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a working partnership between Environment Agency | Met Office

Improving operational decision making and services: collaboration in science, systems and communication

Charlie Pilling, Rob Cowling & colleagues (inc EA-BoM MoU)

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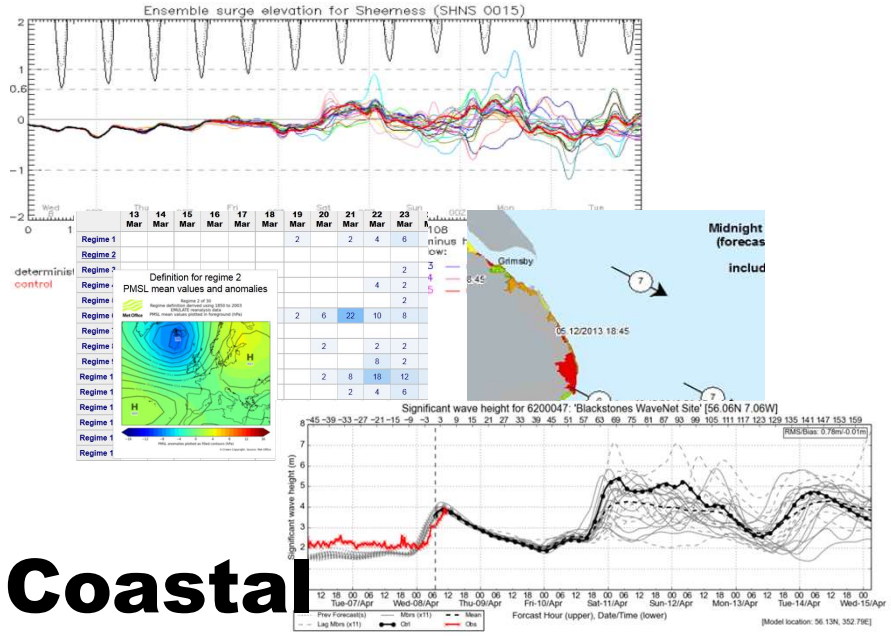
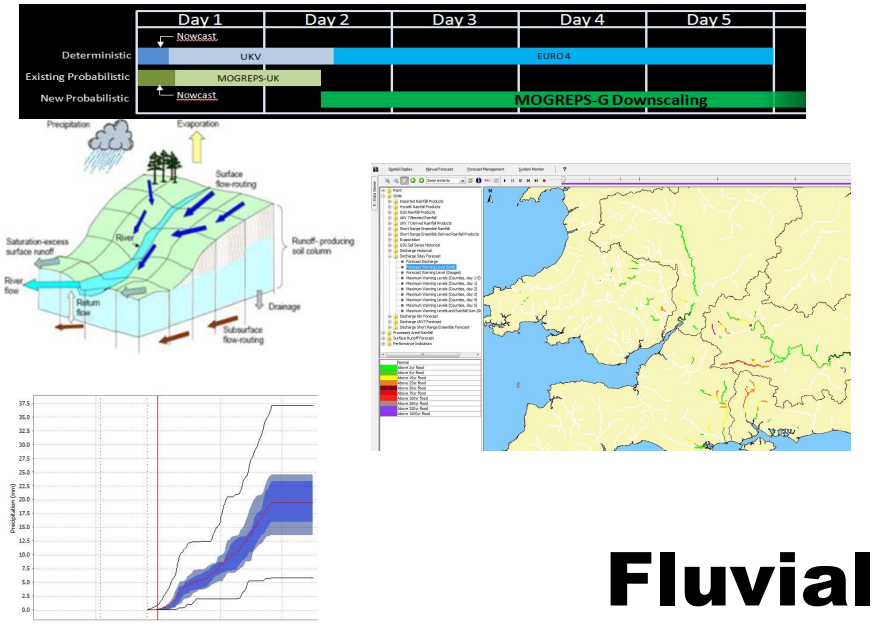


Coastal



Fluvial

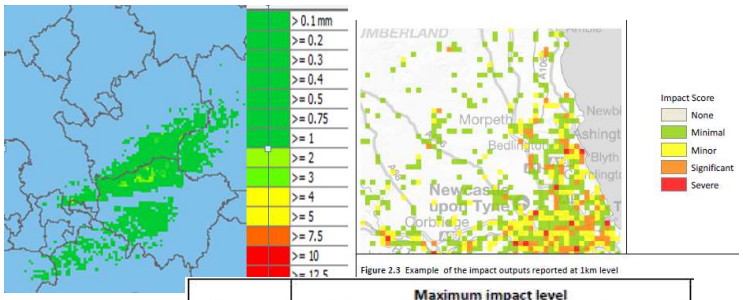
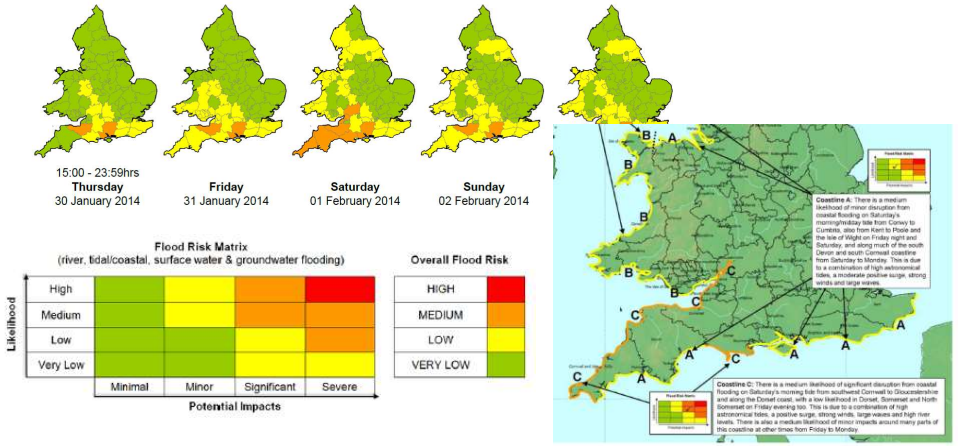


Figure 2.3 Example of the impact outputs reported at 1km level

Impact	Maximum impact level			
	Minimal	Minor	Significant	Severe
No of ensembles	6	8	8	2
Likelihood (%)	24/24 x 100%= 100%	18/24 x 100% = 75%	10/24 x 100% = 41.7%	2/24 x 100% = 8.3%
Likelihood	High	High	Medium	Very low
Risk	Very low	Low	Medium	Low

Surface Water



Communication

Flood Guidance Statement

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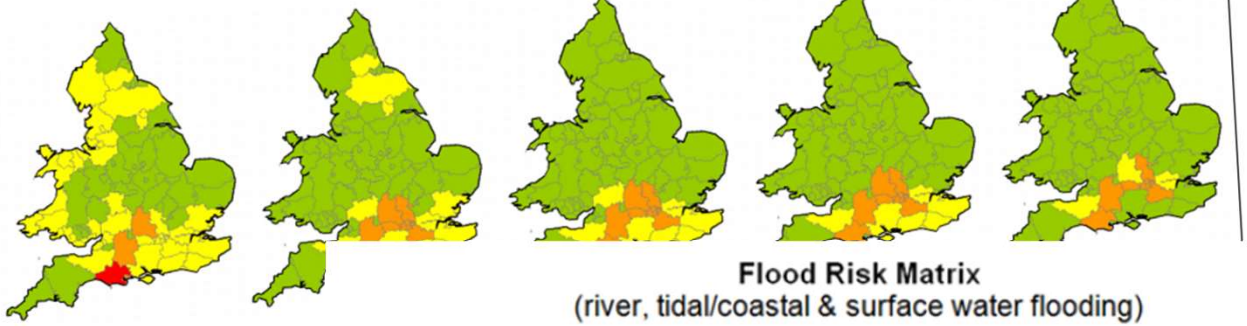
Flood Guidance Statement 10:30hrs Monday 06 January 2014

Our assessment of daily flood risk for England and Wales, working with flood forecasting teams in the Environment Agency and Natural Resources Wales, is below.



