Improved flood modelling for the built environment

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WATER INFRASTRUCTURE AND RESILIENCE WIRe

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Background

Intro: Flood inundation models have become an extremely and powerful tool in understanding the hydrodynamics of flood events, assessing flood risk, and predicting future floods that will cause damages in urban fabric. Hydrodynamic models are undergoing a period of rapid development by new simulation methods and in an increase computational power, which can predict the direction and the extend of flooding.

The gap: Urban flood modelling is a challenging task due to the complex topography (buildings, roads, sewers etc) of a city, on the surface and below ground. Most flood risk exists in cities and built-up areas due to the growth of urbanization and climate change. It is a priority to accurately the representation of urban features into hydrodynamic models to assess flood risk to properties, assets, infrastructure etc in an uncertain future.

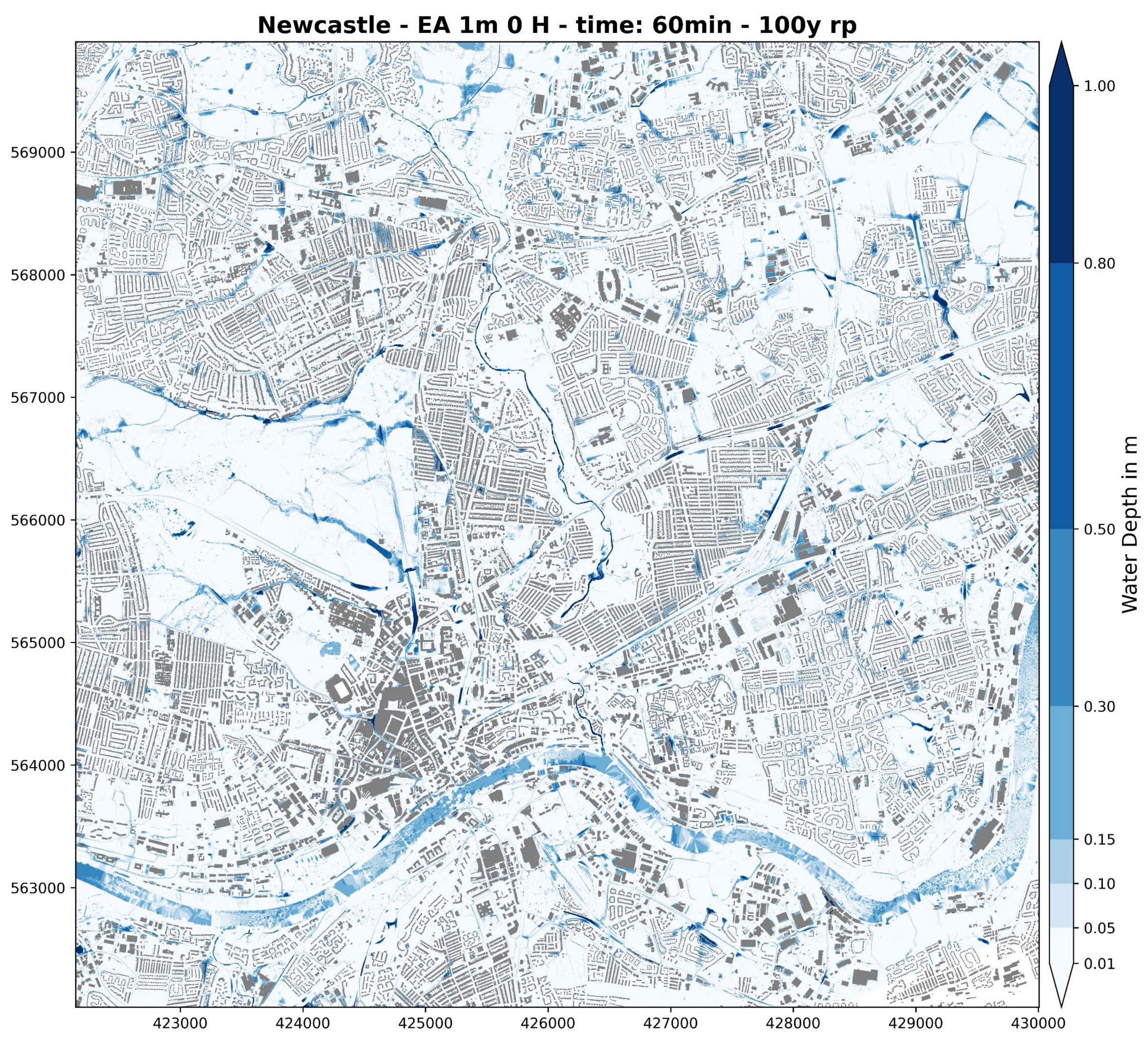

Figure 1: Flood depth map from a CityCAT simulation for Newcastle at 1m resolution

Representation of urban features in hydrodynamic models

'Building Hole': This approach presents buildings as void space where the cells within the building removed from the computational grid. The surface flow cannot flows into the cells where they are buildings, and the water flows around the building boundary. In addition, the reduction of the simulation time is an advantage, especially for densely built-up areas. Note that the buildings are retained as objects and the flow processes are more realistic and quicker to model.

