

Verification at the Bureau of Meteorology

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Australian Government
Bureau of Meteorology

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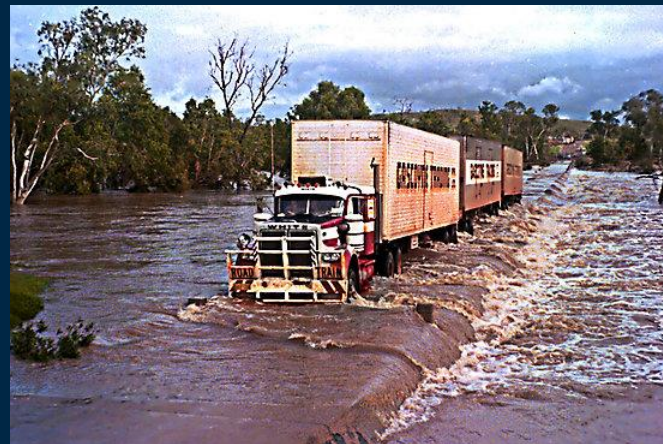
Regional Hydrology Manager
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Flood Forecasting and Warning in WA



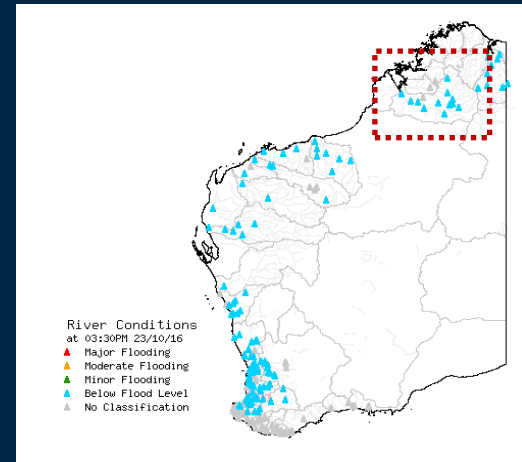
Presentation Overview

- The Bureau's flood warning service: a WA perspective
- Defining verification and its aspects
- Why is verification important to us?
- Verification activities underway in the Bureau
- Key challenges: verifying forecast 'value'



FFW in WA – Perspective

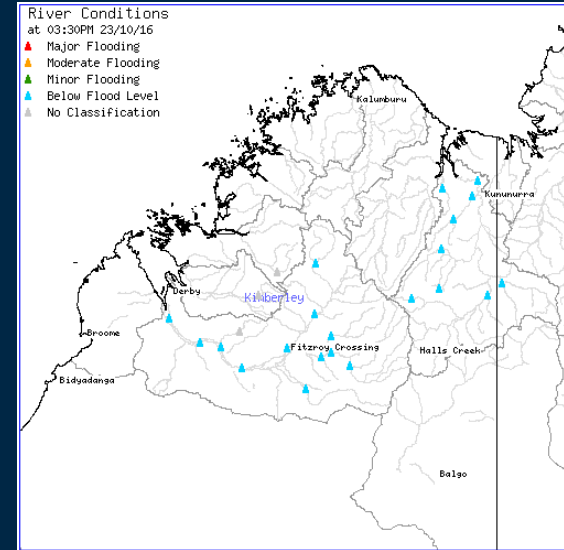
- Very large river systems
- Relatively sparse observation network
- Limited population dispersed through catchments
- Potential for huge flood damage resulting from impacts to infrastructure and logistics



POP QUIZ:

Q: How many Netherlands would fit in the Fitzroy River catchment?

A: 2.25 (or two Netherlands and a Jamaica)

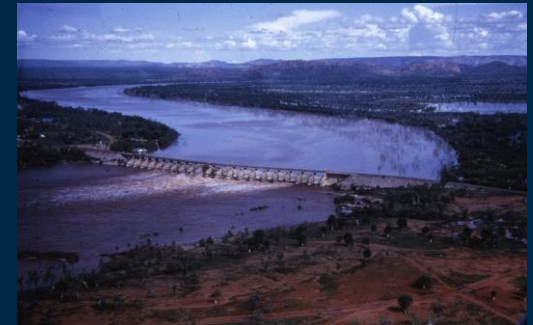


Verification – What is it and why do it?

