On improving urban flood prediction through data assimilation using CCTV images

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DARE steps in flood forecast improvement

To collect CCTV images of floods for a number of cities and towns in the UK.

To understand the data - quality control, information extraction, error information.

To improve the SAR delineation algorithm for urban areas. (David Mason)

To assimilate data extracted from CCTV and SAR images into flood models.
Urban flood observations

- **river gauges**
  (sparse in space, frequent in time);

- **SAR satellite images**
  (cover large spatial domains);

- **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, areal images).
SAR observations

Synthetic-aperture radar (SAR)

Aerial photo of flooding in Wraysbury, West London (about 300 x 300 m)

CSK sub-image (1 x 1 km) of Thames flood in Wraysbury (dark areas are water). Red outline shows the area covered by the aerial photo.
SAR observations

Issues in urban areas:
• resolution
• shadow regions
• double backscatter

Layover (AB) and shadow (CD) regions in a flooded street (AD) between adjacent buildings of height h1 and h2 (θ = incidence angle).
CCTV images
Quality control of CCTV

Lots of data thinning do since:

- some cameras move, zoom etc;
- obstructed view due to rain, vehicles, etc;
- faulty connections, low light;
- low resolution.

Powered by TfL Open Data
Rivercam test case: Tewkesbury Nov/Dec 2012

River cameras are used to monitor rivers for various purposes: water heights, fishing, bridge conditions, etc.

- HD cameras;
- Images available every 10s;

The densest network of river cameras in UK is provided by Farson Digital Watercams (https://www.farsondigitalwatercams.com/).
Rivercam test case: Tewkesbury Nov/Dec 2012

- 21/11/2012 - 05/12/2012
- LisFLOOD-fp model (García-Pintado et al. 2015)
- 7 SAR images available and assimilated
- EA gauge data used for verification
- 4 Farson Digital Ltd river cameras available in the domain with hourly data in the daylight
Rivercam test case:
Tewkesbury Nov/Dec 2012
Rivercam test case:
Tewkesbury Nov/Dec 2012

Evesham 21 Nov 2012
Rivercam test case:
Tewkesbury Nov/Dec 2012

EA Lidar 1m DSM

Image used with permission of Farson Digital Ltd
Rivercam test case:
Tewkesbury Nov/Dec 2012
Rivercam test case: Tewkesbury Nov/Dec 2012

Inflow ensemble at Evesham station

García-Pintado et al. (2013)
García-Pintado et al. (2015)
Results with SAR data

N = 100
Along network localisation

Assim.: SAR water levels
Aug.: inflows
Initial data test

N = 21
Along network localisation

Assim.: SAR + camera WL
Aug.: inflows
Summary

- We are working on improving urban flood predictions using data of opportunity - CCTV & river camera images, within our data assimilation system.
- Continuously collecting urban flooding data visible on CCTV from chosen cities in the UK.
- Advancing SAR delineation algorithms for use in urban areas;
- Investigating more advanced urban hydrological model and DA assimilation setup;
- Testing different DA methods to improve accuracy of inflow boundary conditions.
Bibliography

