National surface water flood forecasting: developing an operational, risk-based approach

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SURFACE (PLUVIAL) FLOODING

Periods of heavy rain overwhelm drainage systems and concreted surfaces, preventing water from draining away.

- Paving prevents water draining into the ground
- Drainage systems become overwhelmed
- Flooding from overland flow and ponding in local depressions
- In unpaved areas water can drain into the ground more easily
Surface Water Flooding (SWF) Risk

- “Hidden” Risk, rapid onset
- Urban areas often affected, not always near rivers, those at risk may not be aware
- More people and property (3m) at risk from SWF compared to river and coastal flooding (2.7m)

Surface Water Flooding (SWF) Risk

- Added to the National Risk Register in 2017
Surface Water Flooding (SWF) Risk

- Flooding top risk in UK Climate Change Risk Assessment

Figure 2: The Adaptation Sub-Committee's assessment of the top six areas of inter-related climate change risks for the UK

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>More Action Needed</th>
<th>Research Priority</th>
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<tbody>
<tr>
<td>Flooding and coastal change risks to communities, businesses and infrastructure (Ch3, Ch4, Ch5, Ch6)</td>
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<td>Risks to health, well-being and productivity from high temperatures (Ch5, Ch6)</td>
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<td>Risk of shortages in the public water supply, and for agriculture, energy generation and industry (Ch3, Ch4, Ch5, Ch6)</td>
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<td>Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity (Ch3)</td>
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<td>Risks to domestic and international food production and trade (Ch3, Ch6, Ch7)</td>
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<tr>
<td>New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals (Ch3, Ch5, Ch7)</td>
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</tbody>
</table>

NOW ----> RISK MAGNITUDE ----> FUTURE

LOW  MEDIUM  HIGH
SWF Examples

- Hampstead, 14 Aug 1975, over 170mm in ~2.5 hours
  - 1 death, 4 stations flooded, 250 homeless
SWF Examples

- Hampstead, 14 Aug 1975, over 170mm in ~2.5 hours
  - 1 death, 4 stations flooded, 250 homeless

- Summer 2007 floods had major impacts
  - 55,000 properties flooded, ~36,000 due to SWF
  - The biggest rescue effort in peacetime Britain

- UK Government commission Pitt Review
  - Joint EA/Met Office Flood Forecasting Centre
  - Improve Surface Water Flood Forecasting
Surface Water Flooding (SWF)

- Challenges for national Surface Water Flood guidance

- Complex urban hydrology, rapid flooding

- Convective events dominate, hard to forecast

- Modelling Impacts & Risk
Natural Hazards Partnership

- UK consortium of government agencies and research centres
- Exchange of knowledge, ideas & expertise
  - Focus on impacts
  - Emphasis on risk reduction & prevention
  - Develop new services
- Developing Hazard Impact Models (HIMs) using a consistent Hazard Impact Framework approach (more in later talks!)

www.naturalhazardspartnership.org
SWF HIM builds on existing models, data and tools.

Rainfall ensembles (MOGREPS-UK)

Grid-to-Grid Hydrology

Rainfall ensembles

SWF Hazard Footprint

Impact Library

Real-time SWF risk outputs

Dissemination

Visual Weather

NPD

NRD

National Receptor Database (NRD)

National Population Database (NPD)

Risk of Flooding from Surface Water map

Flood Guidance Statement

10.30hrs Tuesday 08 August 2017

Increased  Increased  Increased

Steady

TUESDAY  08 AUG 2017
Grid-to-Grid (G2G) Model

- Responds to spatial variation of rainfall input and environment
- Used operationally at 1km resolution for Fluvial Flood Guidance
- Link to detailed surface water flood maps to derive impacts

Moore et al., IAHS Publ. 305 (2006)
Price et al.; Cranston & Tavendale, Water Management (2012)
Risk of flooding from surface water

- Maps produced offline
- Use JFlow+ (2m resolution), 2D modelling
- 9 maps available for
  9 different rainfall scenarios

Key assumption
G2G Surface Runoff equates to “effective rainfall” input to maps

Example offline map
Are G2G surface runoffs useful for SWF?

• Mapped inundation of G2G surface runoffs using JFlow+ for the “Toon Monsoon” and compared to observations.

Comparison with geo-referenced photos

Linking G2G runoffs with JFlow+ simulated observed flooding well

Comparison of simulation depths with point observations
Linking G2G with uFMfSW

Real-time G2G surface runoff accumulations → Check against effective rainfall scenarios → Identify scenario/map for each pixel → Impact Library
SWF HIM Recap

Rainfall ensembles (MOGREPS-UK)

Grid-to-Grid Hydrology

SWF Hazard Footprint

SWF HIM

Real-time SWF risk outputs

Impact Library

Visual Weather

Dissemination

Risk of Flooding from Surface Water map

National Receptor Database (NRD)

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Visual Weather

Risk of Flooding from Surface Water map

National Receptor Database (NRD)

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Developed offline, look up

Categories of disruption (impact criteria)

Impact maps created for each scenario & impact criteria

Judgements needed on counts of impacts per 1km²

More in Tim’s Talk
SWF HIM Risk Outputs

- Regional impact summary for each ensemble member
- Combine impact and likelihood to calculate risk
- Summarises over time, space & uncertainty
- Reporting by County/Authority
SWF HIM Visualisation

- Maximum impact severity at 1km and county scales
- County summary of impact ensemble
- More in Graeme’s talk
SWF HIM: more information

http://www.naturalhazardspartnership.org/science/hims/surface-water-flooding/

Cole et al., FLOODrisk 2016 Real-time forecasts of flood hazard and impact: some UK experiences
Aldridge et al., FLOODrisk 2016 A surface water flooding impact library for flood risk assessment