Improving flood forecast skill using Remote Sensing data

Clarence catchment, Grafton, 2013 Jan 30th (Credits: Mr. Williamson)

Research advisory forum / **2019**

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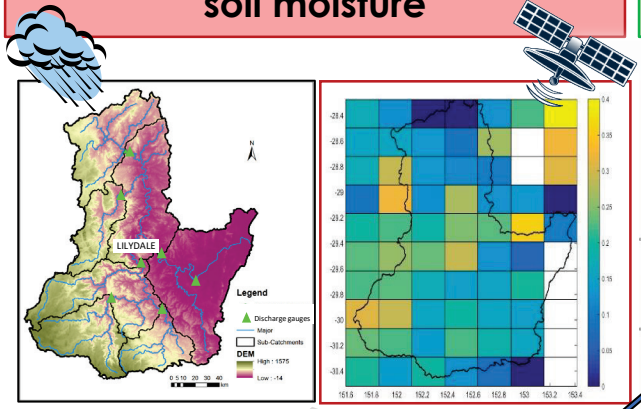
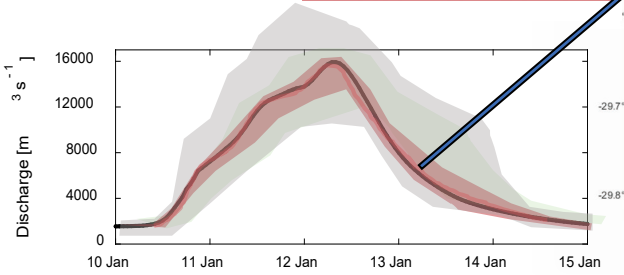
Project outline

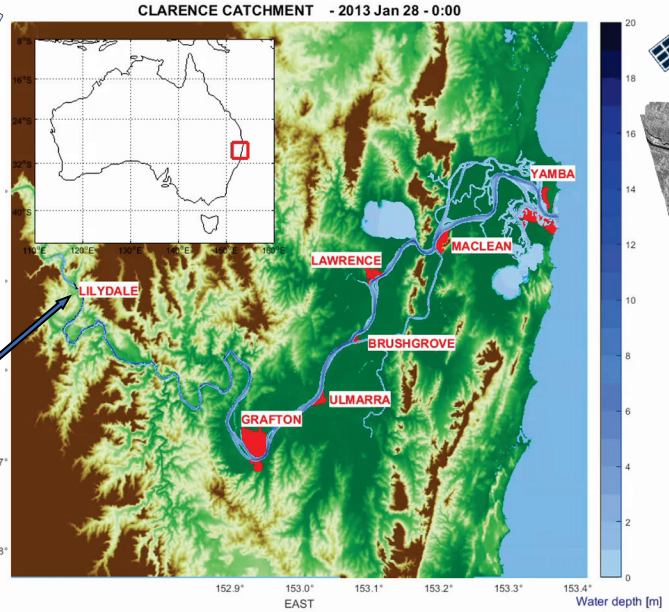
IMPROVED MODELLING AND MONITORING OF INUNDATION DYNAMICS

1. Improved streamflow forecasts using remote sensing soil moisture

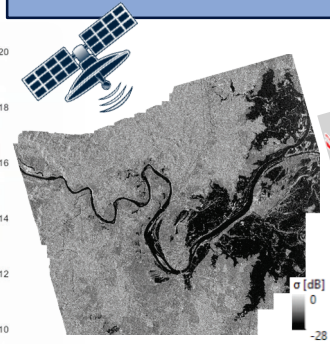




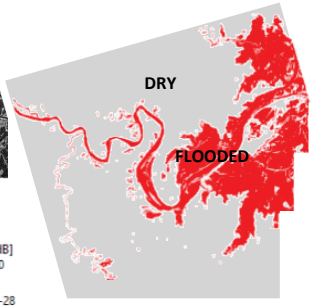
2. Improved floodplain inundation forecasts using remote sensing flood extent



