Improving flood forecast skill using Remote Sensing data

Research advisory forum / **2018**

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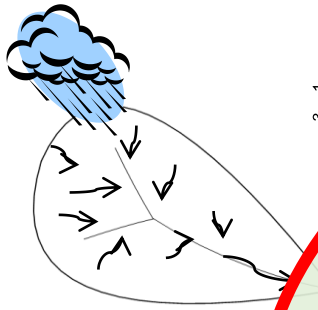
Clarence river, 2013 February 2nd (NSW SES)

@bnhcrc @bnhcrc

Rationale

Accurate flood forecasts are essential for land, water, and emergency management.



GAUGED DATA

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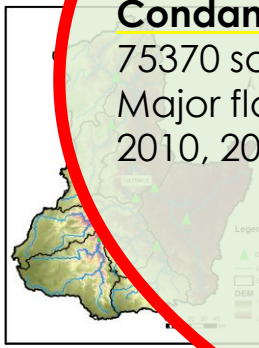
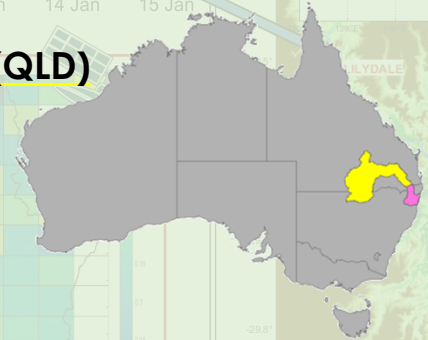


Catchment wetness affects streamflow.

Use of Remote Sensing data to improve flood forecast skill

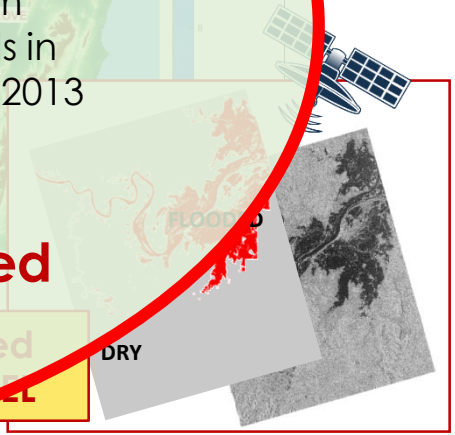
Two test sites

Condamine-Balonne (QLD)
75370 sq. km
Major floods in
2010, 2011, 2012



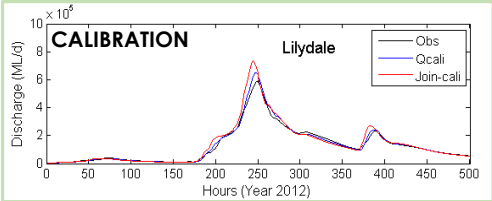
Clarence (NSW)
20730 sq. km
Major floods in
2009, 2011, 2013

Coupled Remote Sensing-constrained hydrologic-hydraulic model by 2020



Research findings: hydrologic model

Model calibration and validation

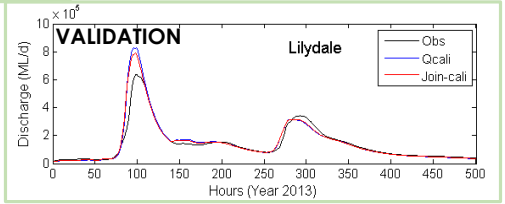


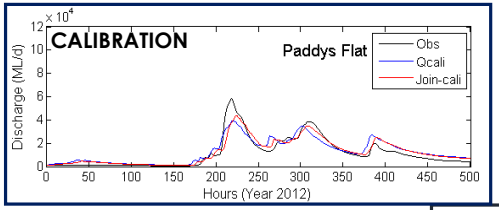
(1 & 2) JOINT dataset

(1) GAUGED DISCHARGE (Q)

(2) REMOTE SENSING SOIL MOISTURE (RS-SM)

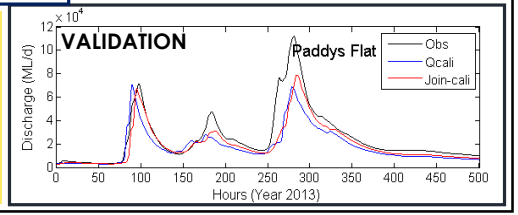
GAUGED SITES *(G)*: 1 & 2 JOINT calibration leads to a **more robust parameter set** which can **improve future streamflow forecasts**.





