Professor Paul Bates

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# Developing whole city flood models

The LISFLOOD-FP code

University of BRISTOL

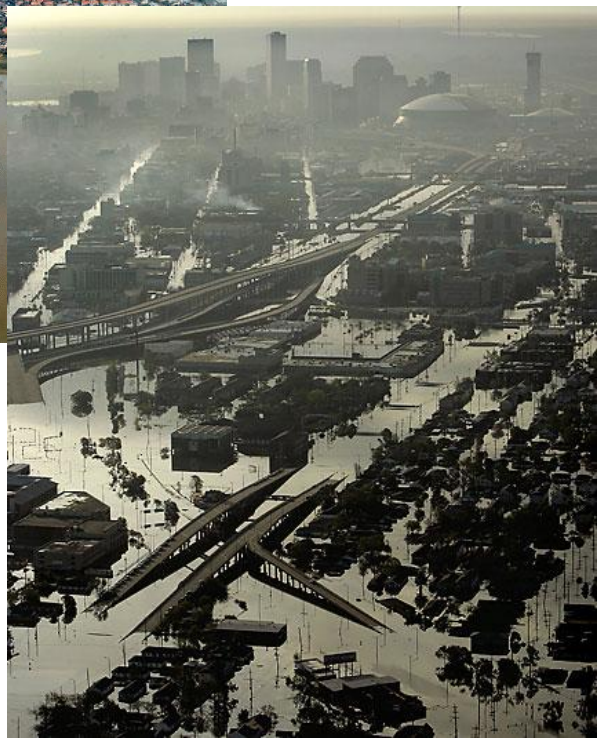
# Support


- This research supported by ….
  - Willis Research Network
  - NERC PhD to Bristol, CASE with Willis Re.
  - NERC DEMON consortium (part of Storm Risk Mitigation programme)

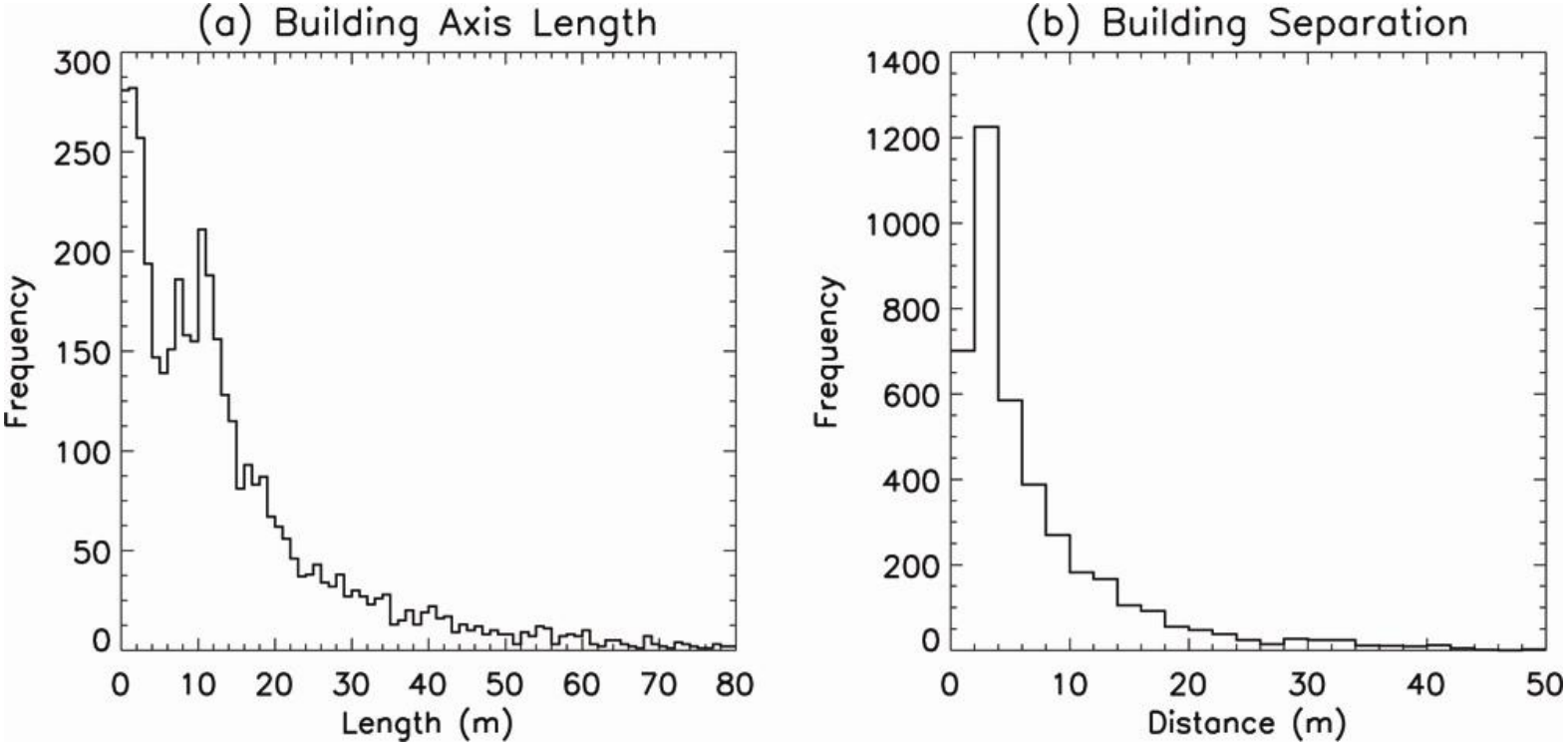
- Previous LISFLOOD-FP investment ….
  - EPSRC Flood Risk Management Research Consortium Phases I and II
  - NERC Flood Risk from Extreme Events programme


