

# Regional scale forecasting for surface water floods

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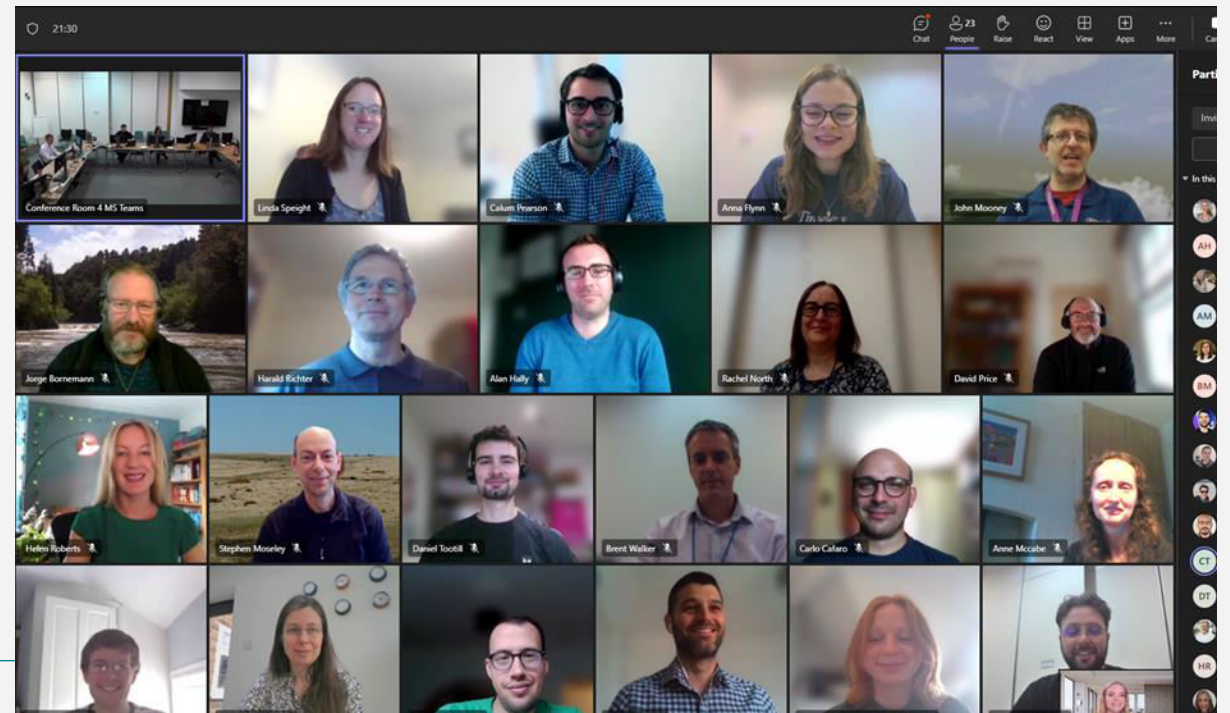
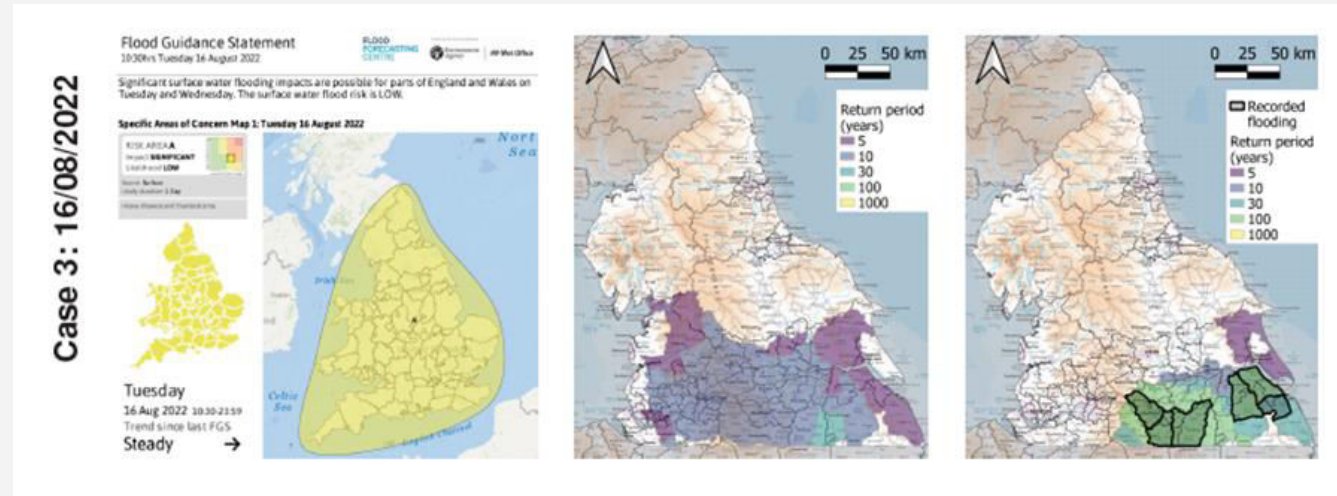
With thanks to...

