Real time 2D urban flood forecasting: a case study

July 2014

JBA trust

Newcastle University School of Civil Engineering & Geosciences

In recent years 2D flood models have been applied routinely in the UK, but not for real time forecasting, where fast and robust models are essential. Meanwhile several groups have developed 2D models designed to achieve shorter run times.

One strategy is to deploy fast Graphics Processing Units (GPUs) as parallel co-processors to speed up the model code.

This case study tested a GPU-based 2D model, JFlow+, in a real-time forecasting context for a flood event that happened on 28 June 2012, in Newcastle-upon-Tyne, North East England.

After this event, Newcastle University gathered photographic evidence about the depth of flood water. We looked at data from four city centre locations

Forecast and actual rainfall data

Four rainfall forecasts (produced at different lead times, see below) were tested, along with estimates of the actual rainfall from weather radar and from rain gauges.

Depth estimated at van bumper approx 0.5m

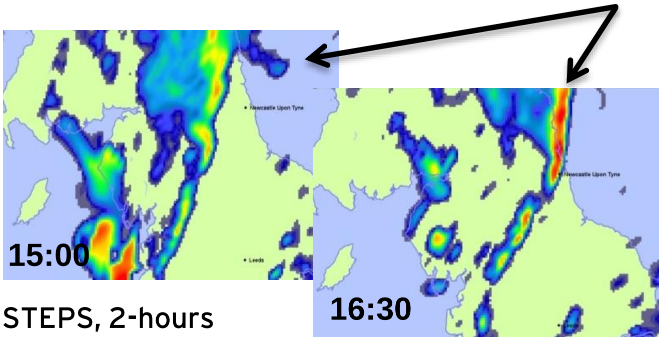
Lead time (hours ahead of forecast outputs) **Time of forecast flood event**

6 — 2 — 1 — 0.5 — 0

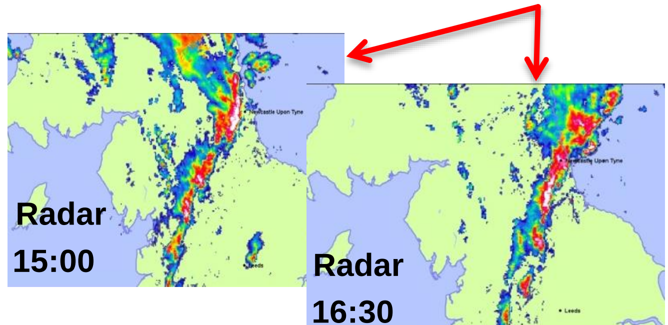
Numerical Weather Prediction (NWP) forecasts for 36 hours into future, made every six hours

Short Term Ensemble Prediction System (STEPS) forecasts for six hours ahead, made every 30 minutes

Radar and rain gauge estimates in real time



STEPS, 2-hours ahead forecasts



Radar, real time

The research described here is based on a study completed by Marion Duprez as part of her MEng in Civil Engineering at Newcastle University. Marion's work was supported by her supervisor Dr Vedrana Kutija and I-Hsien Porter of JBA Consulting's Newcastle office. We are grateful to the Met Office, CEH and Environment Agency for access to data. JBA Trust project W13-5610

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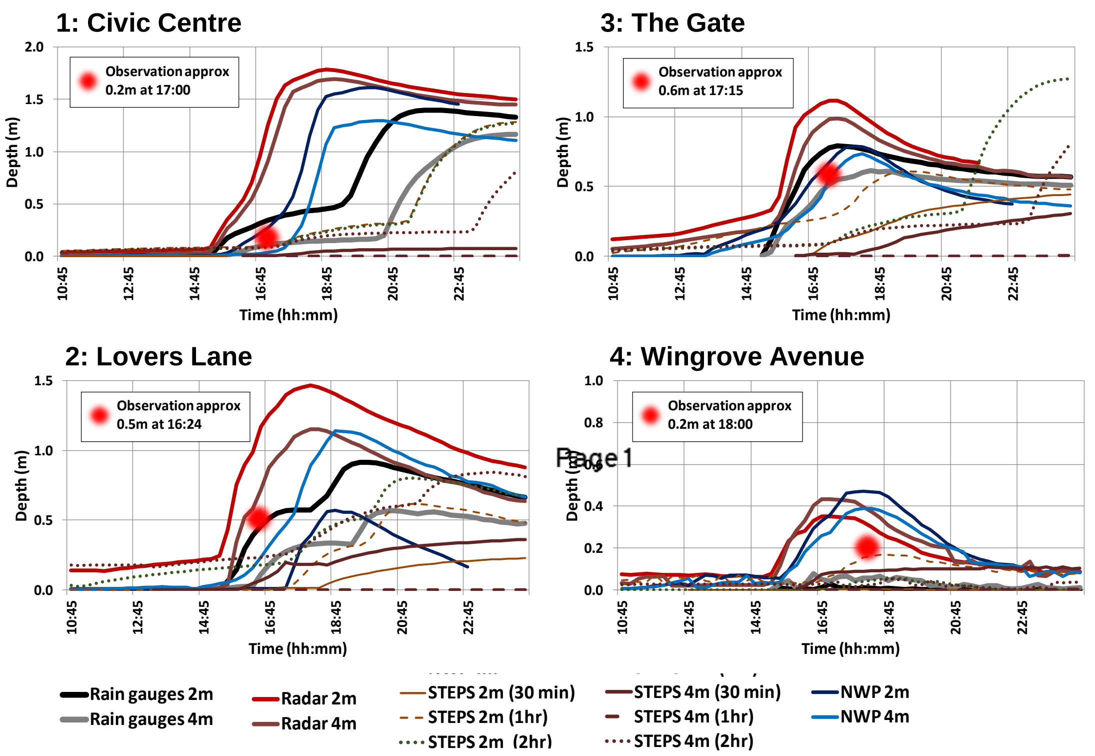
Results are shown for each rainfall input and for two spatial model resolutions, 2m and 4m. Buildings were included in the DTM, and the rain gauge inputs were adjusted to represent drainage systems, both using the methods applied for the Environment Agency's national flood maps for surface water.

The radar data and forecast products did not include a drainage adjustment. Observations are shown as fuzzy data in view of uncertainties in photo interpretation.

Model results at the observation points



The STEPS rainfall forecasts were slightly inaccurate spatially, leading to generally shallower and later flooding predictions.

Predictions based on NWP and radar were deeper than those based on rain gauge data, but this difference would be reduced if the rainfall forecasts were also adjusted to account for drainage.

At six hours ahead the NWP-based forecast could potentially indicate likely areas and approximate timing of flooding, although local terrain and drainage systems mean the modelled flood depths should not be treated as precise predictions.

Run times: Newcastle city centre 2D model (13km^2)

Model grid cell size (m)	Number of cells	Computer time taken to simulate X hours of event time using desktop PC and consumer GPU			
		X = 3 hrs	X = 6 hrs	X = 12 hrs	X = 24hrs
2	3,260,238	26 min	1h 1m	2h 18m	4h 44m
4	815,060	4 min	9 min	20 min	41 min

2D model run times are becoming comparable to operational requirements for early warnings as technology advances.