10:30 - 23:59hrs
Monday
06 January 2014 07

In Dorset, there is a HIGH (
and MEDIUM food risk for
risk from ongoing groundv
Stour and Hampshire Avo
counties in central southe

General overview of flood

There is a HIGH overall flood ri
impacts from coastal flooding in
medium likelihood of significant i

Flood Risk Matrix
(river, tidal/coastal & surface water flooding)

Likelihood	Minimal	Minor	Significant	Severe
High				
Medium		✓		
Low				
Very Low				✓

Potential Impacts

Overall Flood Risk

HIGH
MEDIUM
LOW
VERY LOW

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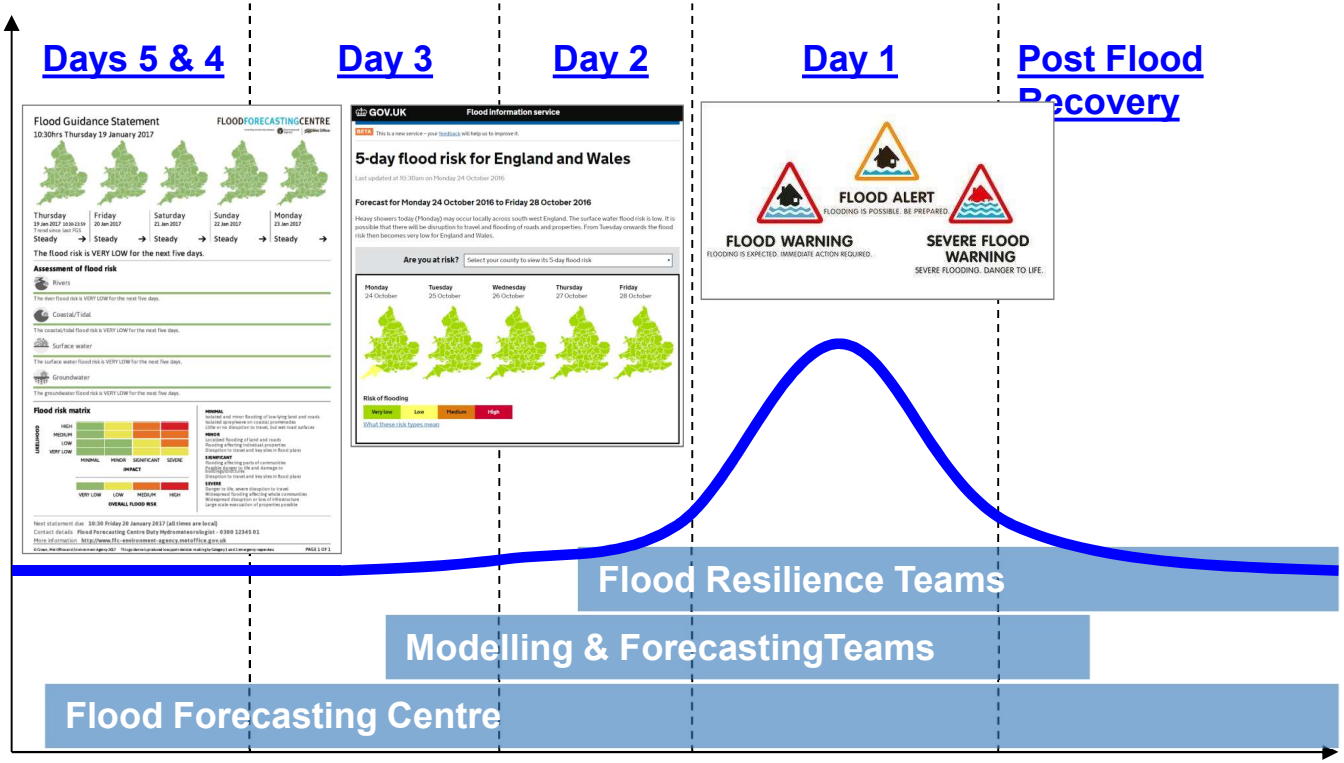
Flood timeline of guidance and warnings

Guidance extended to 6 to 10 days to highlight possible heightened flood risk.



Coastal

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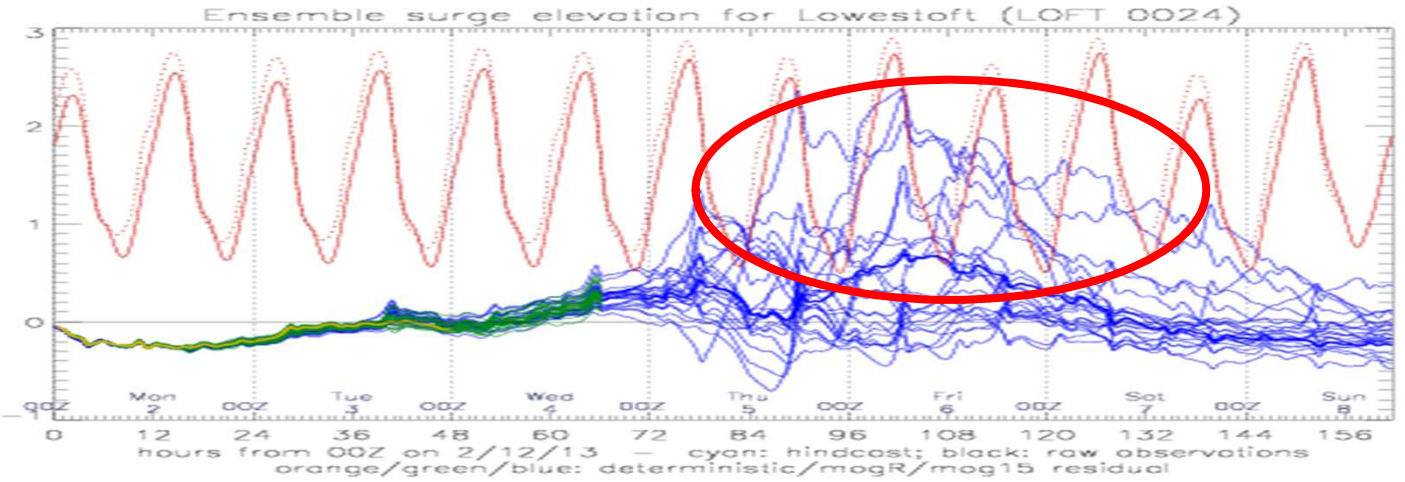
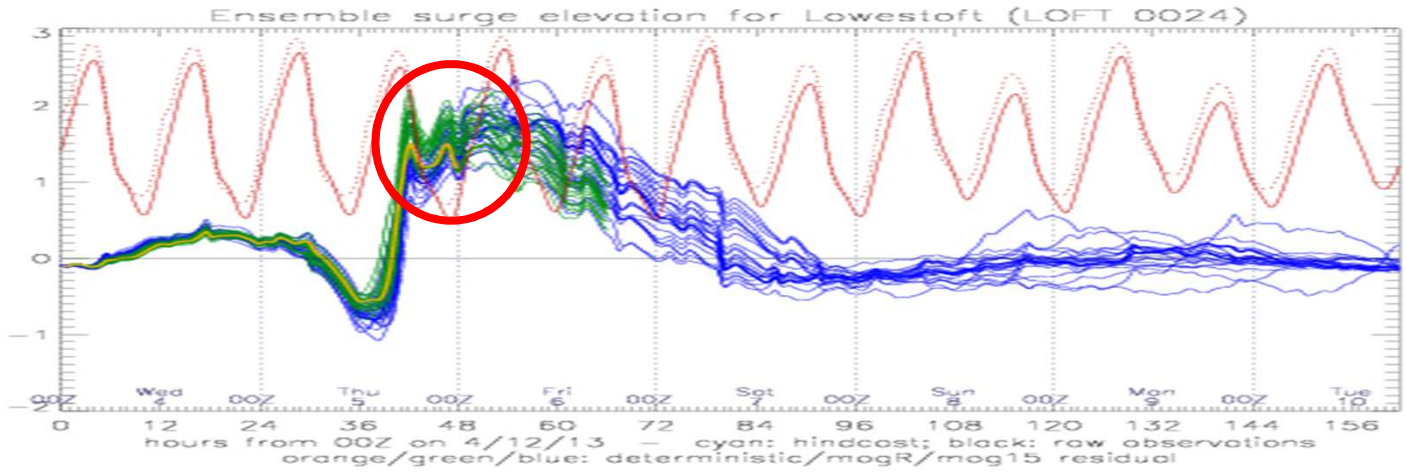
Lowestoft, E England, 5-6 Dec