'Stubby Buildings': The '*stubby*' platform is using the threshold (h) of the building entrance height for the representation of buildings into the model. However, due to the variance entrance height of the buildings and to avoid instabilities in the model with large elevation differences, the most common values are 30cm to 40 cm. Buildings assumed to be constant 30cm above the local ground level elevation of the Digital Elevation Model which prevents water from flowing into buildings until the water depth outside the building exceeds 30cm.

'Building Hole'   *'Stubby Buildings'*

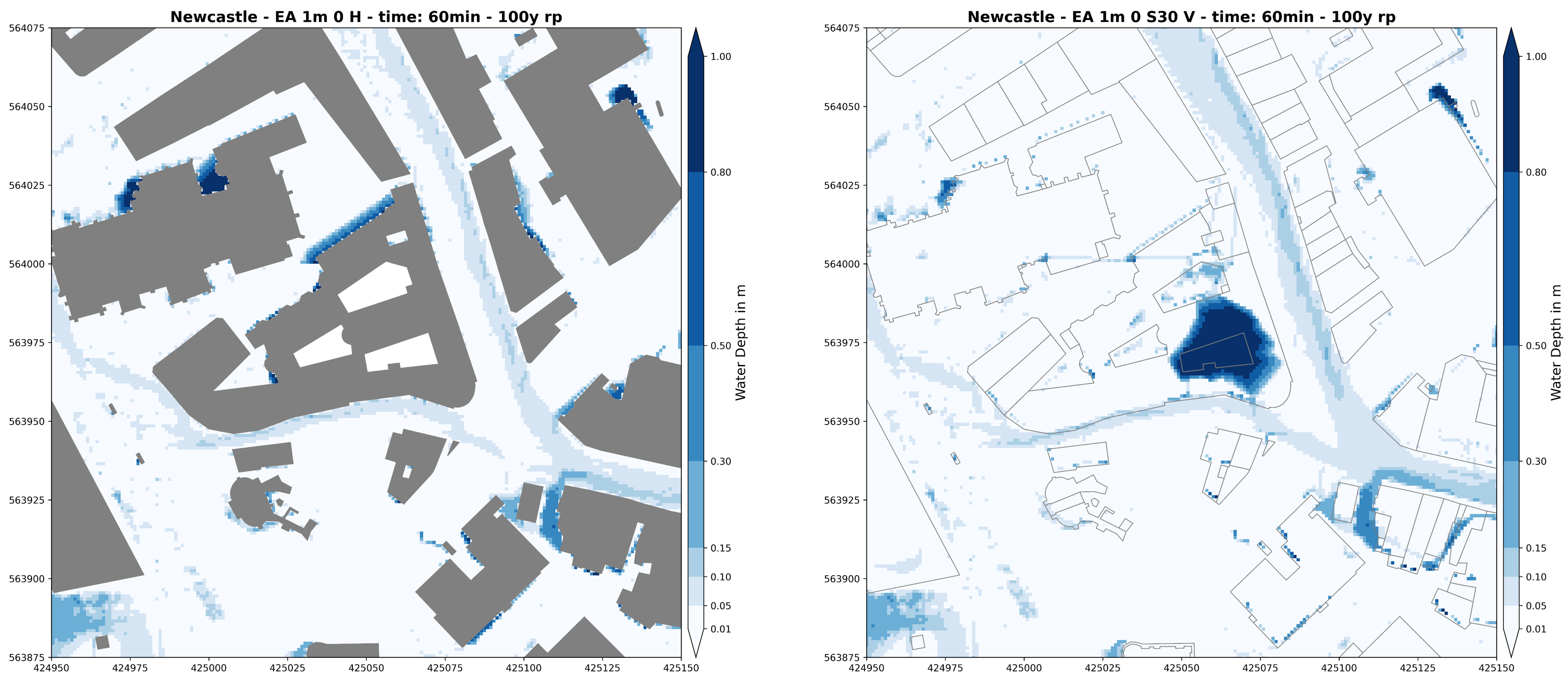

Figure 2: Flooding at Dean Street, Newcastle City Centre for a storm event of 60 min with 100 years return period

Differences:

'Building Hole':

- The water depths are higher;
- The flood water is forced to flow around the buildings;
- Validates well against real flooding;

'Stubby Buildings':

- The flow paths are considerably different;
- Most of the buildings are flooded;
- Unrealistic results against real flood events;

Flood exposure analysis

Flood exposure analysis is a useful tool for the researchers in highlighting and categorised assets, man-made constructions, buildings, and infrastructure according to the distribution of flood depth around them. Buildings were classified as flooded if the flood water is above a typical property threshold of 30cm.