… although getting model development funded has been tricky!

# Urban flooding

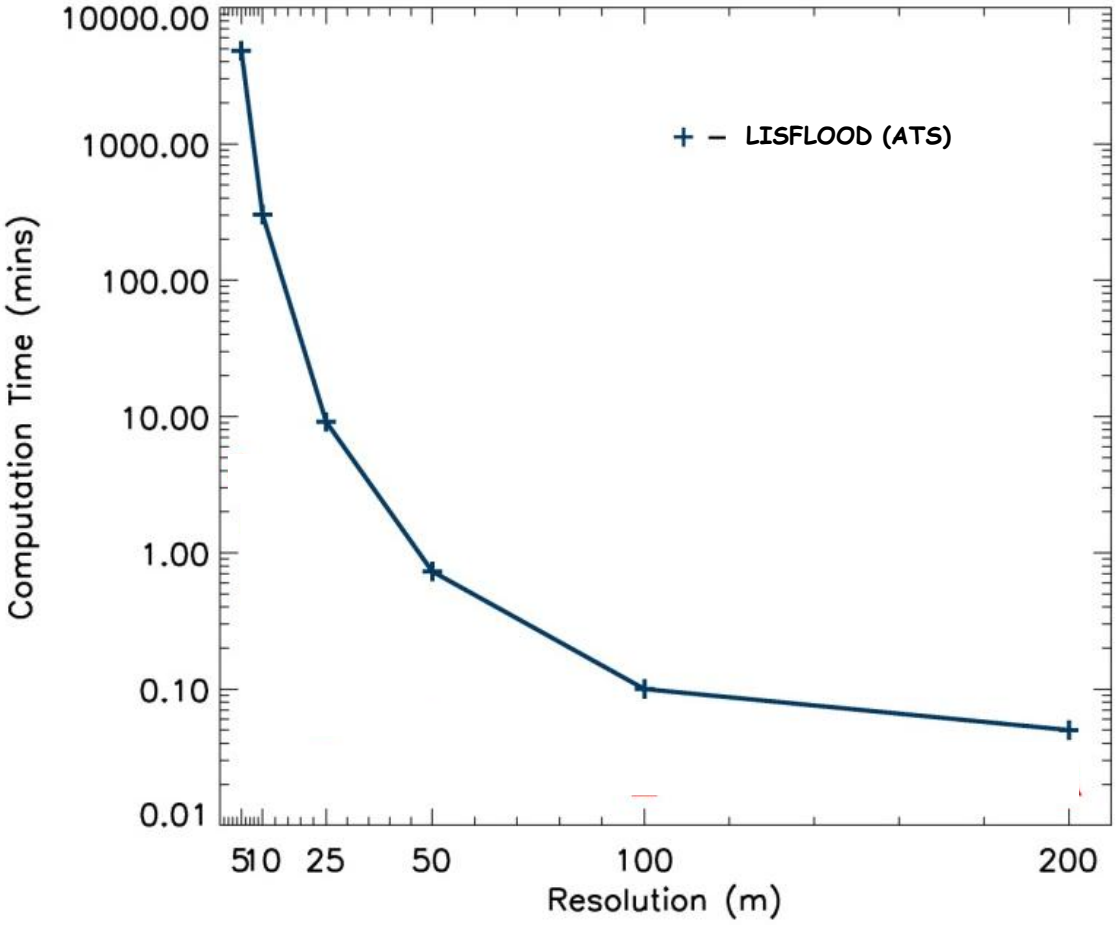


# How much detail do we need?




Fewtrell, T., Bates, P.D., Horritt, M. and Hunter, N. (2008). Evaluating the effect of scale in flood inundation modelling in urban environments. Hydrological Processes, 22, 5107–5118.

