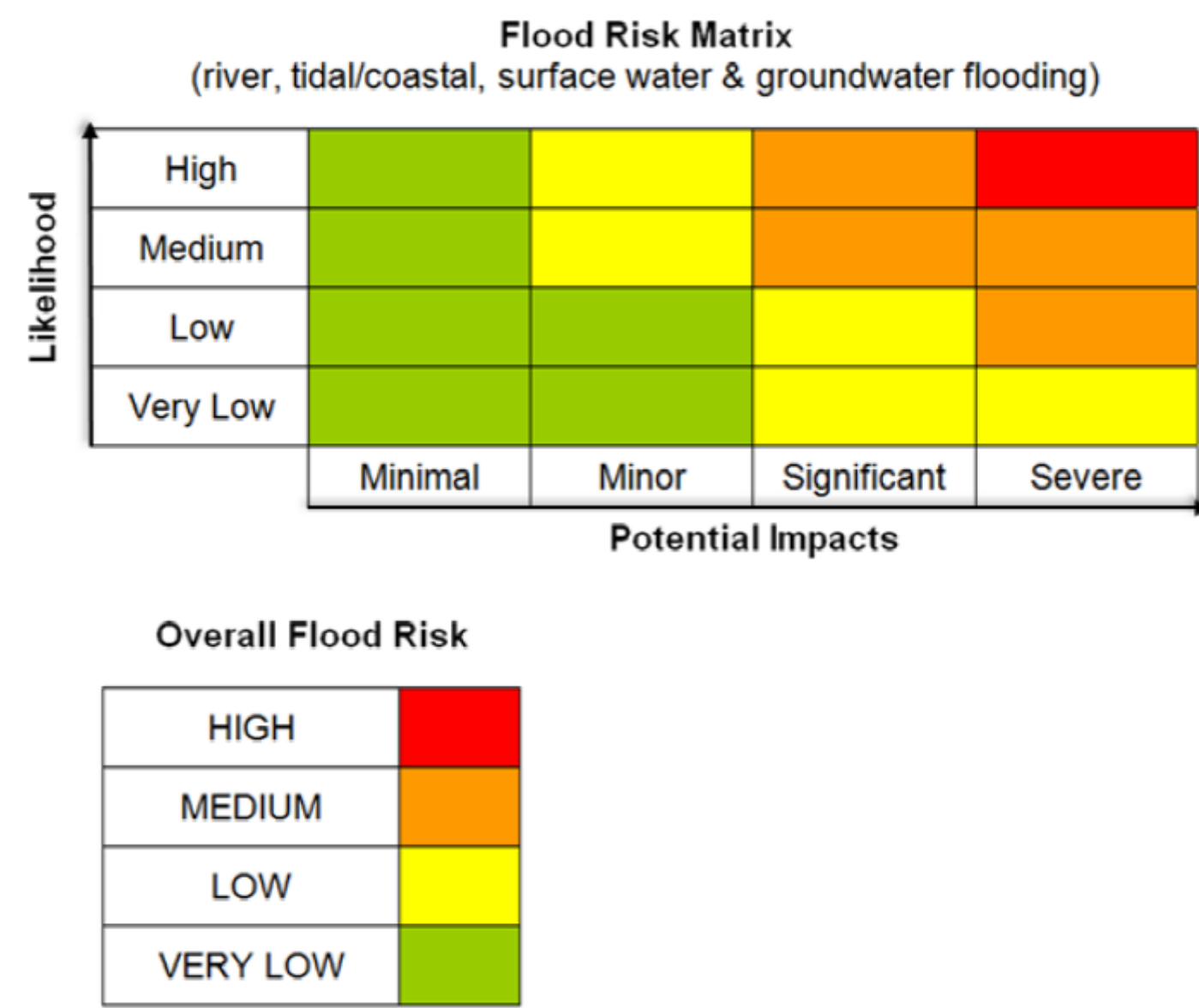


Verification of FFC Flood Risk Forecasts

Julia Perez, Flood Forecasting Centre, Exeter



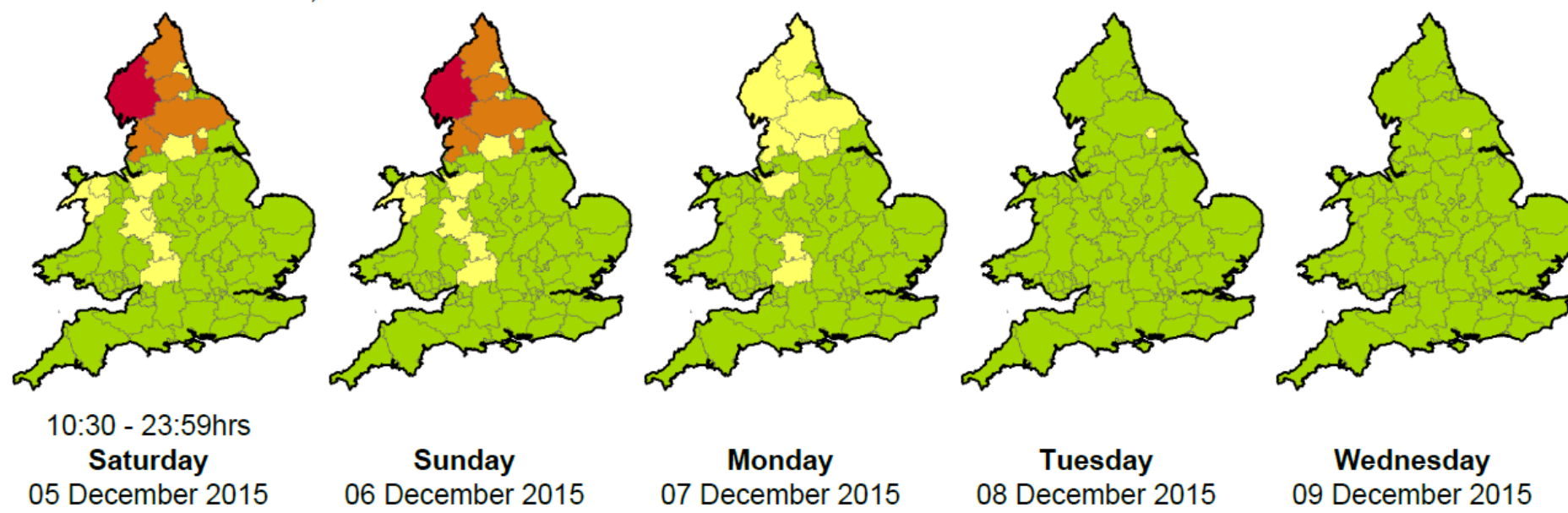
Introduction

The Flood Forecasting Centre (FFC), based at the Met Office in Exeter, is a partnership between the Met Office and Environment Agency. It is responsible for producing forecasts of flood risk from all natural sources of flooding (river, surface water, coastal and groundwater) across England and Wales for the emergency response community. This is in the form of the Flood Guidance Statement (FGS) which uses the Flood Risk Matrix (left). Verification of the FGS is required for communication of our performance to professional partners, customers and colleagues, as well as driving service improvements; however, the probabilistic nature of the forecast and subjective categorisation of flood impacts pose substantial challenges. Over the last year, the FFC has upgraded the FGS Verification System (FGSV) web tool, which has allowed us to improve the choice of verification statistics that are presented to our users, and start to derive more meaningful conclusions on the performance of our probabilistic forecast products.

Forecasting Flood Risk

Flood Guidance Statement 10:30hrs Saturday 05 December 2015

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.