"If we take the term *forecast* to mean **a prediction of the future state** (of the weather, river level etc.), then **forecast verification** is the process of **assessing the quality** of a forecast."

Why do it?

- to monitor and report on forecast performance - *how accurate are the forecasts and are they improving over time?*
- to compare the quality of different forecast systems - *to what extent does one forecast system give better forecasts than another, and in what ways is that system better?*
- **to improve forecasts - the first step toward getting better is discovering what you're doing wrong.**



Verification – Points of truth...

The "truth" data that we use to verify a forecast generally comes from observed data

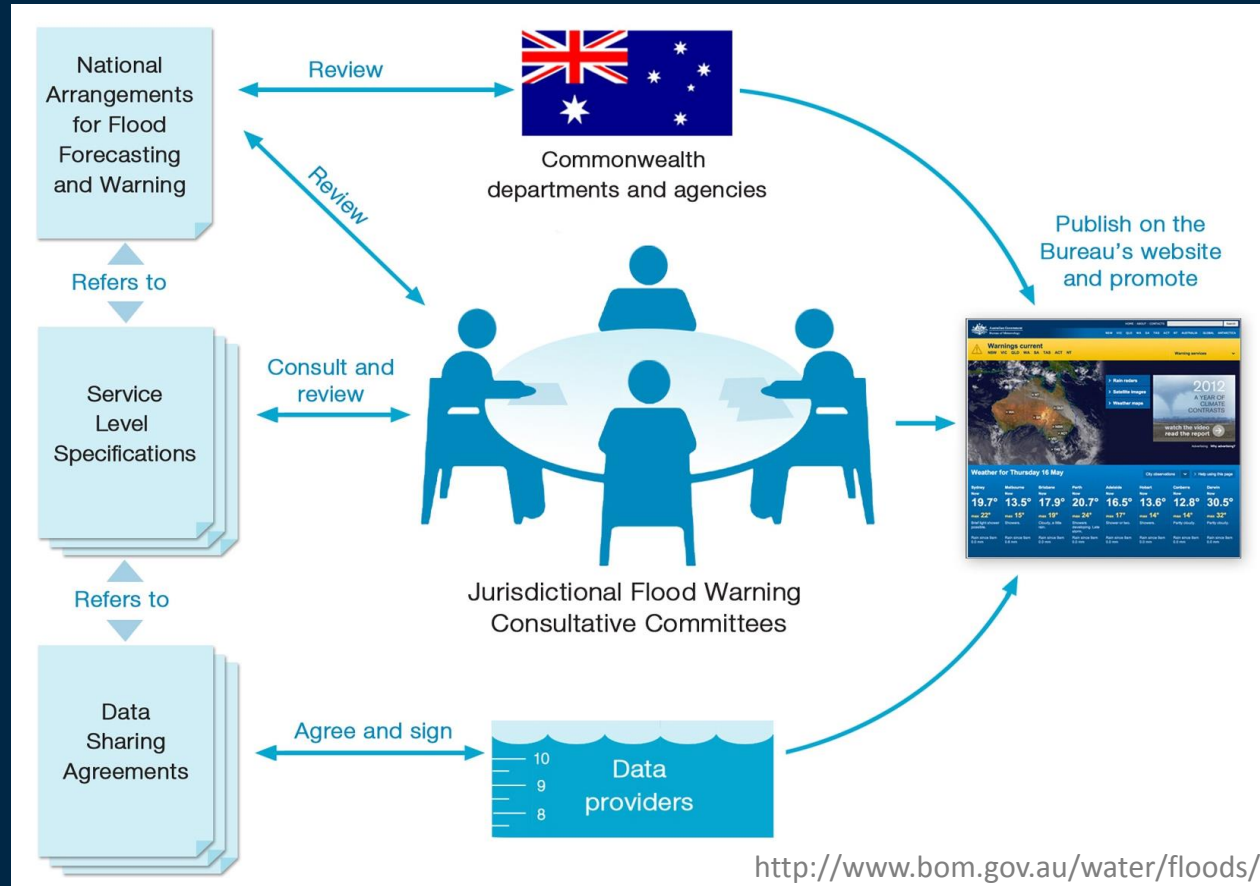
- Potentially limited by availability...
- Fitzroy River is 93,000 km² and we have ~30 rain gauges observing catchment conditions
- Very easy to not observe rainfall from intense local convective systems in the tropics

Other necessities to define forecast performance benchmarks?