~ 4 days lead time



~ 2 days lead time

Fluvial

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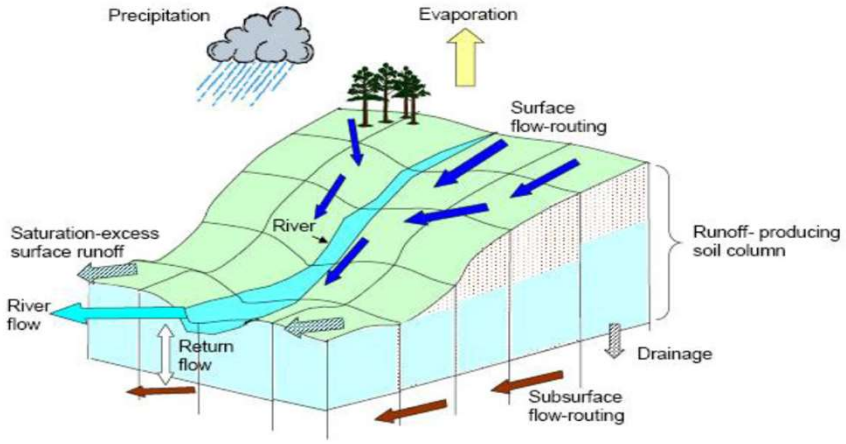
Grid to Grid (G2G) Model

- **Supplements EA local forecasting models**
- Designed to work with gridded rainfall estimates, radar and NWP….
- Forecasts everywhere! at 15 minute timesteps and at a 1km x 1km spatial resolution to 5 days ahead;
- Can provide flow forecasts for ungauged catchments....
- Performs less well in low relief, groundwater dominated catchments



- **The challenge: to generate flows across whole of England & Wales (& Scotland) at 1km x 1km, using a distributed, grid-based, hydrological model, in an operational environment, to provide an overview of flood risk**
- **Very different from calibrating a model for a single catchment**

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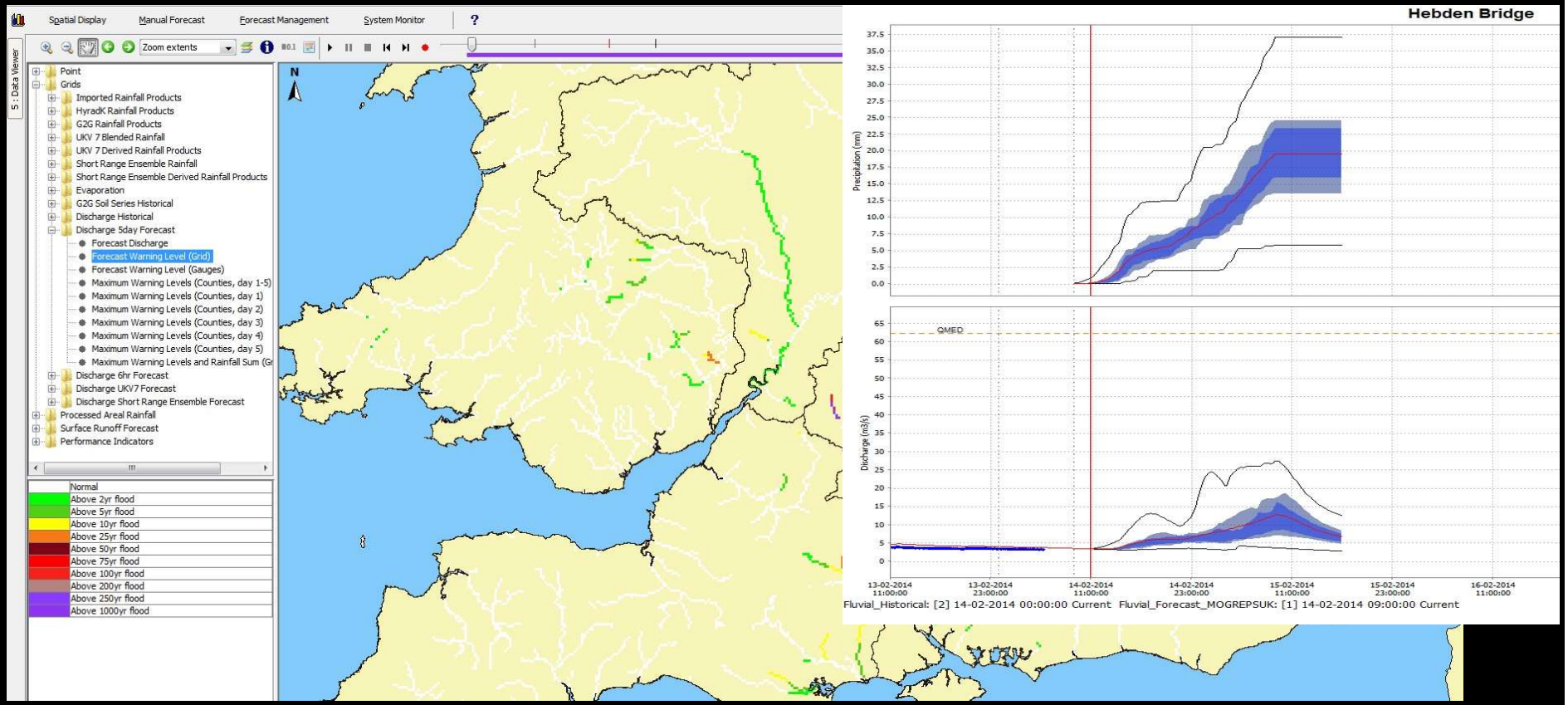
National Flood Forecasting System (NFFS) – Grid to Grid Hydrological Model

Spatial Display showing (1km) gridded return period flow forecast – based on NWP seamless 5 day (deterministic) rainfall forecast