Ben Maybee,  
Cathryn Birch,  
Steven Böing,  
Thomas Willis,  
Aurore Porson,  
Charlie Pilling,  
Kay L. Shelton  
Mark Trigg,  
Julia Perez,  
David Price +  
others

## University of Leeds led (iCASP) project developing regional surface water flood forecasts (FOREWARNS)

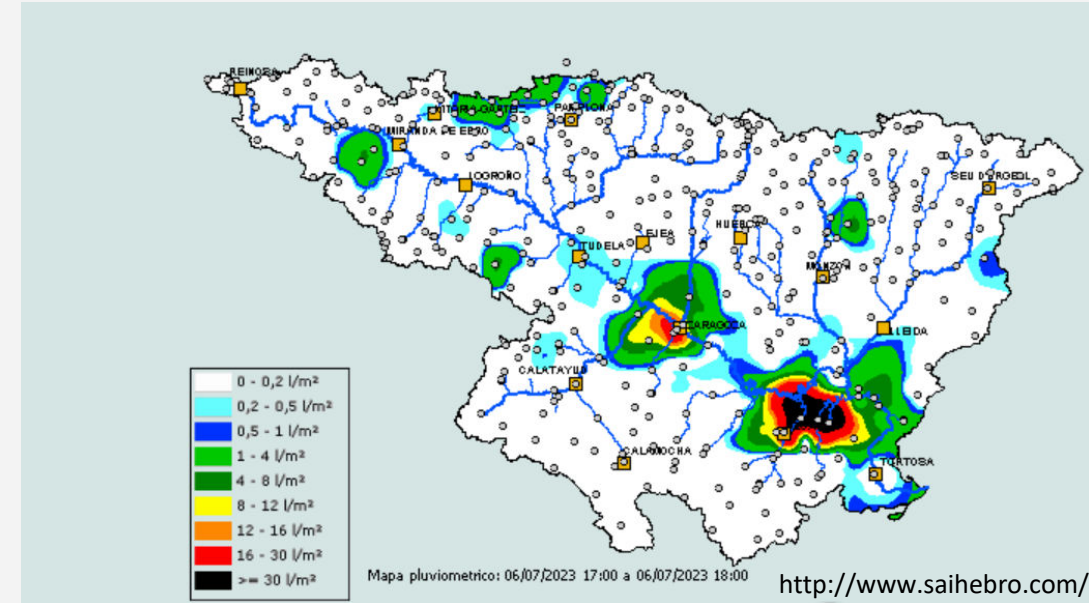
Maybee, B. et al (2023) FOREWARNS: Development and multifaceted verification of enhanced regional-scale surface water flood forecasts. NHESS Discussions. <https://doi.org/10.5194/nhess-2023-83>

## Met Office Summer 2023 Testbed: Convection and Ensembles



# Zaragoza, Spain July 6<sup>th</sup> 2023

(In the first two weeks of July devastating floods also occurred in USA, Indonesia, Russia, Turkey, Brazil and India)



05 JUL 2023 | 10:26 PM UTC

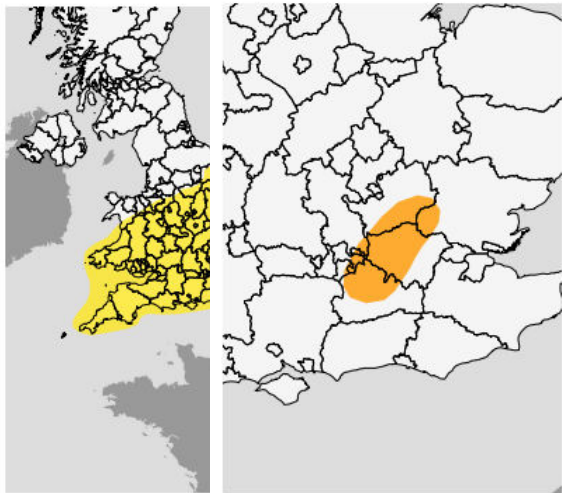
## Spain: Adverse weather forecast across northeastern regions through at least July 8

Severe weather forecast across parts of northeastern Spain through at least July 8. Transport, business, and utility disruptions possible.