3. Use of SAR (Synthetic Aperture Radar) for inundation monitoring



Clarence, CosmoSkyMed, Jan 12th 2011

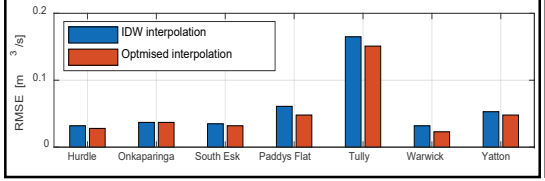


Two test sites:
- Clarence
- Condamine-Balonne

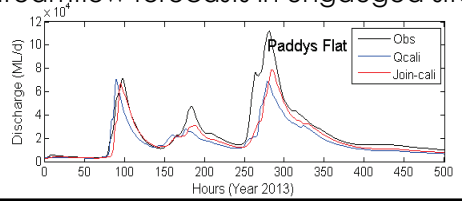
Research outputs – July 2019

1. Improved streamflow forecasts using remote sensing (RS) soil moisture — HYDROLOGIC MODEL

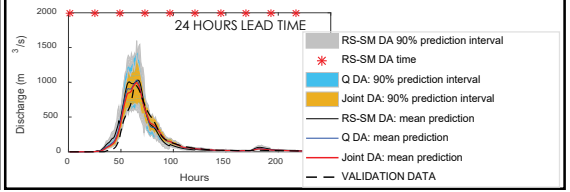
Methodology for the optimization of rain gauges weighting to improve streamflow forecasts.



Joint discharge and RS soil moisture calibration scheme leads to improved streamflow forecasts in ungauged sites.

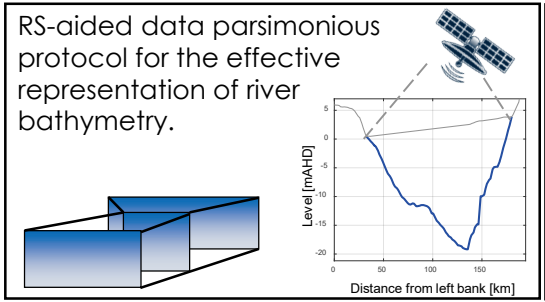


SYNTHETIC STUDY: joint discharge and RS-soil moisture assimilation outperforms the single variable assimilation schemes

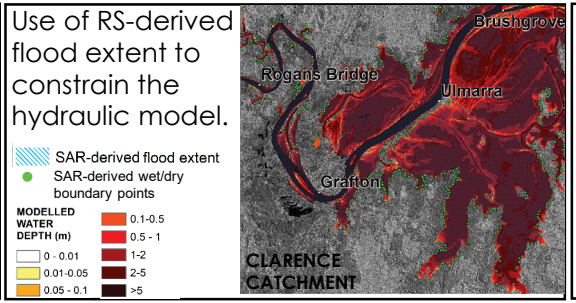


2. Improved floodplain inundation forecasts using RS flood extent — HYDRAULIC MODEL

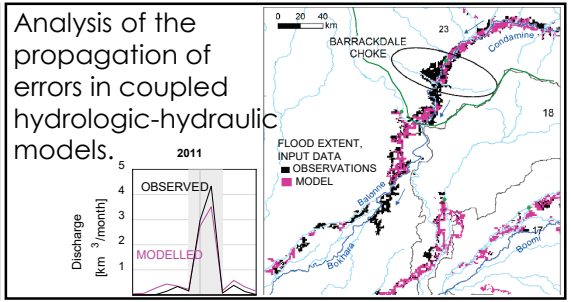
RS-aided data parsimonious protocol for the effective representation of river bathymetry.



Use of RS-derived flood extent to constrain the hydraulic model.



Analysis of the propagation of errors in coupled hydrologic-hydraulic models.