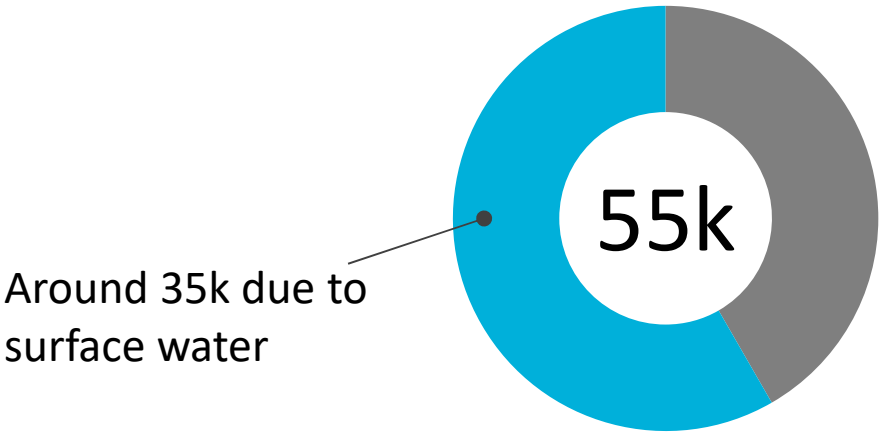
Surface Water Flooding

Hazard Impact Model

- Major risk in E&W → **3 million**
- Summer 2007 flooding

  The "biggest rescue effort in peacetime" Britain

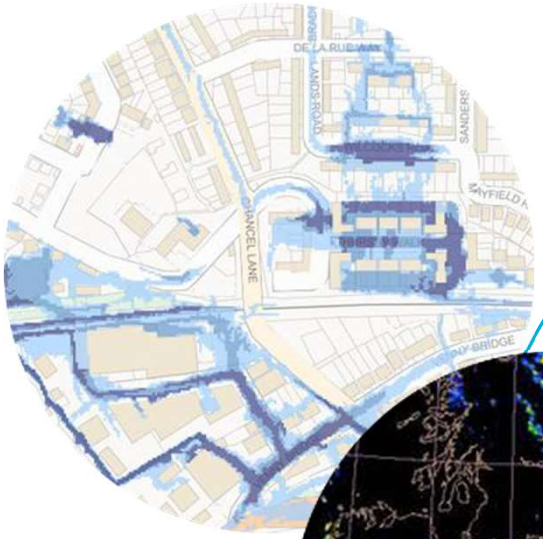
  Disruption to lives and livelihoods

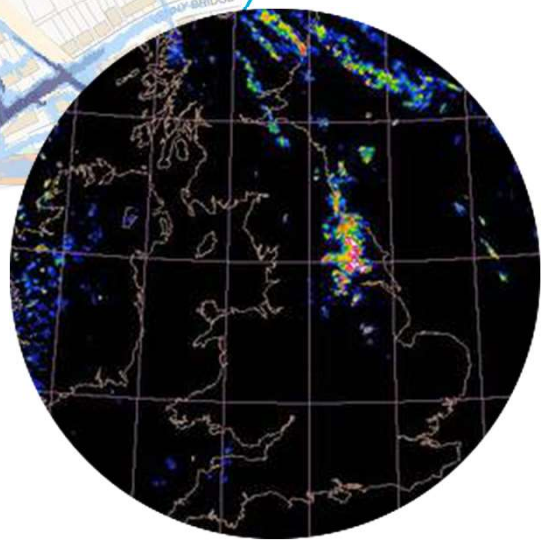



Hull, June 2007 – Hull Daily Mail

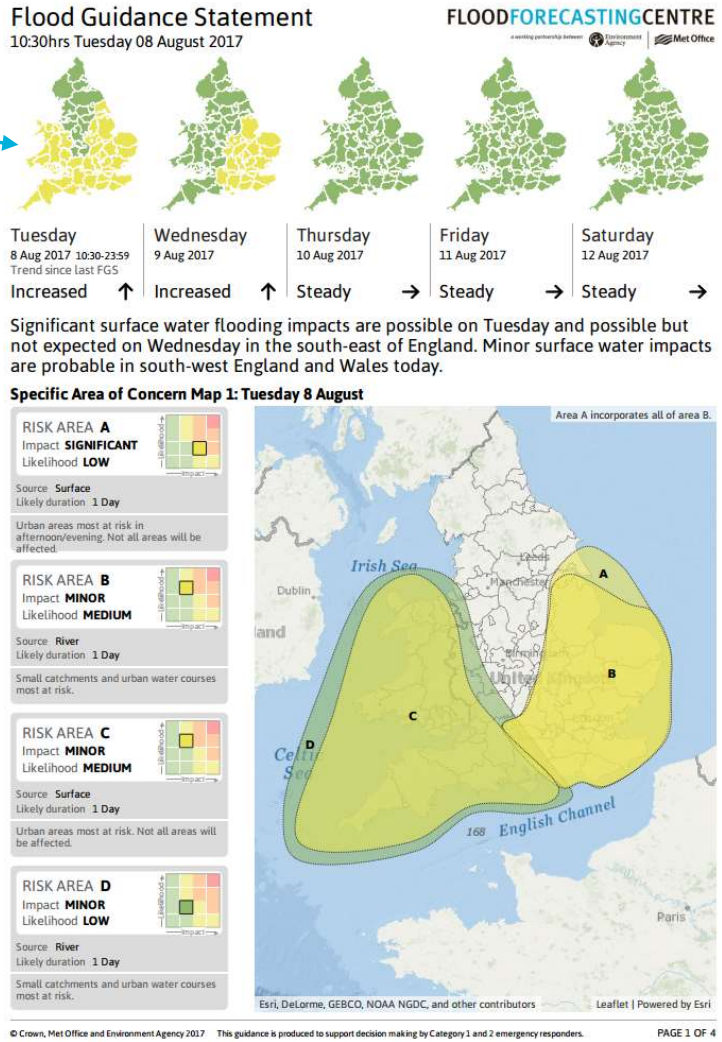
Challenges for national surface water flood guidance

Complex urban hydrology





Convective events dominate



Flood Guidance Statement
10:30hrs Tuesday 08 August 2017

FLOODFORECASTINGCENTRE

Tuesday	Wednesday	Thursday	Friday	Saturday
8 Aug 2017 10:30-23:59	9 Aug 2017	10 Aug 2017	11 Aug 2017	12 Aug 2017
Trend since last FGS				
Increased ↑	Increased ↑	Steady →	Steady →	Steady →

Significant surface water flooding impacts are possible on Tuesday and possible but not expected on Wednesday in the south-east of England. Minor surface water impacts are probable in south-west England and Wales today.

Specific Area of Concern Map 1: Tuesday 8 August

RISK AREA **A**
Impact **SIGNIFICANT**
Likelihood **LOW**
Source **Surface**
Likely duration **1 Day**
Urban areas most at risk in afternoon/evening. Not all areas will be affected.

RISK AREA **B**
Impact **MINOR**
Likelihood **MEDIUM**
Source **River**
Likely duration **1 Day**
Small catchments and urban water courses most at risk.

RISK AREA **C**
Impact **MINOR**
Likelihood **MEDIUM**
Source **Surface**
Likely duration **1 Day**
Urban areas most at risk. Not all areas will be affected.

RISK AREA **D**
Impact **MINOR**
Likelihood **LOW**
Source **River**
Likely duration **1 Day**
Small catchments and urban water courses most at risk.

 This guidance is produced to support decision making by Category 1 and 2 emergency responders. PAGE 1 OF 4

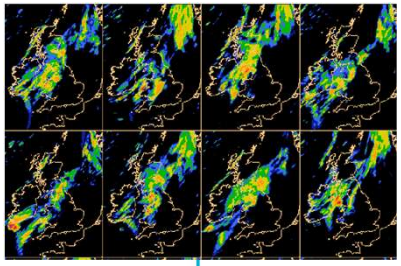
Working in partnership

- Consortium of 17, since 2011
- Exchange of knowledge, ideas expertise
  - Focus on impacts
  - More emphasis on risk reduction & prevention
  - Provides environment for the development of new services
- Hazard Impact Framework, consistent approach

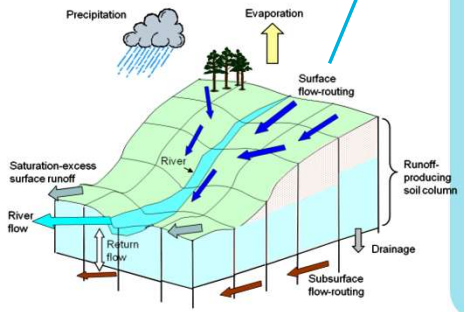
Surface Water Flooding Hazard Impact Model

- Builds on existing models, data and tools

Rainfall ensembles (probabilistic forecasts)



Grid-to-Grid (Runoff generation)