# UK, London July 25<sup>th</sup> 2021

Met Office National Severe Weather Warning Service

**Yellow warning Rain** **Amber warning Thunderstorm** Between **14:33 Sun 25 Jul 2021** and **19:00 Sun 25 Jul 2021**



**Heavy showers and isolated thunderstorms are likely to cause surface water flooding.**

**What to expect**

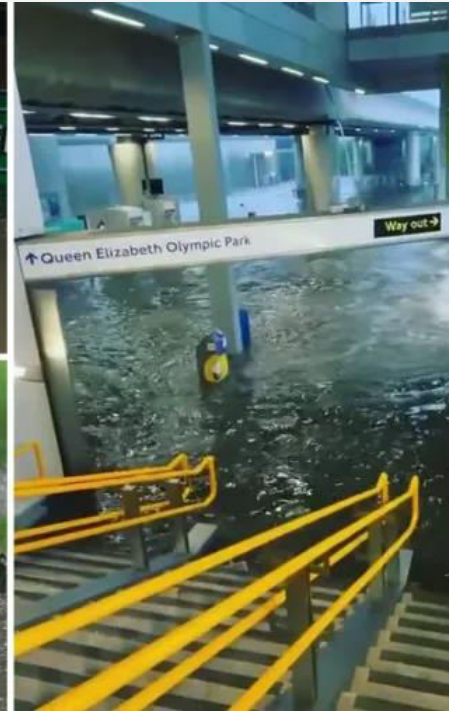
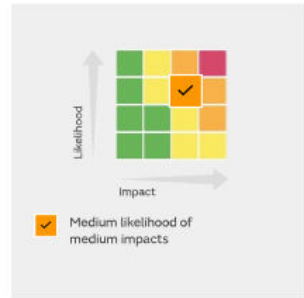
- Flooding of homes and businesses is likely and could happen quickly, with damage to some buildings from floodwater and isolated lightning strikes.
- Where flooding or lightning strikes occur, delays and some cancellations to train and bus services are likely
- Spray and sudden flooding probably leading to difficult driving conditions and some road closures

**Further details**

Outbreaks of rain and some spread from the southwest unsettled conditions to mid Saturday and Sunday. Heavy break out by day, particularly widespread and locally torn expected. Rainfall amounts will vary potential for up to 100 mm the course of the weekend period of time.

**Further details**

Heavy showers and thunderstorms have formed in a line stretching northeast from Surrey towards western Essex. This line will remain fairly slow-moving through the coming hours, while individual showers or storms tend to move southwest along it. Each shower could bring 20-40mm of rainfall within an hour, with isolated locations that experience several showers perhaps seeing 75-100mm of rainfall within the space of a few hours. Although some isolated lightning is likely rainfall and the associated surface water flooding are expected to bring the greatest impacts.



Images from [metro.co.uk](https://www.metro.co.uk)

**Issued at 11:06 Wed 21 Jul 2021**  
 For enquiries regarding this warning please contact the Met Office Weather Desk  
 Phone: 0370 900 0100 E-mail: enquiries@metoffice.gov.uk  
 Visit: www.metoffice.gov.uk/premium

**Issued at 14:33 Sun 25 Jul, 2021**  
 For enquiries regarding this warning please contact the Met Office Weather Desk  
 Phone: 0370 900 0100 E-mail: enquiries@metoffice.gov.uk  
 Visit: www.metoffice.gov.uk/premium/hazardmanager