# Can we model at this scale?




50m = ~1 ($10^0$) min

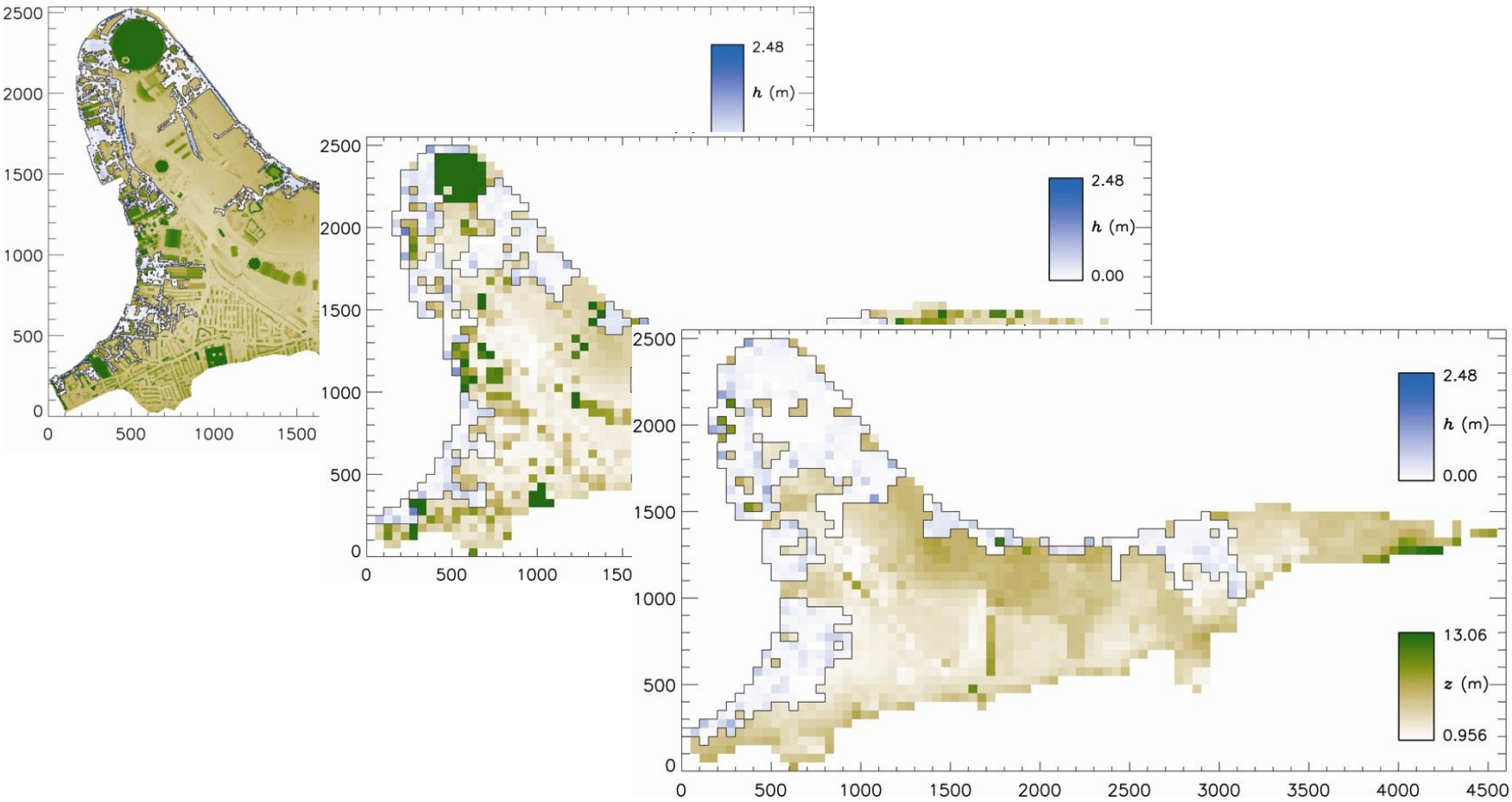
25m = ~10 ($10^1$) mins

12.5m = ~100 ($10^2$) mins

1m = $10^6$ mins or ~70 days

# Current workarounds?

- Current models are generally run at coarse resolution