- Specifications of agreed levels of service provided at defined locations (Service Level Specifications)
- Data sharing agreements for the data provision on which the service is predicated



Clarifying the Bureau's Role in the Total Flood Warning System



Service Level Specifications

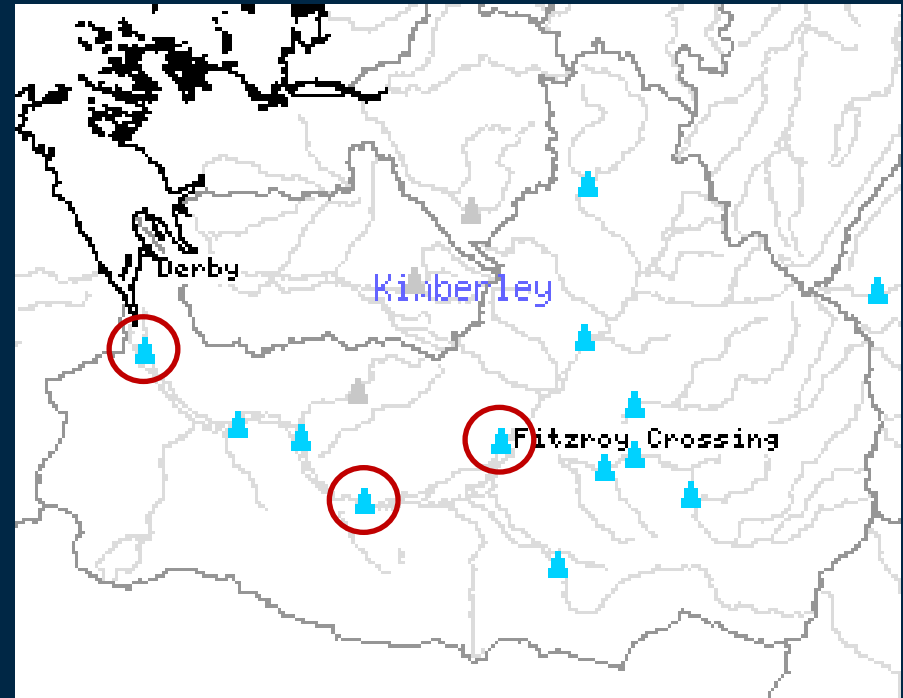
e.g. Fitzroy River, WA

3 Forecast Locations

- Quantitative predictions (peak height / time)
- Relative to Flood Class Level
- Timing to 3 hour blocks

9 Information Locations

- Defined Flood Class Levels
- No quantitative forecasts provided
- Generalised warning information provided



Bureau number	Forecast location	Station owner	Gauge type	Flood classification (m)			Prediction type	Target warning lead time		70% of peak forecasts within	Priority
				Minor	Moderate	Major		Time (hours)	Trigger height (m)		
802 – Fitzroy River (WA)											
503014	Fitzroy Crossing	Department of Water	Automatic	9.5	11.0	12.5	Quantitative	15	Minor	n/a	High
503007	Noonkanbah	Department of Water	Automatic	9.5	12.0	13.0	Quantitative	15	Minor	n/a	High
503013	Willare Crossing	Department of Water	Automatic	8.0	8.8	9.2	Quantitative	48	Minor	n/a	High