# FOREWARNS

**MOGREPS UK**  
Ensemble rainfall forecast

**Reasonable Worst Case Rainfall Scenarios:**  
Percentile-based neighbourhood processing

**Threshold look-ups:**  
Catchment level comparison against model values underpinning static **Risk of SWF maps.**

**Local return period of SWF**

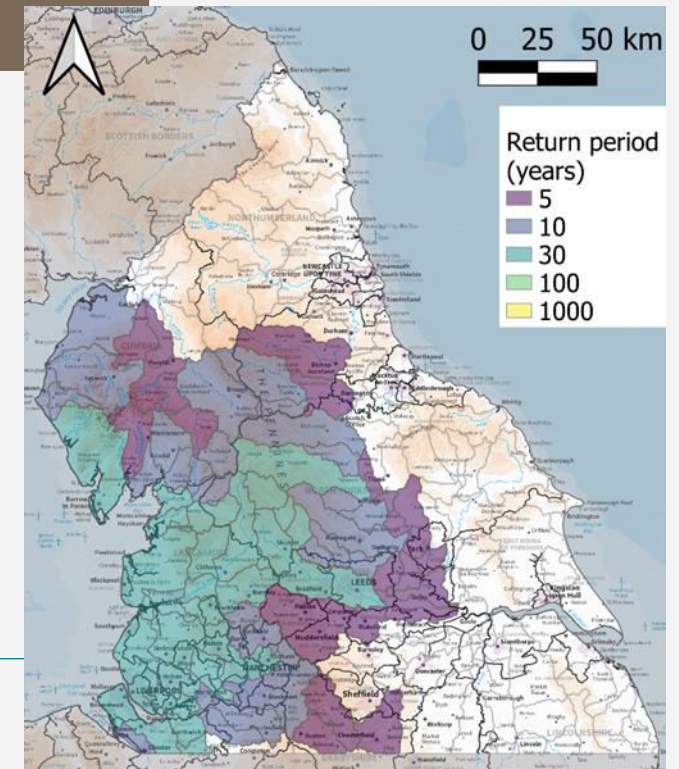
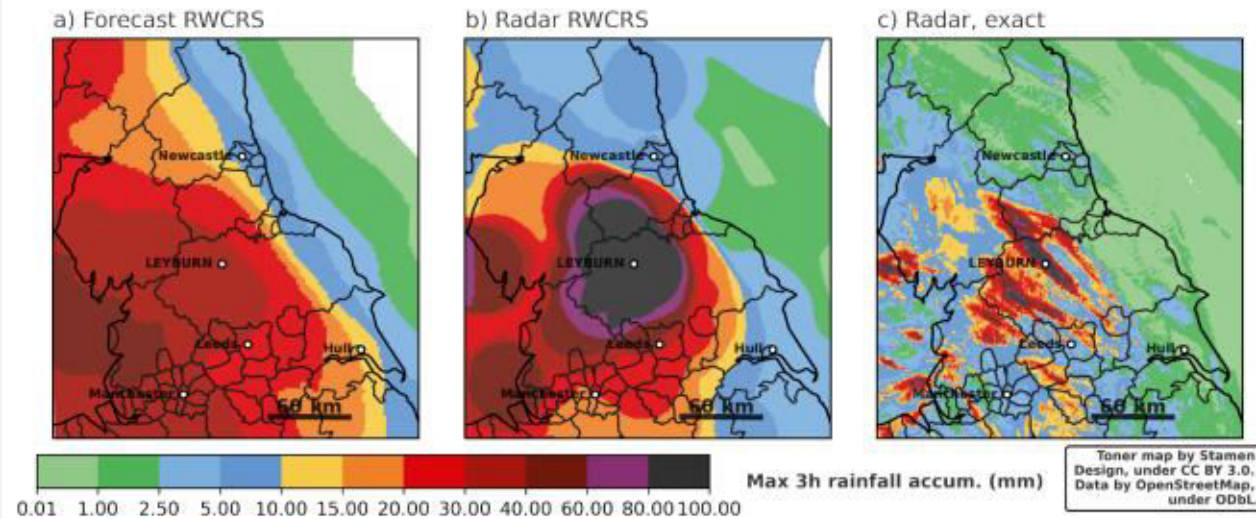
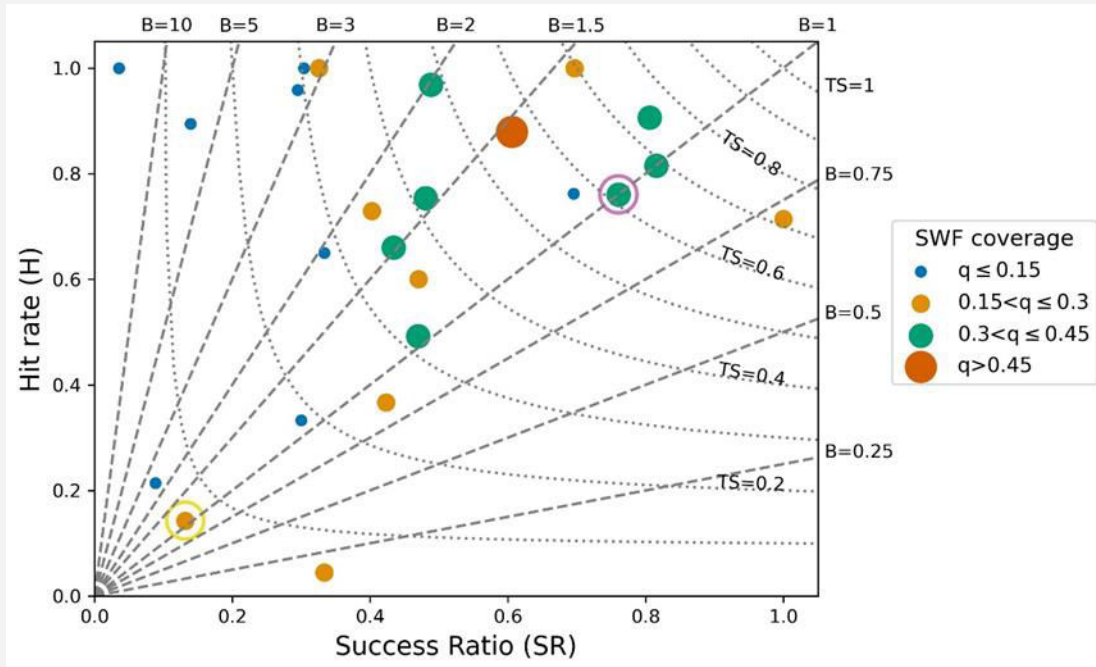