# New LISFLOOD-FP formulation

## Continuity Equation

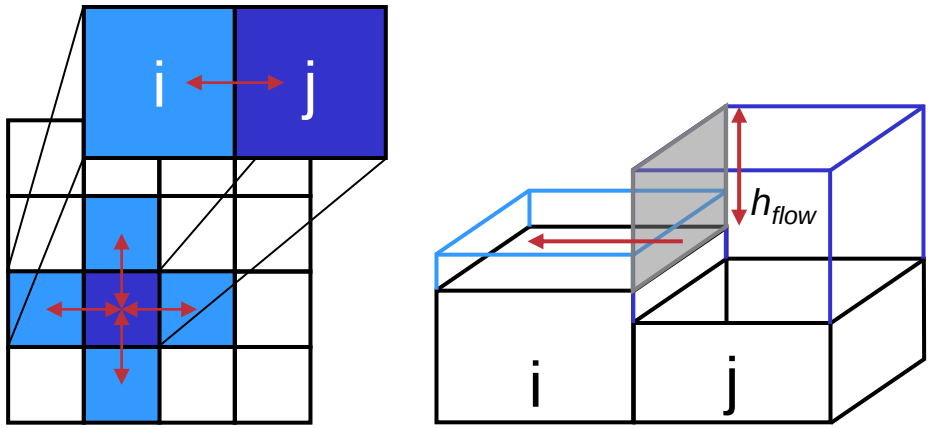
Continuity equation relating flow fluxes and change in cell depth

$$\frac{\Delta h^{i,j}}{\Delta t} = \frac{Q_x^{i-1,j} - Q_x^{i,j} + Q_y^{i,j-1} - Q_y^{i,j}}{\Delta x^2}$$