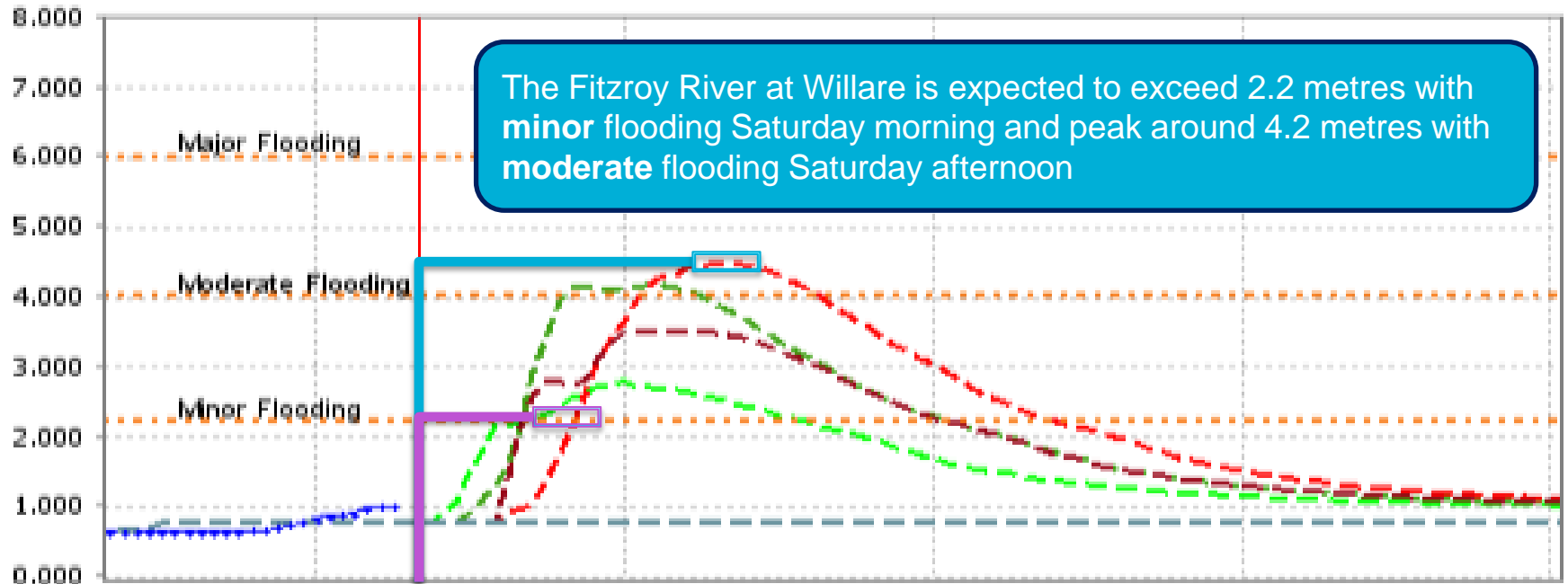
Warning Entry Tool – Example Quantitative Flood Prediction

Rising limb forecast

- Type = Exceed
- Flood class = minor
- Time = 06:00 - 09:00

Peak forecast

- Type = Peak
- Magnitude = 4.2 m
- Time = 15:00-18:00



Warning Entry Tool

Structured Flood Warnings

Warning Region

Warning Sub-Region

Forecast Locations

Latest Observations

Australian Government Bureau of Meteorology, Victoria

Major Flood Warning for the Goulburn and Broken Basins for Major flooding in the Yea River and Minor flooding Goulburn River upstream of Lake Eildon

Issued at 4:38 pm EST on Saturday 4 September 2010
Flood warning number: 6

Since 9 am Friday rainfall totals of up to 50 mm recorded in the Goulburn River Basin. Rainfall is continuing, with further totals of up to 20 mm possible in the Goulburn Basin for the remainder of Saturday.

Stream rises and moderate flooding are occurring throughout the Goulburn basin, with major flooding occurring in the Acheron River, Yea River and Hughes Creek.

Delatite River

Moderate flooding is expected in the Delatite River catchment.

The Delatite River at Tonga Bridge is currently 3.58 metres and rising. The Delatite River at Tonga Bridge is expected to exceed the Moderate Flood Level (4.0 metres) overnight Saturday.

Yea River

Major flooding is occurring in the Yea River catchment.

The Yea River at Devils Bridge is currently at 2.95 metres and rising. It is expected to peak near 3 metres during Saturday evening.

The Yea River at Yea is expected to peak near the moderate flood level (3.9 metres).