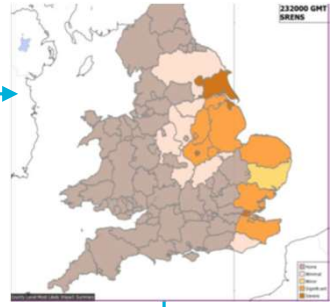


SWF Hazard Footprint

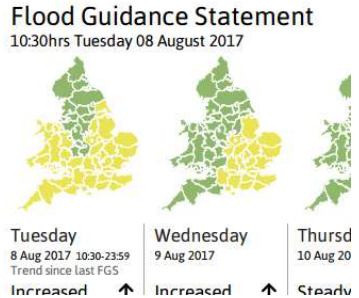
SWF HIM

Real-time SWF risk outputs

Visualisation

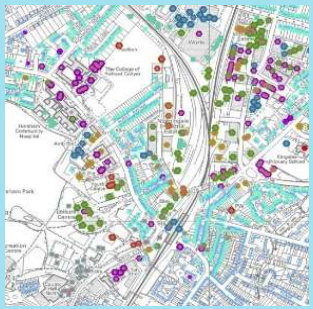


Dissemination



Impact Library

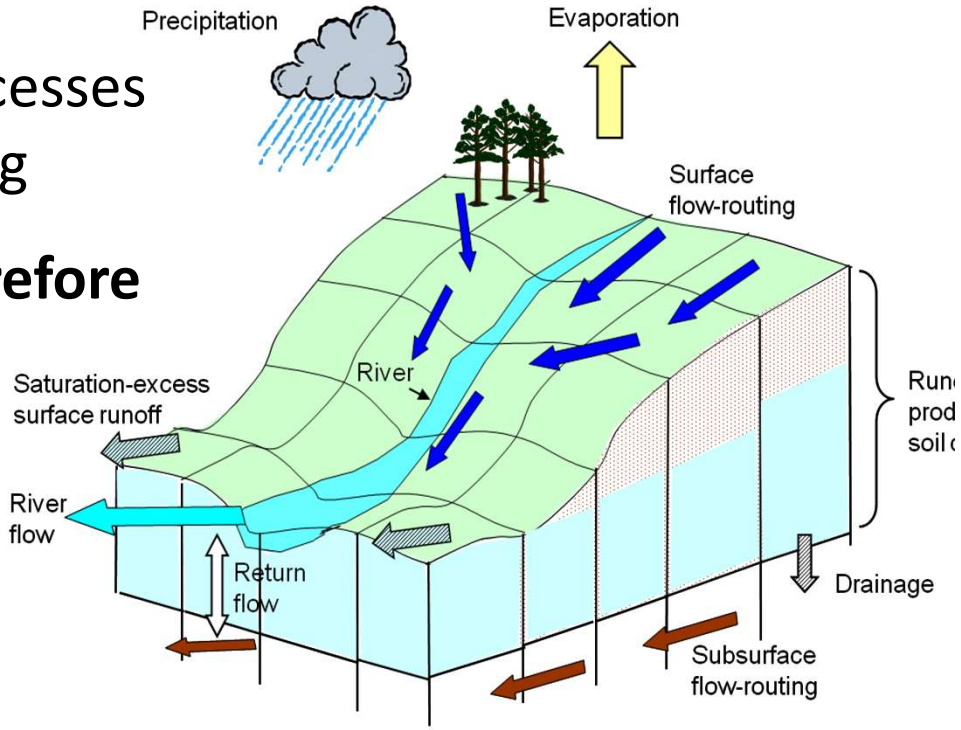
Surface water mapping (using Risk of Flooding from Surface Water maps - formerly UFMfSWF)



Population and receptor databases e.g. National Population Database (NPD)

Why use Grid-to-Grid to drive surface water forecasts?

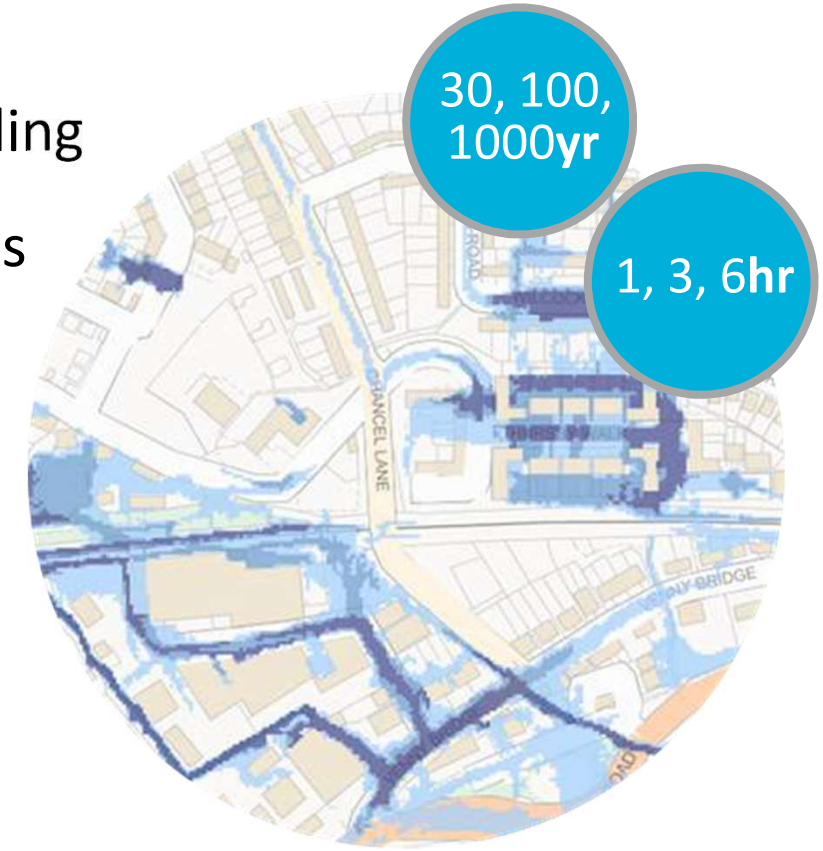
- Used operationally already, and 'efficient'
- Spatial variability in response
- Models the key hydrological processes involved in surface water flooding
- **Too coarse to drive impacts therefore must link it….**



Model schematic – G2G model

Risk of flooding from surface water (RoFSW) map

- Produced offline
- Uses Jflow (2m resolution) 2D modelling
- 9 maps available, covering 9 scenarios



Example output from Risk of Flooding from Surface Water maps

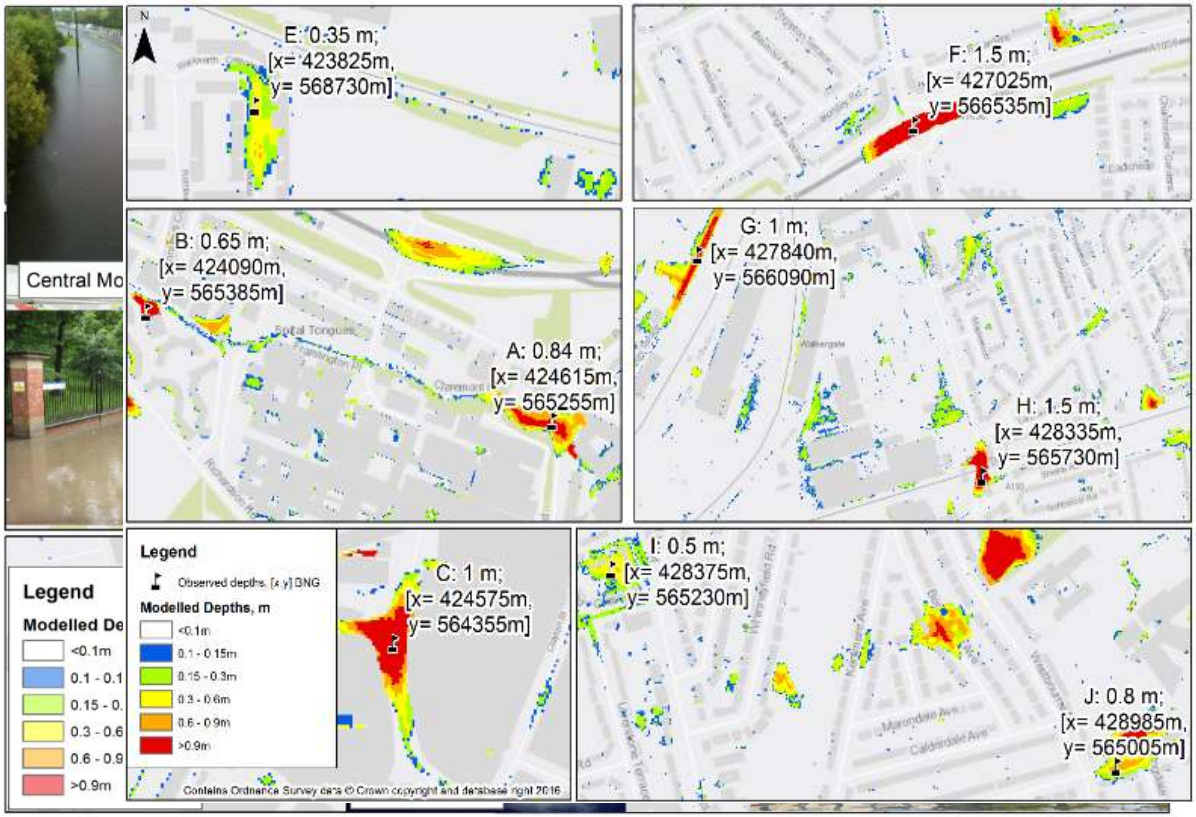
Key assumption

"**effective rainfall**" input into mapping = **G2G surface runoff**

Case study to test assumption

- Reasonable alternative?
- G2G surface runoff input boundary to JFlow for observed events
- Peer-review ‘pragmatic approach’