## Momentum Equation

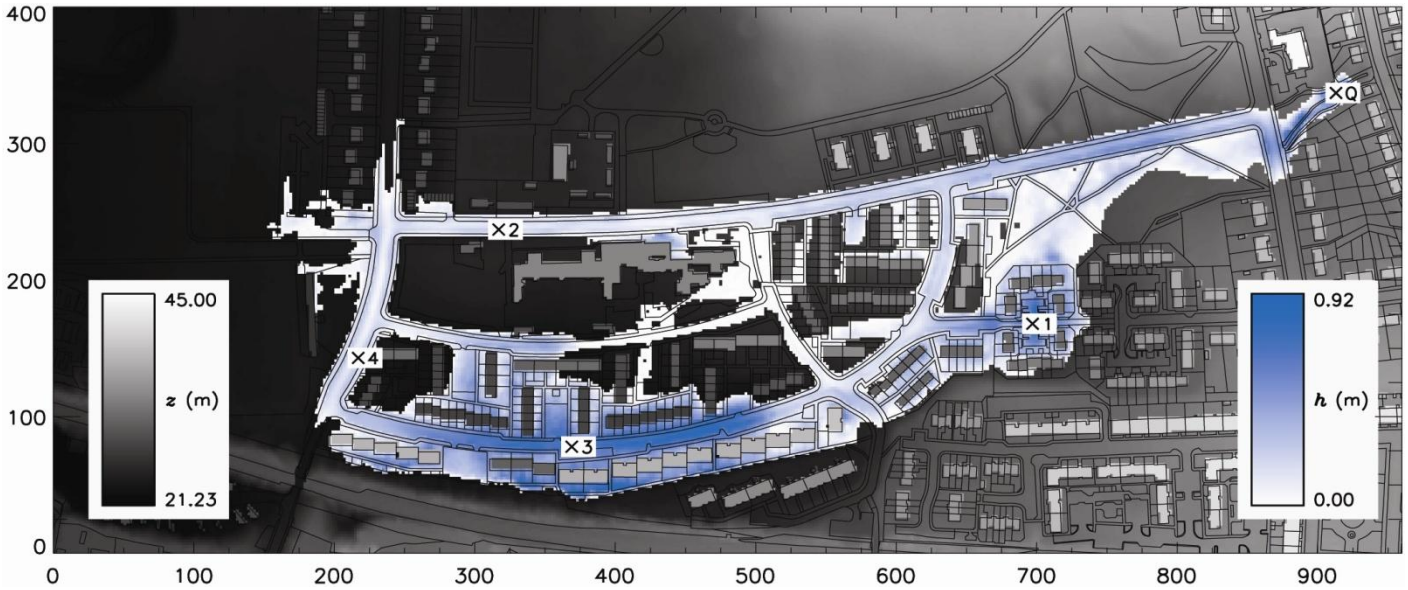
Flow between two cells calculated using:

$$Q = \frac{q - gh_{flow}\Delta t \dfrac{\Delta(h+z)}{\Delta x}}{1 + gh_{flow}\Delta t n^2 q / h_{flow}^{10/3}} \Delta x$$