Figure 1. Forecast and radar observations of maximum daily rainfall accumulation (accum.) in 3 hours for Northern England, valid 30/07/2019. (a) Accumulations forecast by (r30, p98, T180) RWCRS generated from previous day's 20:00 UTC 18 member MOGREPS-UK ensemble rainfall forecast. (b) Benchmark (r30, p98, T180) RWCRS generated from Met Office Nimrod radar observations on 30/07/2019. Labeled town of Leyburn, North Yorkshire, recorded severe SWF impacts. (c) Exact (unprocessed) maximum rainfall accumulations in 3 hours, from same radar product.

# Verification & Testing

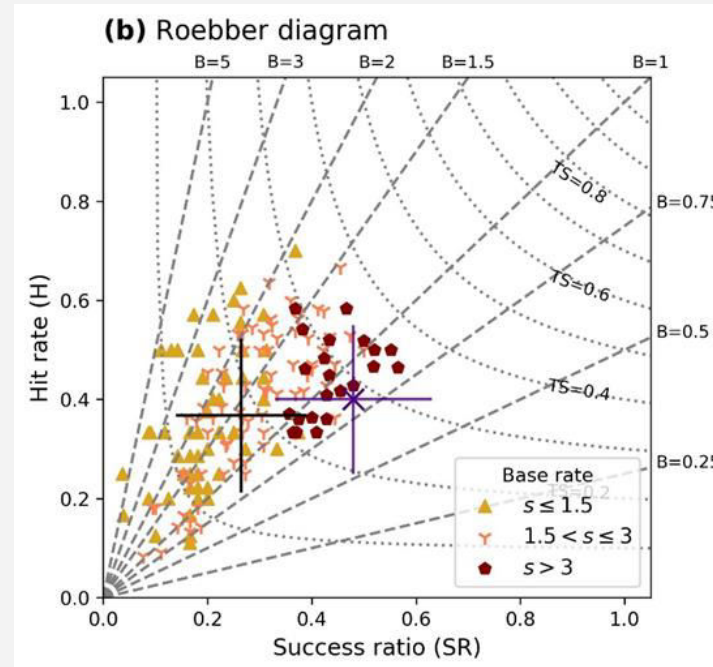
## Spatial (2013-2022)



- High location hit rate but extents overestimated

Roebber performance diagram for (r30, p98) FOREWARNS forecasts of the 28 days recording significant flood events, 2013–2022. Values plotted are spatial skill scores for individual forecast issued, computed against corresponding radar SWF proxy for all return periods (any indication of SWF). Markers shaded and sized based on proportion  $q$  of highlighted catchments. All scores shown are equitable (worst score zero, perfect score one), forecasts close to the top right corner of the diagram show highest skill. All forecasts are based on the 15:00 UTC MOGREPS-UK ensemble forecast issued the day before an even

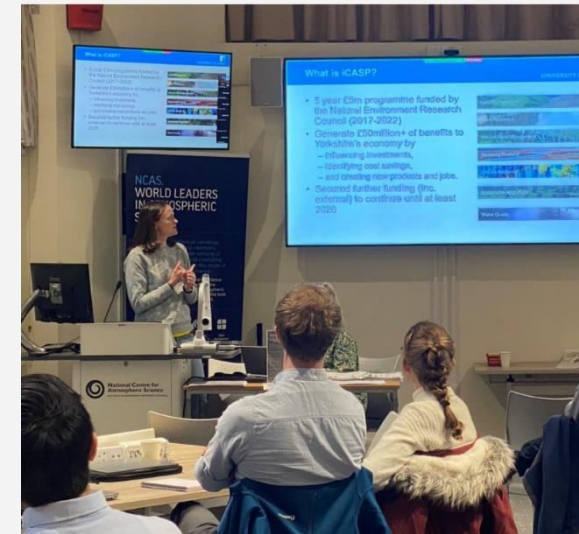
## Temporal (2019-2022)