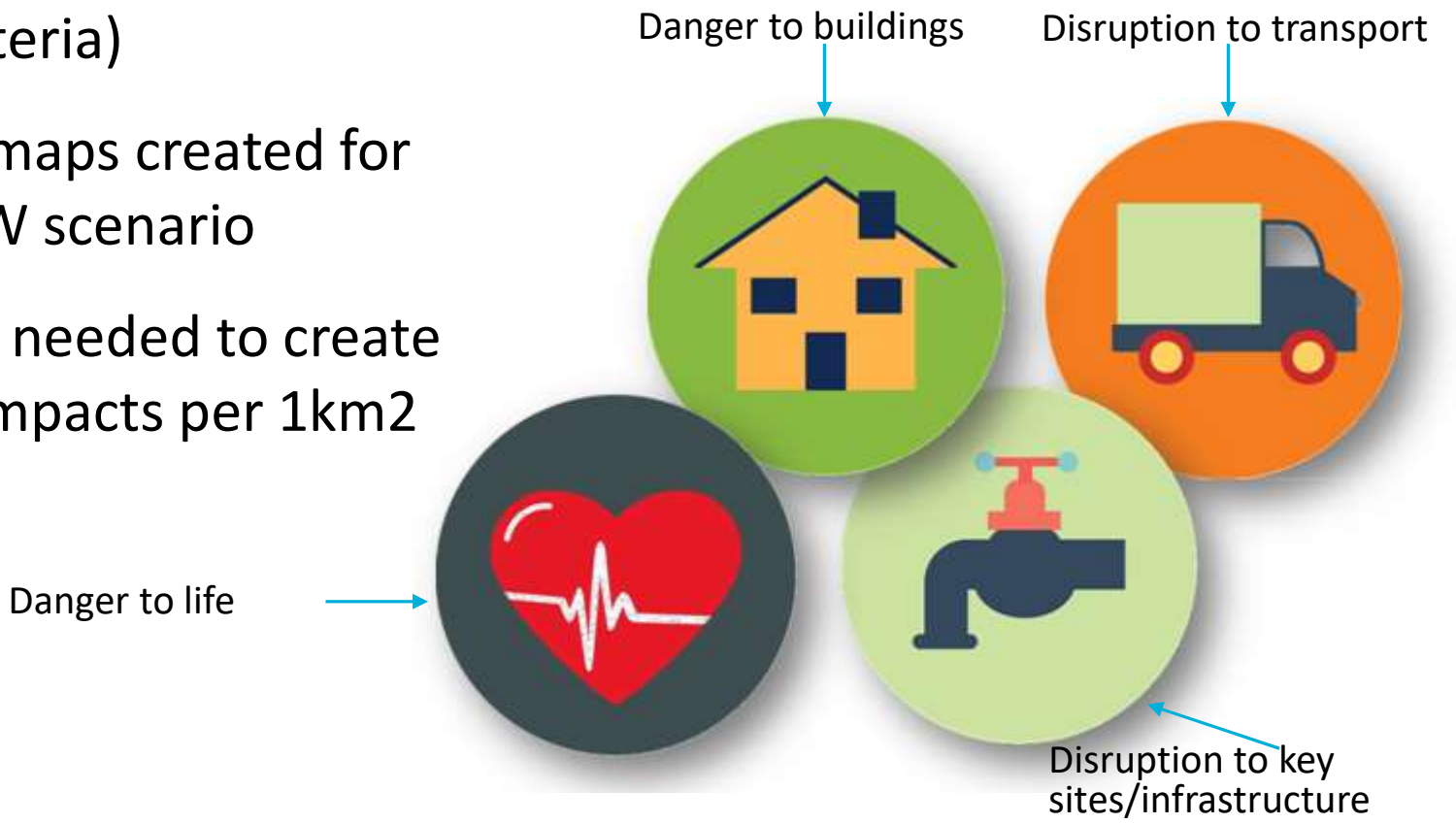
Comparison of JFlow simulation depths with point observations



Spatial comparison with geo-referenced photographs

Impact library

- Developed offline, look-up
- Categories of disruption (impact criteria)
- Threshold maps created for each RoFSW scenario
- Judgement needed to create counts of impacts per 1km2



Impact library construction

Hazard

Risk of flooding from surface water: Extent, Depth, Velocity, Hazard

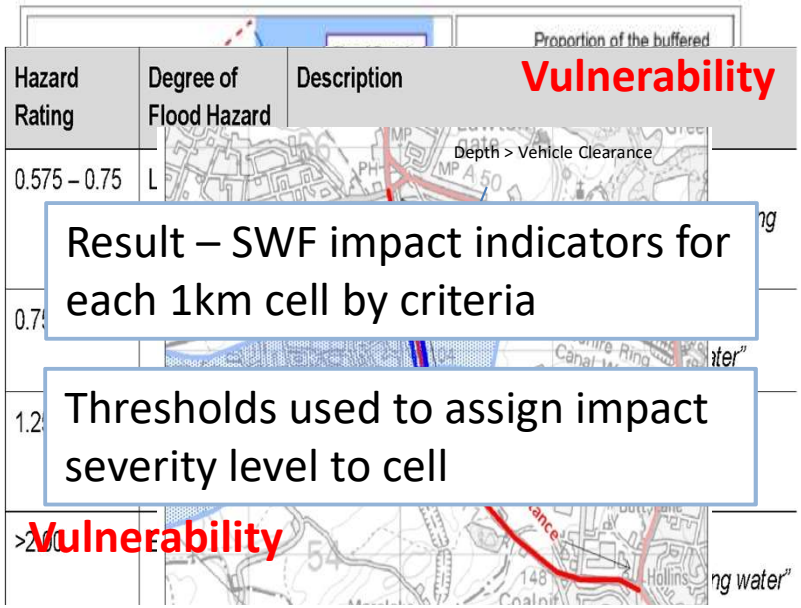
- High resolution (2m)