Representation of flow between cells in LISFLOOD-FP

# Previous approach: Glasgow UK

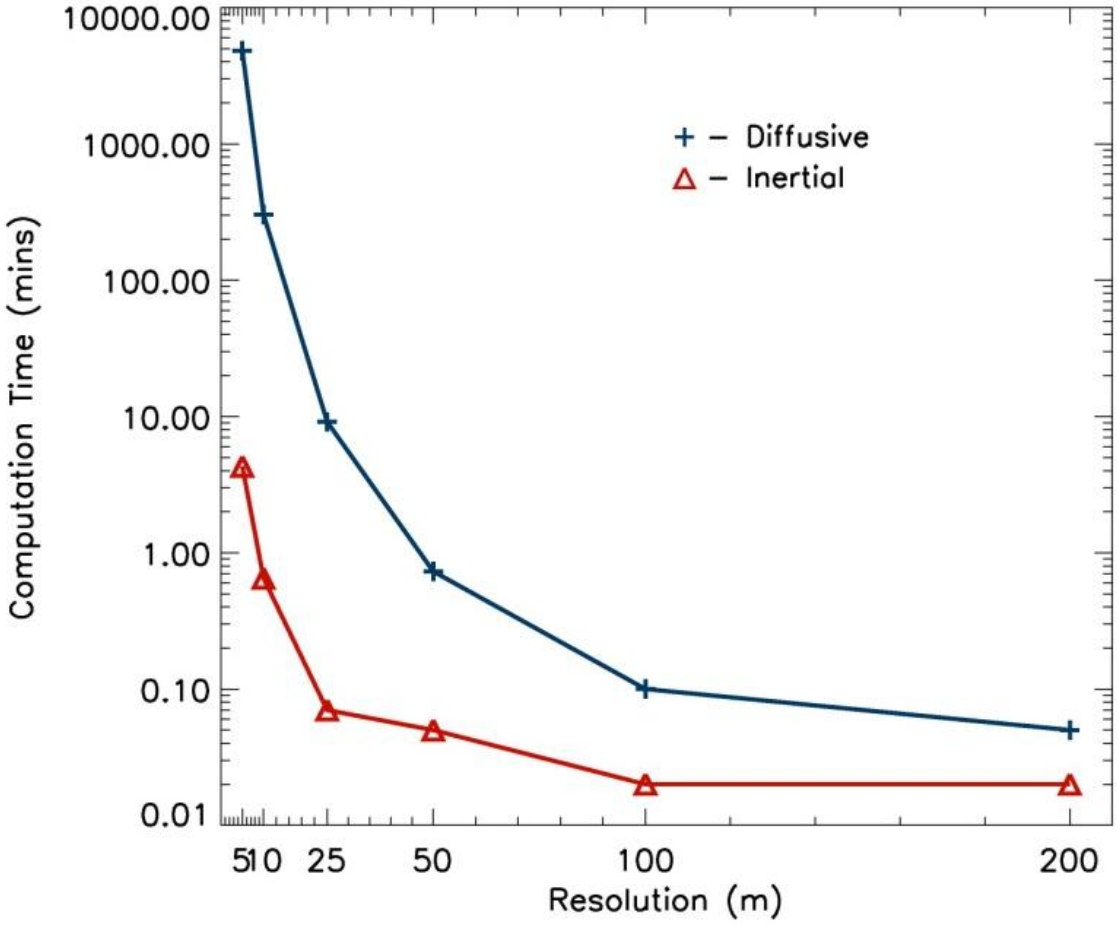



0.4 km$^2$, 2m grid, 90 minute event, 2-40 hours compute time in 2007

# Dynamic wave simulation….. Baltimore, USA

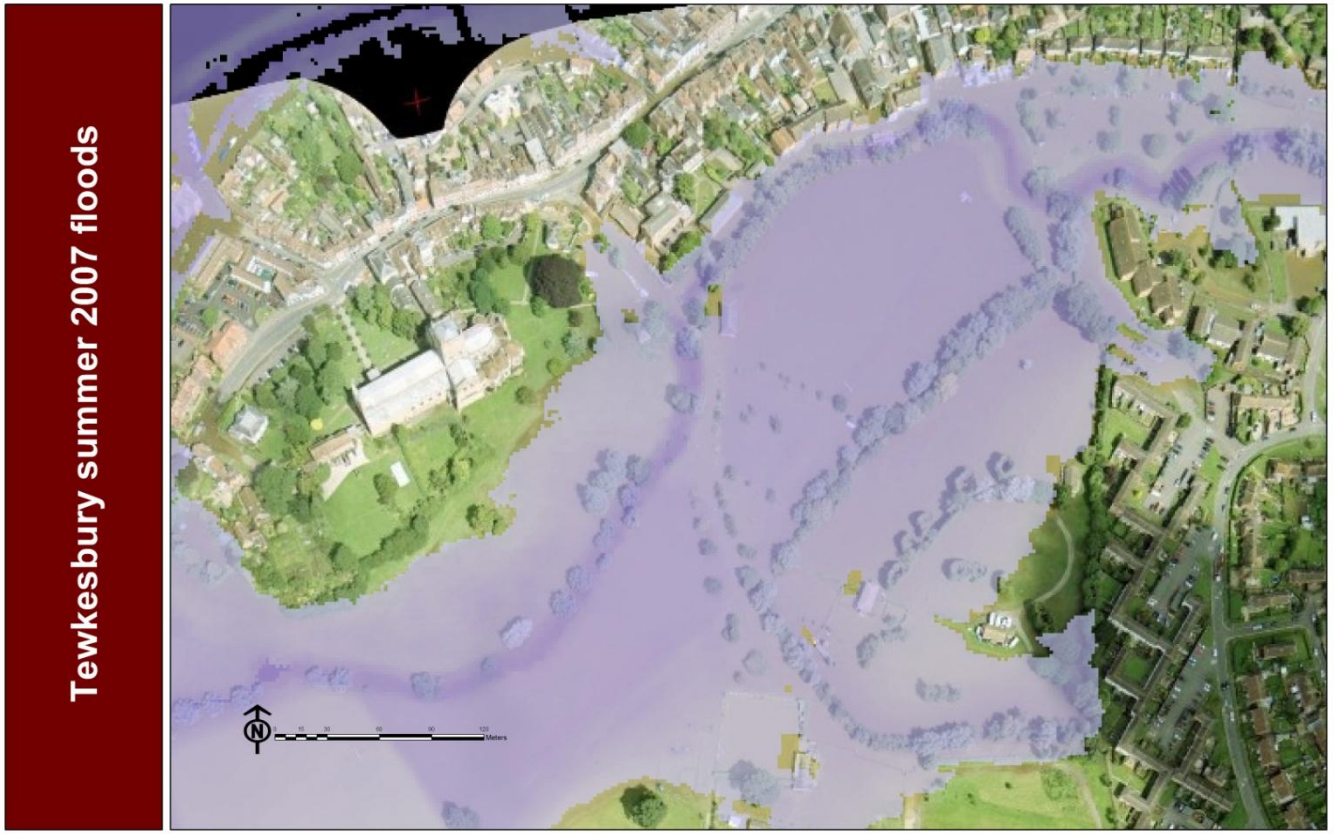

22.5 km$^2$ domain, 6m grid, 3 hour event, <4 min compute time in 2010