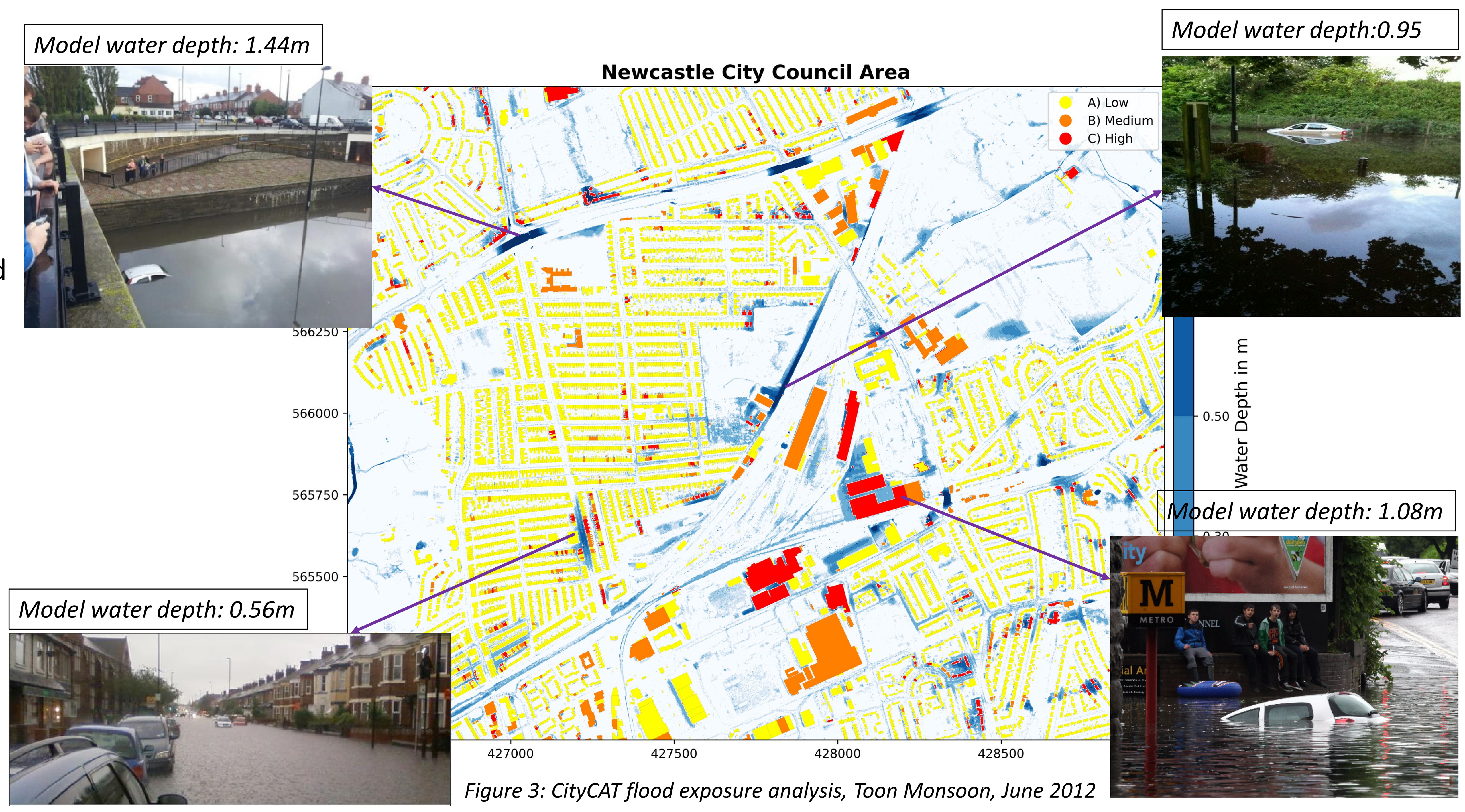

Figure 3: CityCAT flood exposure analysis, Toon Monsoon, June 2012

Future directions

- High resolution modelling to estimate damages to buildings;
- Application to real cities in the UK by covering hazard, exposure, and vulnerability;
- The resilience protection of buildings against flooding, and the reduction of damage inside them;
- Pipe network modelling for more accuracy;

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