SMOS (NASA) satellite soil moisture data

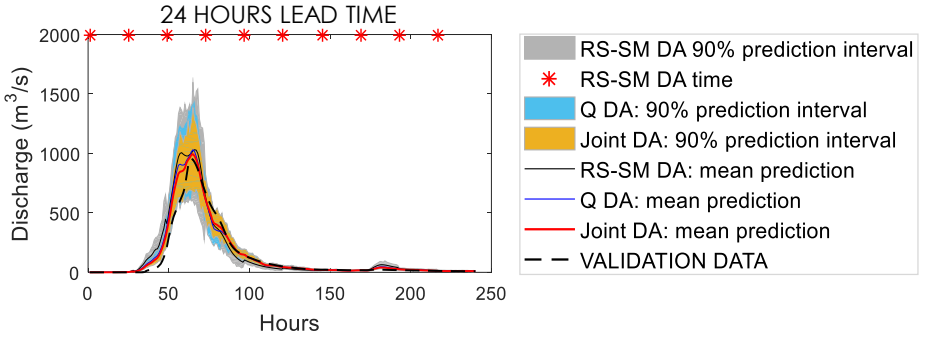
***UNGAUGED* SITES: 1 at *G* & 2 JOINT** calibration leads to **improved** forecast in both the **calibration and validation** periods.



Data assimilation: near real time forecast

Data Assimilation (DA) scheme: Ensemble Kalman smoother.

Synthetic experiment.



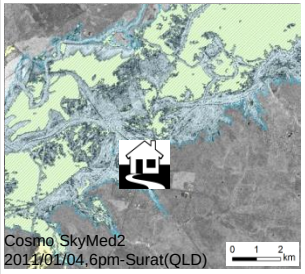
JOINT discharge and RS-SM assimilation outperforms the single variable assimilation schemes.

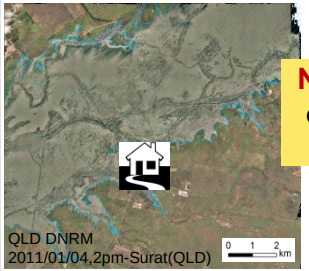
Use of **Remote Sensing-Soil Moisture** enable **more accurate streamflow predictions**.

Research findings: hydraulic model

Remote Sensing data analysis

Synthetic Aperture Radar (SAR) are **active** systems that emit **microwave pulses** → **all time, all weather** (≠ optical data)

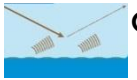




Remote Sensing-derived flood extent
- AIRBORNE
- SAR:"traditional"analysis

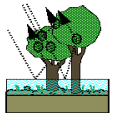
Dry → Flooded

RADAR BACKSCATTER



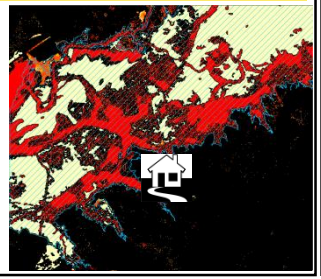
Open water: LOW

Dry surface HIGH



Flooded vegetation: even HIGHER

New algorithm for the **detection of flooded vegetation.**

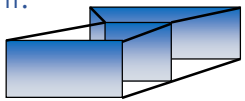


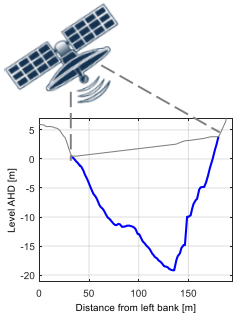
Model implementation

Information on **river bathymetry** is pivotal for floodplain inundation modelling.

1. Field measurements

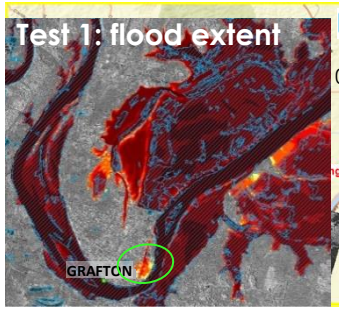
2. Numerical experiment:
a width varying rectangular shape is recommended.