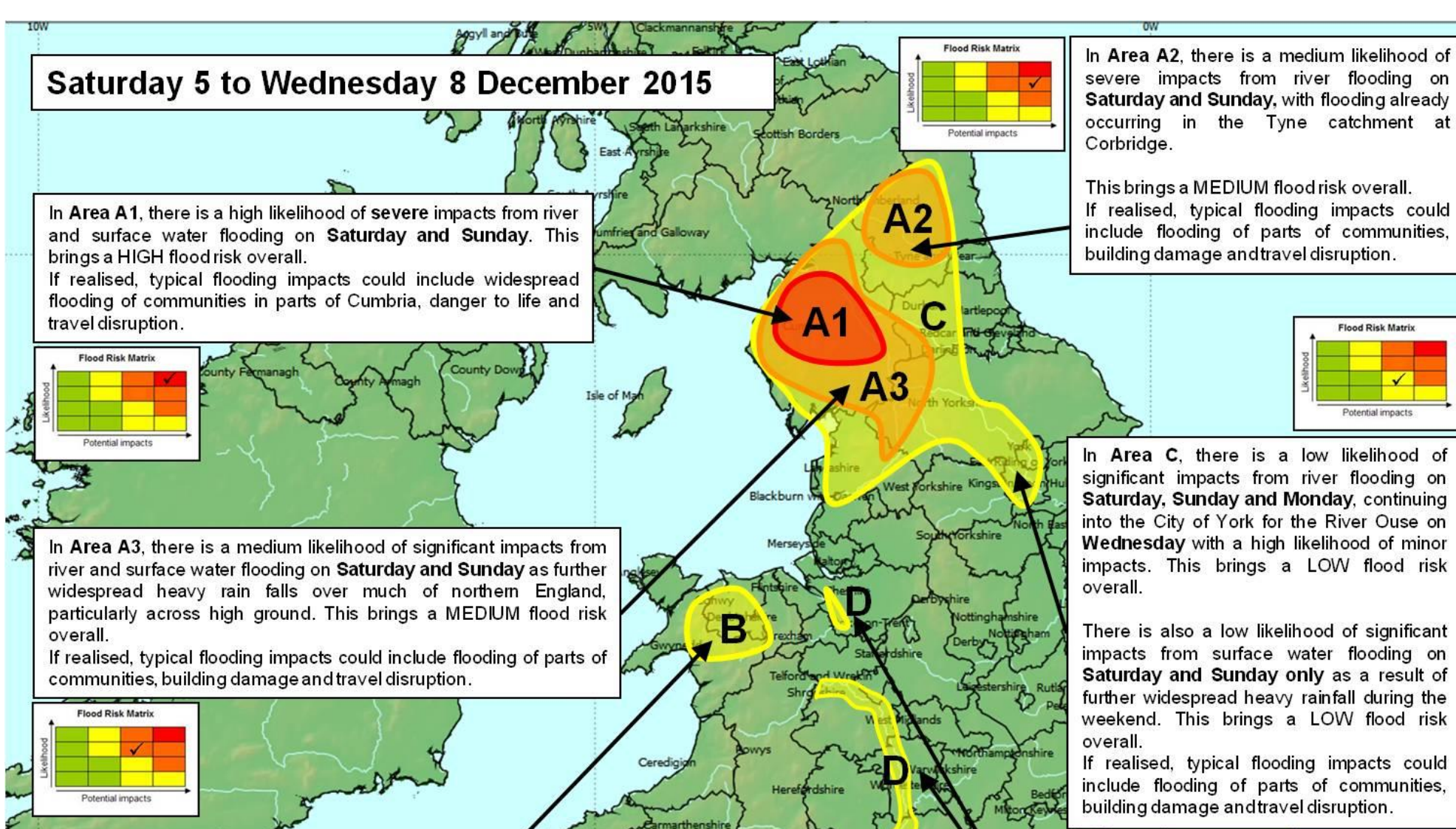


The highest overall flood risk for England and Wales over the next five days is HIGH, with severe impacts likely across northern England.

A daily assessment of the *likelihood* of flooding from each source against the potential *impact* is made, to give the overall flood risk.

Probabilistic forecast information (below) is used to derive the Best Estimate, Reasonable Worst Case, and Extreme Worst Case scenarios if applicable.