- High false alarm rate (better where more SWF)
- Forecasters prioritised regional misses over false alarms

+ Objective mean (individual catchments)  
+ Subjective mean (overall spatial patterns)

## User Workshop



- FOREWARNS positive difference to decision making prior to major events
- Use of reasonable worst-case was better than under-forecasting events

# Comparison against SWFHIM



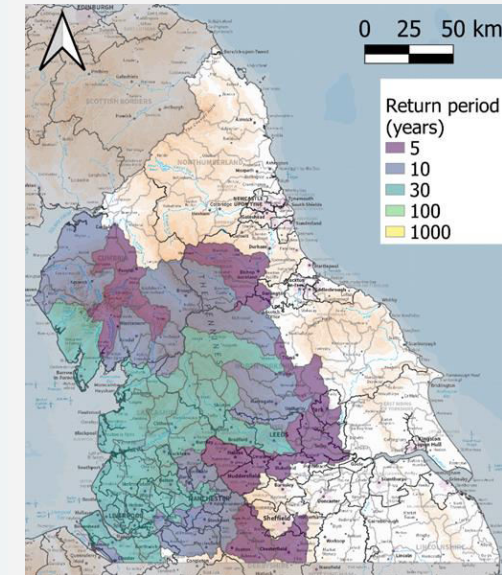
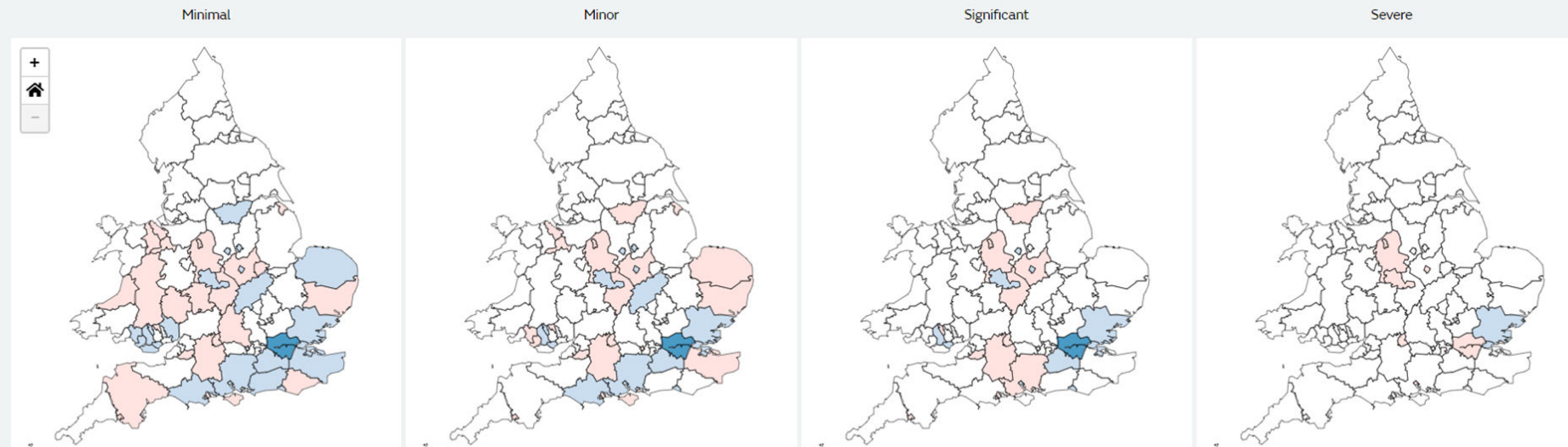
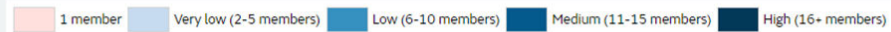
SoGE | School of Geography and the Environment



FLOOD FORECASTING CENTRE | Surface Water Flooding Hazard Impact Model | County | Grid (20km) | Grid (1km) | Status | A working partnership between Environment Agency | Met Office

View: Tue 16 Aug 2022 1845 GMT | Critical Storm Duration: 3 hours | Aggregation: 24 hours