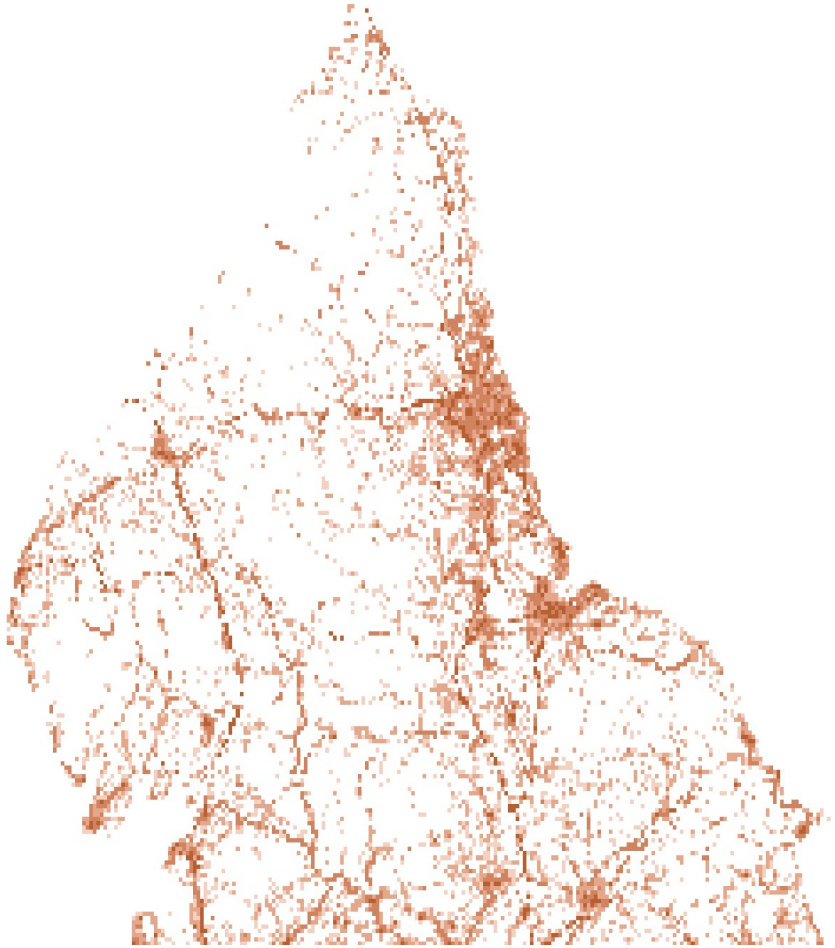
Exposure datasets

Is property flooded?

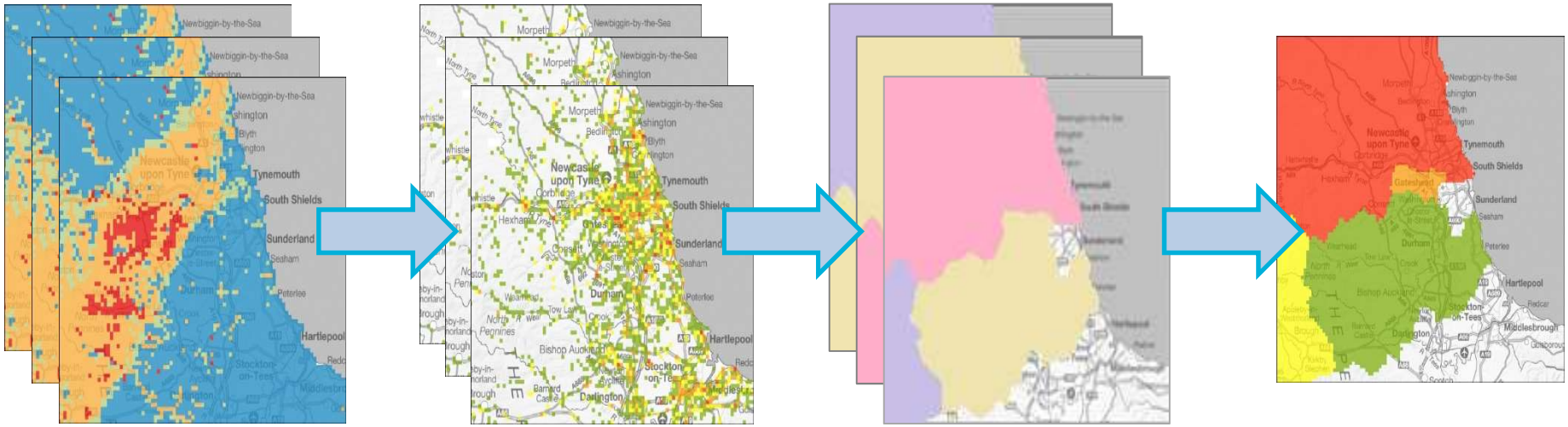
OS MasterMap Building Information

Danger to life?





Outputs and visualisation



Ensemble of SWF hazard footprint

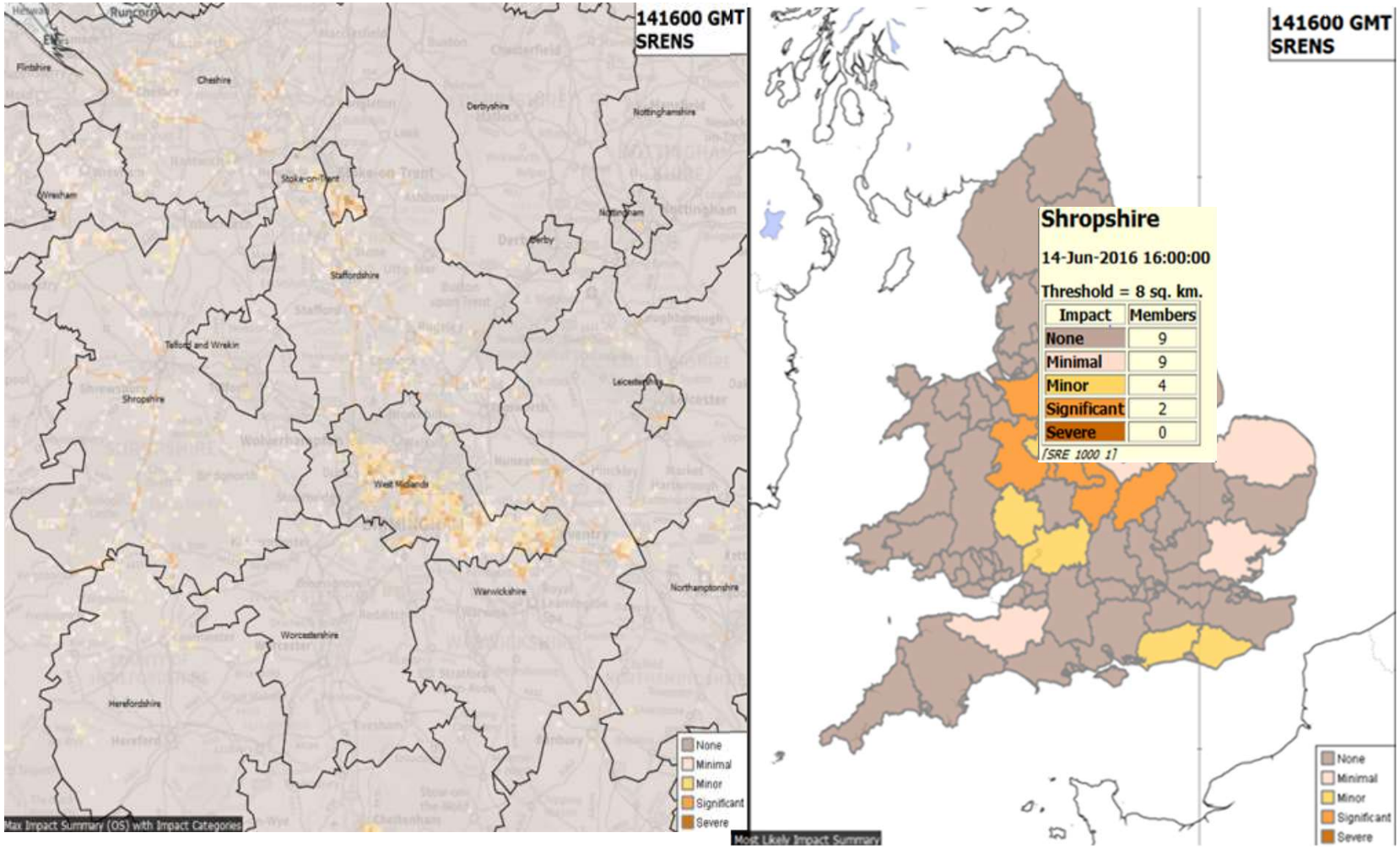
1km impacts from impact library

County summary of SWF impact

County summary of SWF risk

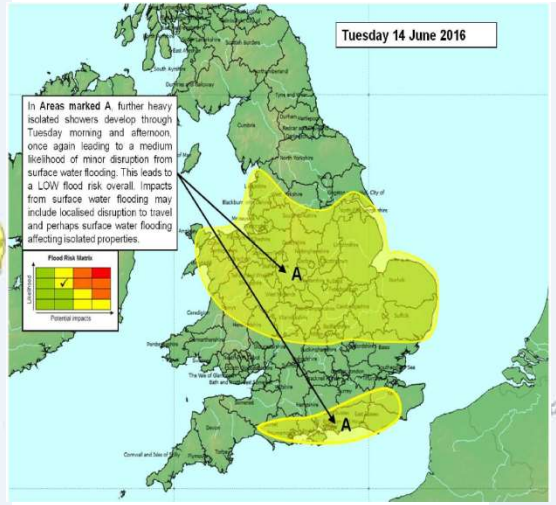
County impact summary for each ensemble member
Combine impact **and** likelihood to calculate risk
Reporting by County/Unitary Authority
Summarises over time, space & uncertainty