- MOGREPS-UK/G total precipitation probability
- ECMWF total precipitation probability and EFI
- G2G medium range fluvial flow ensemble (using MOG-UK and downscaled MOG-G precipitation)
- MOGREPS-G wave and surge ensembles
- ECMWF wave height probability and wind EFI
- Surface Water Flooding Decision Support Tool (to be replaced by Surface Water Hazard Impact Model)
- Environment Agency and Natural Resources Wales 'what-if' fluvial flow and coastal inundation modelling



FGS Specific Areas of Concern map

Conclusions

- FGS performance analysis using measures 1-3 shows that the FGS performed well against rolling 36 month targets for FY 2015/16.
- Future POD & percentage verified RAG targets should be increased for surface water and river flooding.

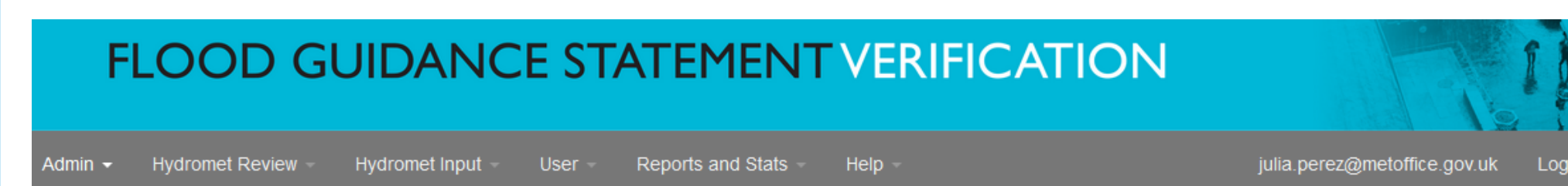
Assessing Flood Impacts

Both the forecasting and observation of flood impacts is based on a subjective assessment, using the criteria in the Flood Impacts Table.

| FLOOD IMPACTS TABLE | | | |
|---|--|---|--|
| to be used by FFC (FGS), EA and Met Office (weather alerts / warnings of heavy rain) as an optional link on websites | | | |
| Typical impacts | Minimal impacts | Minor impacts | Significant impacts |
| <ul style="list-style-type: none"> • Generally no impact, however there may still be • Isolated and minor flooding of low-lying land and roads • Isolated instances of spray/wave overtopping on coastal promenades • Little or no disruption to travel although wet road surfaces could lead to difficult driving conditions | <ul style="list-style-type: none"> • Localised flooding of land and roads - risk of aquaplaning • Localised flooding could affect individual properties • Individual properties in coastal locations affected by spray and/or wave overtopping • Localised disruption to key sites identified in flood plans (e.g. railways, utilities) • Local disruption to travel - longer journey times | <ul style="list-style-type: none"> • Flooding affecting properties and parts of communities • Damage to buildings/structures is possible • Possible danger to life due to fast flowing/deep water/wave overtopping/wave inundation • Disruption to key sites identified in flood plans (e.g. railways, utilities, hospitals) • Disruption to travel is expected. A number of roads are likely to be closed | <ul style="list-style-type: none"> • Widespread flooding affecting significant numbers of properties and whole communities • Collapse of buildings/structures is possible • Danger to life due to fast flowing/deep water/wave overtopping/wave inundation • Widespread disruption or loss of infrastructure identified in flood plans (e.g. railways, utilities, hospitals) • Large scale evacuation of properties may be required • Severe disruption to travel. Risk of motorists becoming stranded |

Reports of flood impacts are collated and manually input to FGSV, from various sources:

- Environment Agency and Natural Resources Wales HELP reports and sit reps
- Media, twitter, traffic & fire service reports
- Met Office Weather Observations Website (WOW)