Run Time (RT): Tue 16 Aug 2022 1845 GMT



Valid Time (VT): Thu 18 Aug 2022 0000 GMT

The Flood Forecasting Centre use the Surface Water Flood Hazard Impact model (SWFHIM) to inform their assessment of SWF risk for the national Flood Guidance Statement. SWFHIM is driven by MOGREPS UK and uses the Grid-to-Grid (G2G) hydrological model to link forecast rainfall to SWF scenarios based on the Environment Agency / NRW Risk of Flooding from Surface Water maps and an impact library ([Aldridge, et al. 2020 JRFM](#))

# Testbed activities

## 1. Draw “risk areas” based on the flood forecast

Name of your group: A1  
Forecast activity date: 08 July 2023

Likelihood	High		B	E	G
	Medium				
	Low		A	C	F
	Very Low				D
		Minimal	Minor	Significant	Severe

Impact

Comment box: RS IL and FOREWARNS update.  
Largely based on FOREWARNS.

Risk Area Labels:

A B D E F G

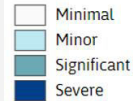
## 2. Qualitatively assess the forecast against observed rainfall and impacts

### FGS Verification & Observed Impacts

#### Key - Risk



#### Key - Impact



Properties in Wrexham were flooded following heavy rainfall throughout the day on Saturday (>30mm)

Mostly Jazz Funk & Soul Festival

UPDATE

We're absolutely devastated that this evening's weather took such a biblical turn. Thank you to everyone for your patience and cooperation, we're relieved that everyone made it out safely. We're very grateful to all our staff for managing a safe evacuation. (1)



19:56 PM · Jul 8, 2023

Festival evacuated – Birmingham (>40mm?)

**Birmingham:** We are awaiting confirmation on properties flooded but at this stage believe the figure to be between **80 & 90** and these were from surface water flooding.

**Derbyshire:** We have had confirmation of **internal flooding of 15 commercial properties from surface water.**



Midlands



# Consistency

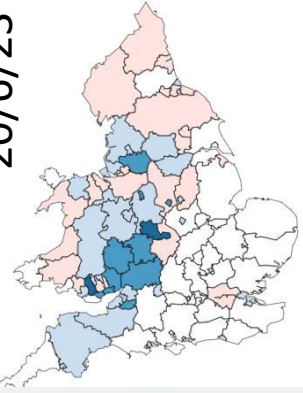


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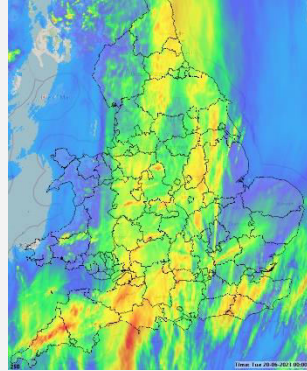
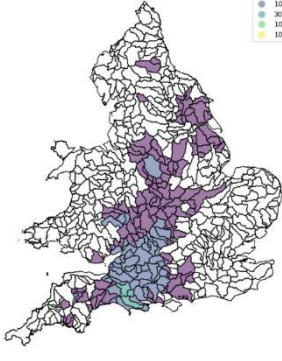


Minor

20/6/23



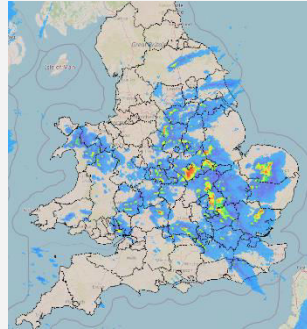
(r30,p98) FOREWARNS forecast valid 20/06/2023  
From 19/06/2023 15UTC MOGREPS-UK cycle



22/6/23



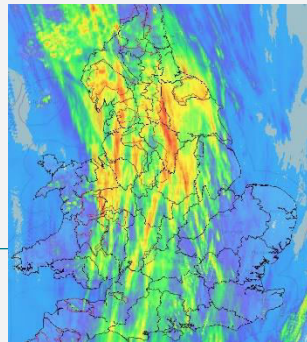
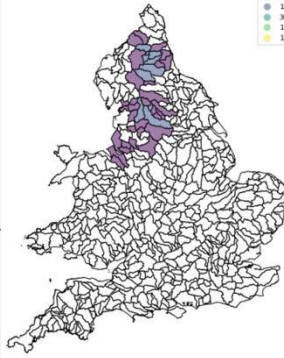
(r30,p98) FOREWARNS forecast valid 22/06/2023  
From 21/06/2023 15UTC MOGREPS-UK cycle