Flood Safety Advice:

The SES suggests the following precautions in the interest of community safety:

- Don't walk, ride or drive through flood waters
- Don't allow children to play in floodwaters
- Stay away from waterways and storm water drains
- Keep well clear of fallen power lines

Current emergency information is available at: www.ses.vic.gov.au

For emergency assistance contact SES on 132 500

For life threatening emergencies, call 000 immediately

Current road and traffic information is available at the VicRoads website at:

www.vicroads.vic.gov.au/trafficalerts

Next issue:

The next warning will be issued by 7:30 pm EST Saturday 4 September 2010

Latest river heights:

Goulburn R. at Seymour	3.6m rising	02:45 PM SAT 04/09/10
Hughes Ck. At Taroombe Rd	4.25m rising	04:34 PM SAT 04/09/10
Goulburn R. at Murchison	4.53m steady	04:31 PM SAT 04/09/10
Goulburn R. at Arcadia Downs	6.63m steady	04:02 PM SAT 04/09/10



Forecast Verification Objectives

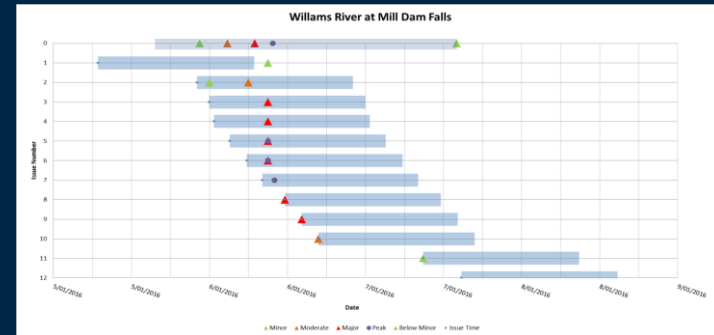
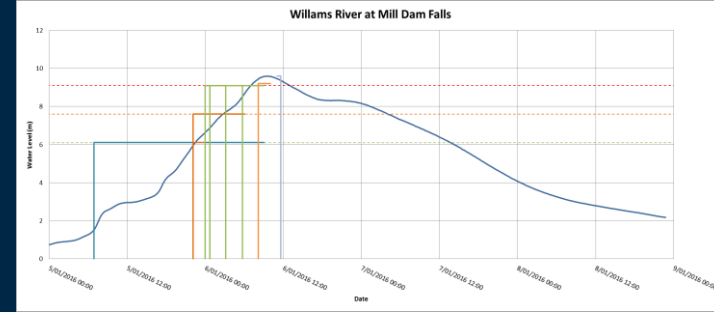
What makes a forecast good?

Allan Murphy (1993) distinguishes three types of forecast "goodness":

Consistency - the degree to which the forecast corresponds to the forecaster's best judgement about the situation

Quality - the degree to which the forecast corresponds to what actually happened

Value - the degree to which the forecast helps a decision maker to realize some incremental economic and/or other benefit



Forecast 'Quality' vs. 'Value'

Forecast quality is not the same as forecast value.

A forecast has high quality if it predicts the observed conditions well according to some objective or subjective criteria.

It has *value* if it helps the user to *make a better decision*.

This is very important to FFW in Australia, particularly in remote areas of Western Australia.



Verification for flood forecasting the Bureau?

We're developing a **Verification Analysis Tool** to assess the performance of predictions issued in flood warnings against a variety of metrics.

It will streamline and automate the current labor-intensive and incomplete process for creating performance reports.

The Verification Analysis Tool is being developed with close connection to the operational HyFS (FEWS) system.