Observation summary

Saturday 05 December 2015

| Observation basic ID | Observation Date | Counties affected | Comment | Impacts added |
|----------------------|---------------------------|---|---|---------------|
| 1784 | Saturday 05 December 2015 | Counties: Cumbria, Gwynedd | Major incident declared. Widespread and severe disruption. Communities evacuated. Road and rail disruption. Some areas cut off. Assistance from fire and rescue, red cross, RLU and armed forces. 3 bridge collapses. | 50 |
| 1785 | Saturday 05 December 2015 | Counties: Durham | Properly flooding and cars stuck in water. Fire service assisting. | 5 |
| 1786 | Saturday 05 December 2015 | Counties: Darlington, Northumberland, Tyne and Wear | Village evacuated when River Tyne burst its banks. 30 properties confirmed flooded on EA National Flood Brief Report. | 50 |

Verification Measures & Targets

The FFC measures FGS performance for forecasting significant or severe flood impacts, on forecast Day 2 for surface water, Day 3 for river and coastal, and Day 5 for groundwater.

Measures 1-3 (right) were chosen for reporting as they are widely used and easy to interpret. They do not, however, account for the probabilistic nature of the forecast. Red/Amber/Green (RAG) targets are applied to the rolling 36 month period only to allow for meteorological variability.

1. Probability of detection (POD)

Count of *county scale* obs. in brackets

| Flood Source | Lead time | POD (FY 2015/16) | POD (Rolling 36 months) |
|---------------|-----------|------------------|-------------------------|
| Surface Water | Day 2 | 69% (35) | 61% (131) GREEN (>50%) |
| River | Day 3 | 58% (47) | 72% (364) GREEN (>40%) |
| Coastal | Day 3 | N/A (0) | 58% (71) AMBER (>60%) |
| Groundwater | Day 5 | N/A (0) | 74% (156) GREEN (>70%) |

2. Percentage verified (1-FAR)

Count of *national scale* forecasts in brackets

| Flood Source | Lead time | % Ver (FY 2015/16) | % Ver (Rolling 36 months) |
|---------------|-----------|--------------------|---------------------------|
| Surface Water | Day 2 | 25% (32) | 30% (76) GREEN (>10%) |
| River | Day 3 | 30% (33) | 55% (124) GREEN (>20%) |
| Coastal | Day 3 | N/A (1) | 19% (31) AMBER (>30%) |
| Groundwater | Day 5 | N/A (0) | 74% (66) GREEN (>30%) |

3. Lead time of first correct forecast

Lead time which at least half of correct *county scale* forecasts exceeded.

| Flood Source | Target Lead time | Dominant Lead Time (FY 2015/16) | Dominant Lead Time (Rolling 36 months) |
|---------------|------------------|---------------------------------|--|
| Surface Water | Day 2 | Day 4 | Day 4 GREEN |
| River | Day 3 | Day 4 | Day 5 GREEN |
| Coastal | Day 3 | N/A | Day 4 GREEN |
| Groundwater | Day 5 | N/A | Day 5 GREEN |

4. Reliability

Although initially discounted as an external verification measure due to concerns over its complex interpretation, analysis of the *county scale* FGS reliability is giving valuable insights into our usage of the Flood Risk Matrix e.g. over-forecasting of low and medium likelihood significant and severe impacts.

| Forecast Likelihood | Forecast Impact Level | | | |
|---------------------|-----------------------|-------------|-------------|-----------|
| | Minimal | Minor | Significant | Severe |
| High 60% - 100% | 96% 921,618 | 69% 324 | 63% 43 | 58% 52 |
| Medium 40% - 60% | | 31% 4948 | 23% 245 | 3% 47 |
| Low 20% - 40% | | | 6% 2561 | N/A 0 |
| Very Low < 20% | | | 2% 3202 | N/A 0 |

Table of FGS forecast reliability for FY 2015/16 (all sources of flooding, at all lead times). Small numbers are a count of county scale forecasts.

→ Currently scoping project to automatically ingest impact databases such as the EA Flood Warning & Forecasting Validation database (FWFVdb)

- The categorisation of impacts needs to be improved to remove some of the ambiguity of the definitions.
- FFC currently working with NSWWS to re-define impact definitions.