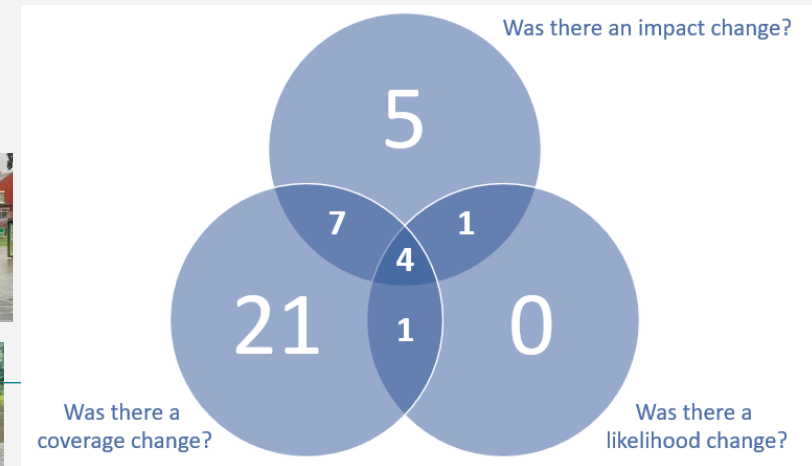
6/7/23



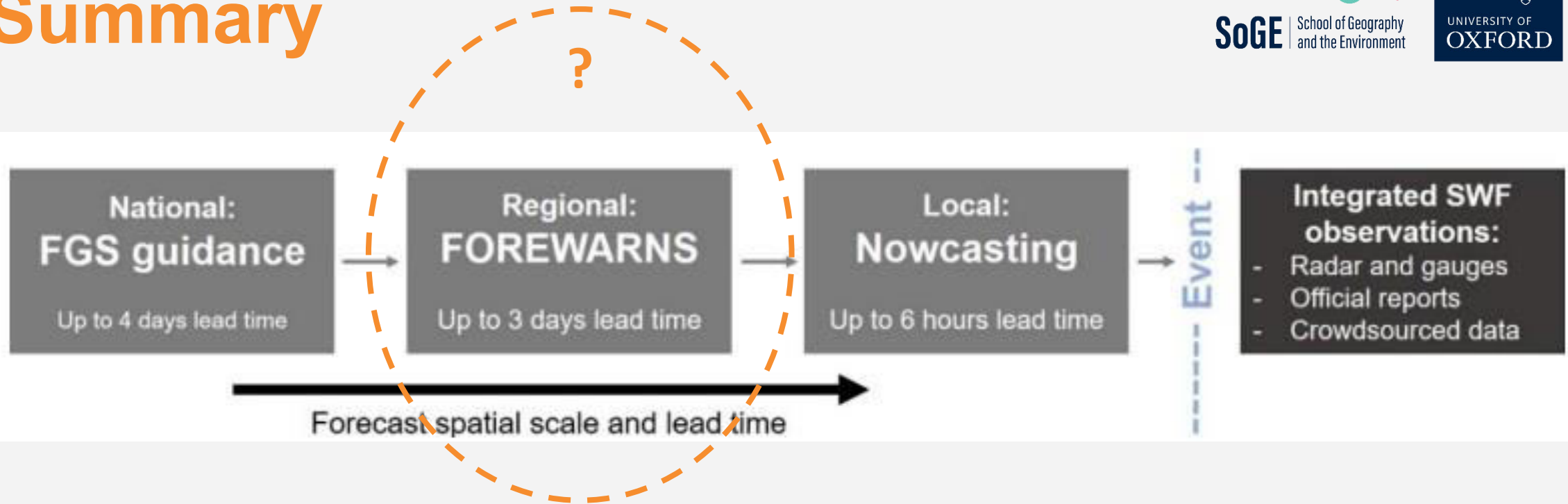
(r30,p98) FOREWARNS forecast valid 08/07/2023  
From 07/07/2023 15UTC MOGREPS-UK cycle



		FOREWARNS					Total
		Hit	Miss	Correct Reject	False alarm	Unsure	
SWFHIM	Hit	25%	2%	0%	0%	4%	30%
	Miss	6%	8%	0%	0%	4%	17%
	Correct reject	0%	0%	21%	0%	0%	21%
	False alarm	4%	4%	8%	0%	0%	15%
	Unsure	6%	6%	2%	0%	4%	17%
Total		40%	19%	30%	0%	11%	100%



# Summary






- Urgent need to plug the gap at lead times of 1-2 days and at a regional scale
- Potential to make better use of rainfall ensembles based on user requirements
- Something is (hopefully) better than nothing

# Thank you for listening

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