DARE: Urban observations and their assimilation

S. Vetra-Carvalho (UoR)  S. L. Dance (UoR)
D. Mason (UoR)  J. Garcia-Pintado (UoB)

9th January 2018
Which urban observations?

+ *river gauges* (sparse in space, frequent in time);
+ *SAR satellite images* (frequent in time and space, but have some issues);
+ *CCTV cameras* (varied spatial distribution, frequent in time);
+ *rivercams* (sparse in space, frequent in time);
+ *surface water road sensors* (where available);
+ *other crowdsourced data* (e.g. Twitter, smartphone images).
CCTV images

All big cities have a dense network of various CCTV cameras including traffic management cameras.

This image is the property of Leeds City Council.
Difficulties to consider...

Lots of post-processing to do since
- some cameras move, zoom etc;
- obstructed view due to rain, vehicles, etc;
- faulty connections, low light;
- usually low resolution.
Difficulties to consider...

Lots of post-processing to do since
- some cameras move, zoom etc;
- obstructed view due to rain, vehicles, etc;
- faulty connections, low light;
- usually low resolution.
**Current work - use CCTV images to improve urban flood prediction**

**Our aim** is to use CCTV images to complement SAR observations in urban areas and assimilate them in the model using ensemble methods to improve the flood forecasts in cities.

![CCTV Image](image1)

![SAR Image](image2)

CSK image of Thames flood west of London on 12/02/2014.
River cameras are used to monitor rivers for various purposes: water heights, fishing, bridge conditions, etc.

The densest network of river cameras in UK is provided by Farson Digital Watercams (https://www.farsondigitalwatercams.com/).

- HD cameras;
- Images available every 10s;
Tewkesbury 2012 testcase

Inflow error correction through the use of: **RiverCams**.

- Perfect test-case
- Hourly images from 6 river cameras with permission from Farson Digital Cameras.
- 21/11/2012 - 05/12/2012
- LisFLOOD-fp model (Garcia-Pintado et al. 2015)
- EnKF, EnKS
Tewkesbury test-case

Tewkesbury camera between 21st Nov 2012 and 5th Dec 2012.
Tewkesbury test-case

Tewkesbury camera between 21st Nov 2012 and 5th Dec 2012.
Tewkesbury test-case

Tewkesbury camera between 21st Nov 2012 and 5th Dec 2012.
Tewkesbury test-case

Tewkesbury camera between 21st Nov 2012 and 5th Dec 2012.
How to use these observations?

Proof of concept in the test-case,

- Manually assess water height/extent in images;
- Field trip to Tewkesbury to inspect the six stations;

Any ensemble data assimilation system requires knowledge of

- observation errors, \( R \);
- observation operator, \( \mathcal{H} \);

\[
x^a = x^f + K \left( y - \mathcal{H}(x^f) \right)
\]
\[
P^a = \left( I - KH^T \right) P^f
\]

where \( K = P^f H^T \left( HP^f H^T + R \right)^{-1} \).
Summary

We are working on improving urban flood predictions using various angles:

- Advancing SAR delineation algorithms for use in urban areas;
- using novel data sets in assimilation methods: rivercam and CCTV images;
- assessing CCTV observation impact using complex system;
- setting up DA system with more advanced urban hydrological model;
- testing different DA methods to improve accuracy of inflow boundary conditions;
Pilot projects

Deadline: January 15

- £75k available - expect to fund 3x £25k projects
- research, knowledge exchange or science outreach activities
- application of digital technologies to help the human and natural environments be more resilient and adaptable to climate change.
- Anything considered! (Some workshop activities to help with ideas)
- Must have a concrete deliverable

Eligibility:
- UoR has to obey EPSRC rules
- Early career
- Business
- Overseas

Application: 1 page case for support; 1 page budget; (letter of support)