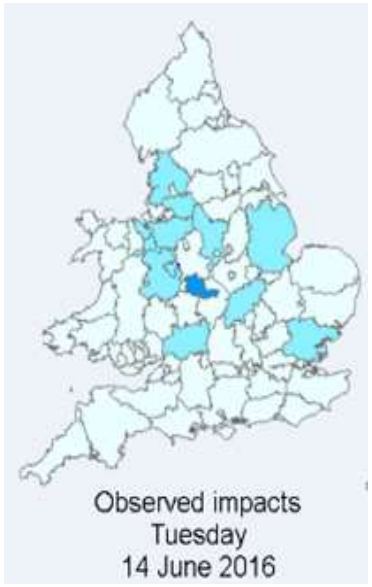
SWF HIM Visualisation – maximum impact summaries

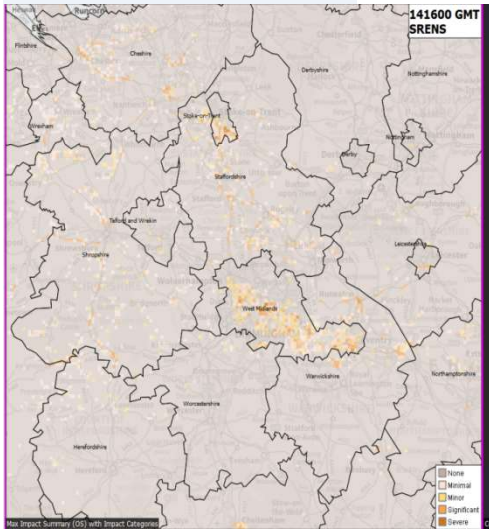


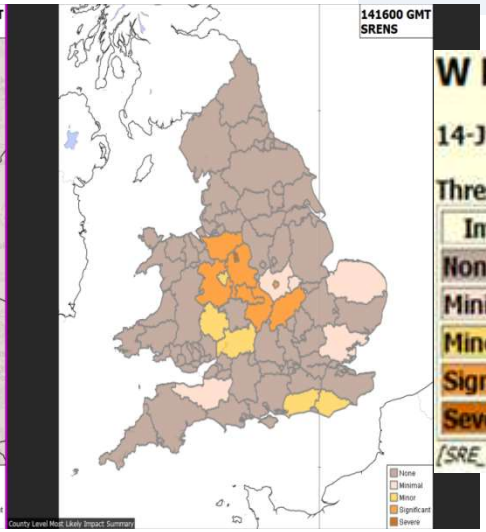
1km & county summary of maximum impact severity & county summary of ensemble members

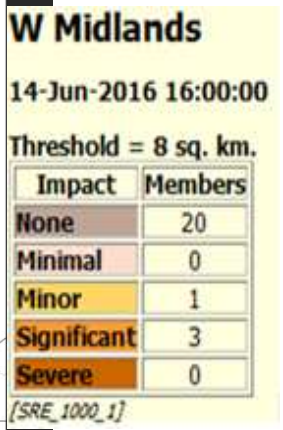
SWF HIM Case Study – 14 June 2016











Forecast for 1600hrs, from 0400hrs model run

To summarise - common challenges……for example

Shoni Maguire | National Manager, Disaster Mitigation Policy, BoM

- **Bureau & Emergency Service agencies**: all reviewing the way we do warnings to improve their effectiveness with the community
- **World Meteorological Organisation**: recommended an impact based approach to forecasts and warnings to overcome the barriers in the community understanding hazard information
- **Impact based forecasting** has been implemented in a variety of ways in various countries
- Learn from these experiences and collaboration with organisations, and NHMS such as , the EA & MO
- **Integration** of appropriate data sets is a key in enabling the development of these new services
- the 'Data Integration Partnership for Australia' is one such initiative underway that is looking to bring together the building blocks to enable new services to be delivered

A pilot on impact based forecasting,
https://www.bnhcrc.com.au/resources/poster/3710

Harald Richter, Beth Ebert, Jeff Kepert, Russell Stringer[1], Craig Arthur, Martin Wehner, Claire Krause, Mark Dunford, Mark Edwards, Jane Sexton, Russell Hay[2]

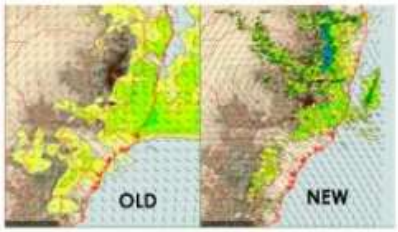
[1] Bureau of Meteorology [2] Geoscience Australia

THIS PROJECT WILL DEVELOP A PILOT CAPABILITY TO PREDICT IMPACTS OF EXTREME WIND AND RAINFALL ON THE BUILT ENVIRONMENT WITH THE GOAL OF IMPROVING TIMELY MITIGATING ACTIONS BY A WIDE RANGE OF STAKEHOLDERS. THIS PILOT PROJECT WILL INITIALLY FOCUS ON EAST COAST LOW EVENTS THAT OFTEN SEVERELY IMPACT THE SUBTROPICAL EAST COAST OF AUSTRALIA VIA A RANGE OF HAZARDS INCLUDING HIGH WIND AND RAIN.

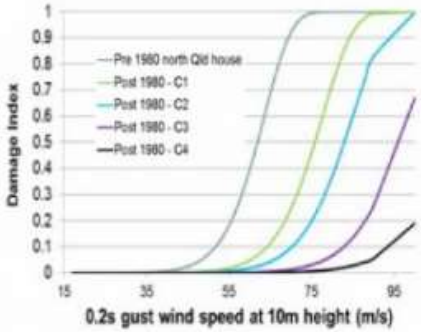
Current hazard forecasts issued by the Bureau of Meteorology are based on meteorological analyses of many data sources, combined with local knowledge, and informed by conceptual models and years of experience in the issuing and verification of forecasts.

Until recently, forecasts were somewhat general in nature, due in part to uncertainty in forecast accuracy, and the need for brevity in worded forecasts and warnings.

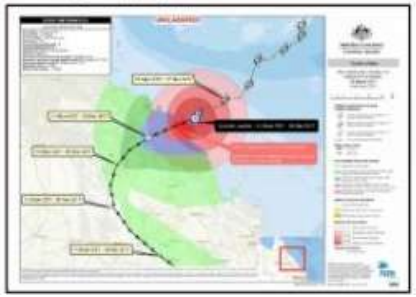
Forecast accuracy has substantially improved over the last couple of decades, with higher resolution models and model ensembles now increasingly available, allowing the forecaster to specify the associated uncertainty.



The Bureau now provides operational forecasts as national gridded data.



Geoscience Australia has also been trialling impact products with the Attorney-General's Department to understand what is exposed before, during and after events. These trial products will be a starting point for the development of impact forecasts during this project.



PROJECT METHODOLOGY

The project aims to provide more tailored information in hazard forecasts so that emergency managers can address questions such as:

1. What does a wind speed of 90 km/hr mean for my area of responsibility?, or
2. What can I do ahead of the event to minimise impact?

To do this, the project will undertake the following components:

- Planning (including identification of use-cases, user requirements, available regional and national scale data, review of international approaches)
- Develop workflows to integrate high resolution meteorological forecast models with impact models and test the results against historic data
- Assess data issues relating to scale, and uncertainty
- Develop impact statements that relate thresholds of hazard to impact
- Trial workflow implementation and test outputs with a range of users

Climbing the same hill

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