flooding of 30 July 2002, (b) selected interim results (March 2011) from the modelling for the Glasgow Surface Water Management Strategy which used a detailed integrated surface-drainage model and LiDAR data.

The qualitative assessment undertaken confirmed that the method provided satisfactory results for identification of areas susceptible to pluvial flooding influenced by topography (as represented in the DTM) at national and regional scales.