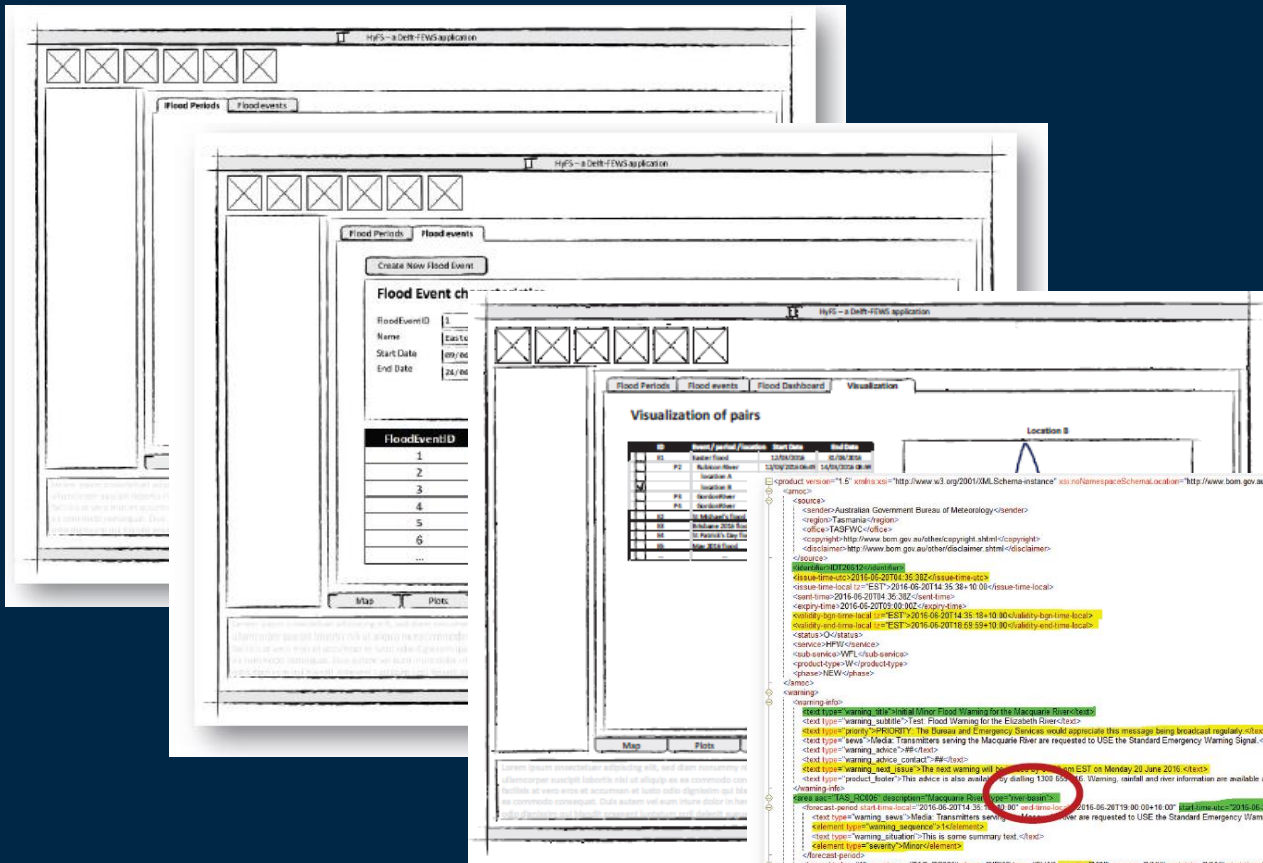


The Verification Analysis Tool

Will deliver the following functionality:

- store information on flood events in database of tagged flood forecasts (WET e.g. issue date, target date, forecast magnitude) along with corresponding flood observations
- access metadata about flood class levels and SLS information
- calculate various verification metrics
 - *probability of detection, false alarm rate, average forecast lead time, and mean absolute error of peak magnitude and/or timing*
- intuitive user interface and report generation
- integration with internal forecasting systems (HyFS)





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WHICH IS REALLY GREAT!

But...

- All this effort is currently focused on *forecast quality*
- What are we doing about verifying *forecast VALUE*?
- How do you do it consistently and objectively?

These are issues we're currently dealing with in consultation with our key stakeholders



Question...

Does a remote indigenous community utilise a water level forecast that's +/- 0.2m at a location that's literally hundreds of kilometres away? Would another type of forecast be better?



Question...

Does the community surrounding the gauge make decisions based on our forecasts? What information do they use? Does it need to be +/- 0.2m in accuracy? How do we find out?



Moving towards user-focused service delivery...

- Historically, we have often decided what's best for our users
- We're becoming more consultative in our approach
- Working closer with emergency response agencies and public stakeholders to better tailor our service to match their needs
 - *Product education activities and feedback (better interpretation / better design)*
 - *Regular stakeholder meetings (Flood Warning Consultative Committees)*
 - *Post event debriefs after significant floods / Commission of inquiry*
 - *Social media monitoring*
- We are starting to **build a culture of verifying forecast value** as a business practice
- Plenty of opportunity to begin extracting forecast value information from current business activities



Thank you

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