# New equation speed up

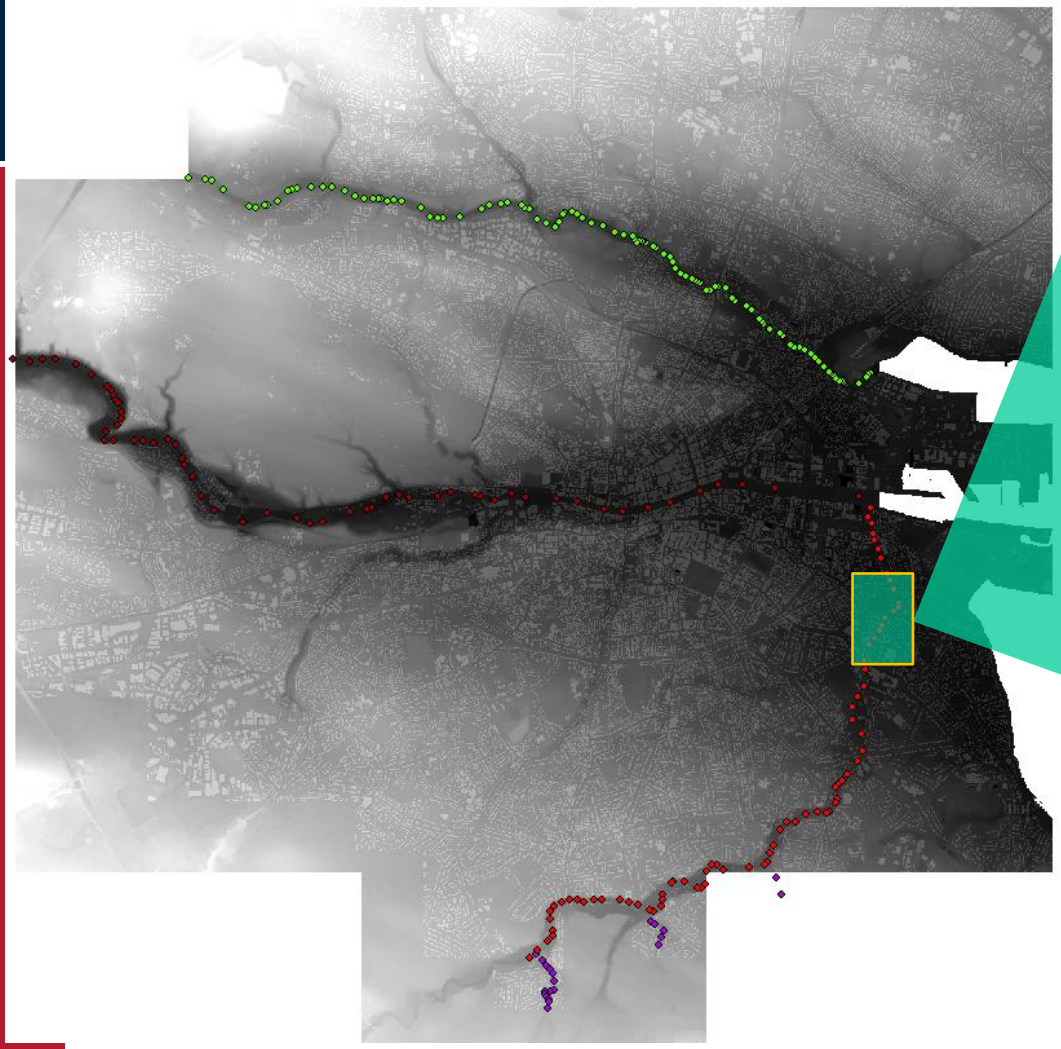


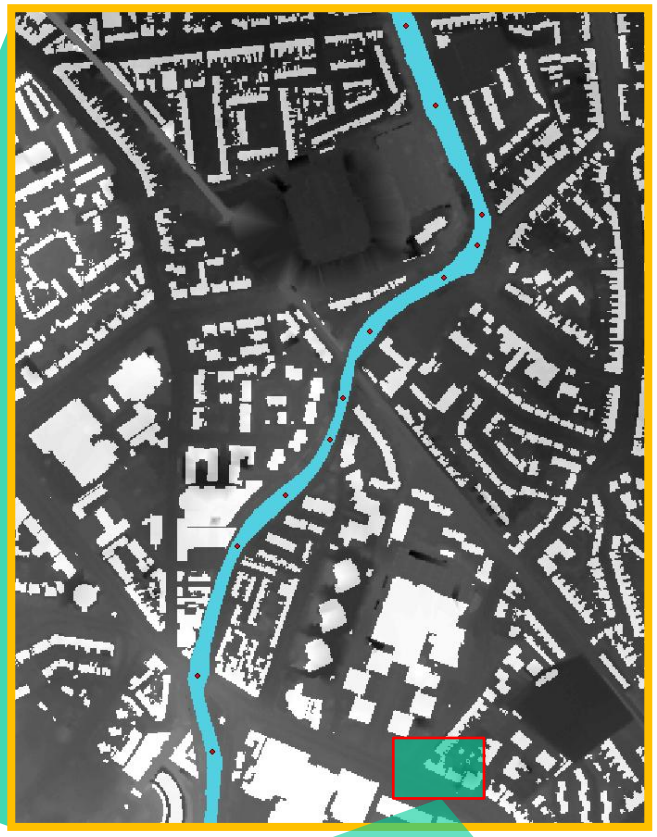
# Does it work?

- Whole city flood modelling at 2m resolution – Tewkesbury, UK summer 2007



# Dublin City Hydraulic Model





2 m

# Knowledge transfer

- Pathways
  - Complete blueprint placed in public domain via peer-reviewed journal paper
  - Journal paper sent to key end users
  - Shareware version of executable (~130 downloads in last year)

- Take up so far in UK
  - Willis Re in-house flood model
  - HR Wallingford RFSM-EDA to be used in future EA National Flood Risk Assessment (NaFRA)
  - Ambiental Ltd. Flowroute-i model
  - JULES