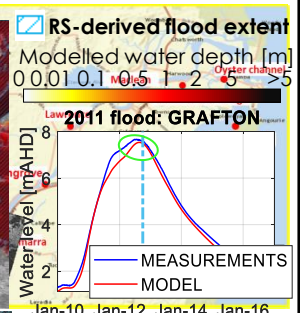


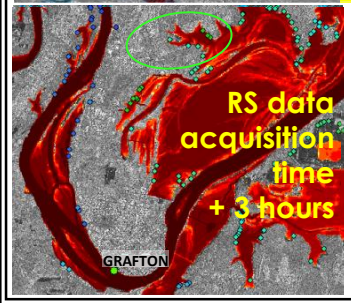


Data parsimonious **implementation method**: **Remote Sensing-derived river width** combined with **a few measurements of river depth** at strategic locations.

Model verification







RS-derived flood level [m]
2 3 4 5 6 7

Remote Sensing data allow more comprehensive ways to verify flood extent and arrival time.

Use of **Remote Sensing-derived** river width, flood extent, and level enables **more accurate modelling of floodplain inundation dynamics.**

Algorithm for accurate **flood detection.**

Utilisation – technical details

RESEARCH OUTCOMES		PRIMARY END-USER and HOW THIS RESEARCH OUTCOME COMPLEMENTS THE CURRENT CAPABILITIES
In a nutshell…	**Detailed description**	
IMPROVED **STREAMFLOW MODELLING**	Use of **Remote Sensing Soil Moisture** for calibration, validation, and real time constraint of **hydrologic models.**	**Australian Bureau of Meteorology** The **Remote Sensing constrained hydrologic modelling** capabilities will enhance the reliability and accuracy of probabilistic **streamflow forecasts**. The **Remote Sensing constrained hydraulic model** will provide the assessment of **flood extent** and enable more detailed information on the **impact** of floods. *– Soori Sooriyakumaran, Chris Leahy*
IMPROVED **INUNDATION EXTENT MODELLING**	Use of **Remote Sensing-derived river width, flood extent and level** for implementation, calibration, and validation of **hydraulic models**.	
IMPROVED **FLOOD FORECAST SKILL**	**Coupled** hydrologic-hydraulic modelling chain constrained using Remote Sensing data.	
ALL WEATHER, ALL TIME **FLOOD DETECTION**	New algorithm for the detection of flooded vegetation using single SAR data.	**Geoscience Australia** Current flood extent detection capabilities are based on optical data (e.g. Water Observations from Space). Thanks to the use of **SAR** data, this research will enable **flood detection under clouds, at night time, and under vegetation**. – *Norman Mueller, Fang Yuan.*

Utilisation potential

RESEARCH OUTCOME		A potential wider community of users	Recommended research developments
In a nutshell…	**Spatial scale of application**		
IMPROVED **STREAMFLOW MODELLING** IMPROVED **INUNDATION EXTENT MODELLING** IMPROVED **FLOOD FORECAST SKILL**	✓ Two test sites:  ✓ **ROADMAP** for the use of Remote Sensing data to improve flood forecast skill. → Potential application at the continental scale.	❖ State Emergency Services. ❖ Councils. ❖ Consulting companies.	➢ Assimilation of Remote Sensing-derived flood extent/level for **near real time constraint of hydraulic models**. ➢ Flood **risk** assessment. ➢ Analysis of flooding **impacts** on infrastructures (e.g. bridges, levees). ➢ Coupling with **tidal** models.
ALL WEATHER, ALL TIME **FLOOD DETECTION**	✓ Tested on a number of SAR images acquired by different sensors. → Potential application to future image acquisitions from new sensors (e.g. NOVASAR)	❖ Irrigation and water management companies.	➢ Integration within **environmental and water management plans** (e.g. wetlands conservation and irrigation plans).

RESEARCH TEAM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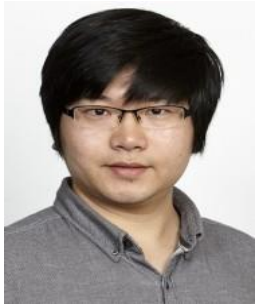
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Thanks for your kind attention!

END USERS

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SES
NSW STATE EMERGENCY SERVICE