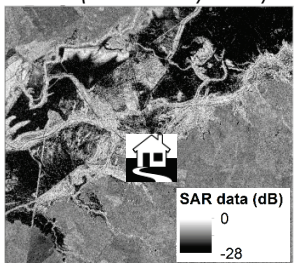


3. Use of SAR (Synthetic Aperture Radar) for inundation monitoring — NUMERICAL ANALYSIS

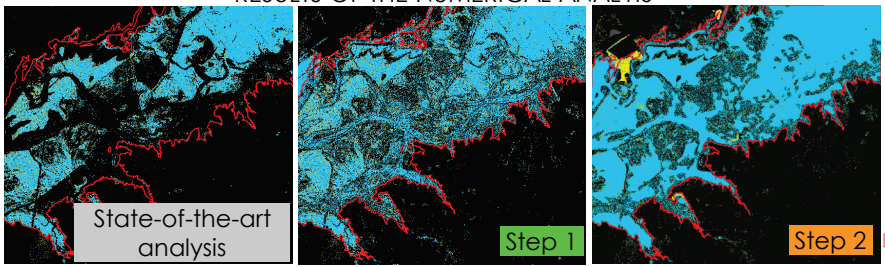
Algorithm for the retrieval of inundation extent in flooded areas with emerging vegetation using SAR images.

Condamine-Balonne, 2011 →

SAR (CosmoSkyMed)

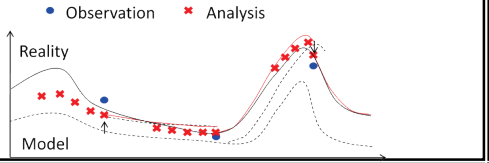


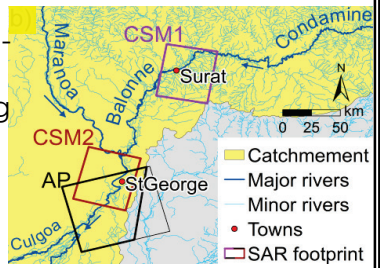
RESULTS OF THE NUMERICAL ANALYSIS

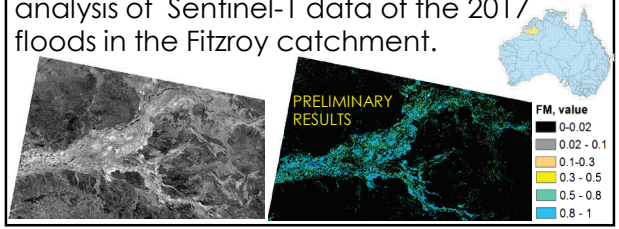


Research outputs – end of the project

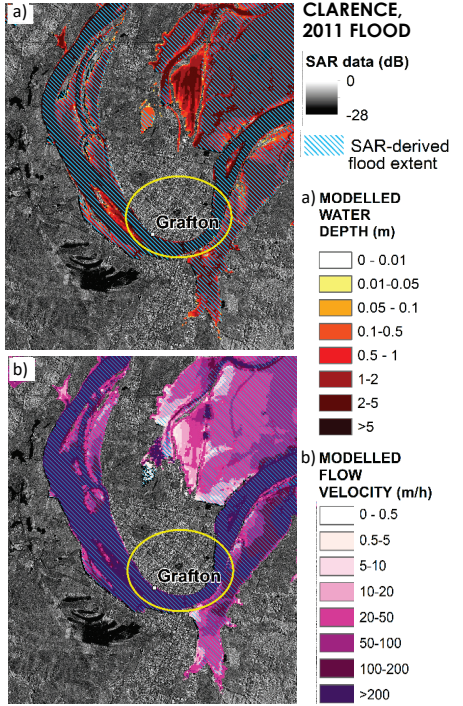
		COMPLETED	IN PROGRESS	DELIVERABLES
1. Improved streamflow forecasts using remote sensing (RS) soil moisture	HYDROLOGIC MODEL	✓ Optimal interpolation of rain gauges. ✓ Joint discharge and RS-soil moisture calibration. ✓ Synthetic experiment: joint data assimilation.	Application of the joint discharge and RS soil moisture data assimilation scheme for the analysis of real flood events.	Use of **RS Soil Moisture** for calibration, validation, and real time constraint of **hydrologic models.**
2. Improved floodplain inundation forecasts using RS flood extent	HYDRAULIC MODEL	✓ RS-aided protocol for the assessment of river bathymetry. ✓ Propagation of errors in coupled hydrologic-hydraulic models. ✓ RS-based protocol for the evaluation and constraint of hydraulic models.	Application of the proposed RS-based protocols for the modelling of floods in the Condamine-Balonne catchment.	**Coupled** modelling chain constrained using RS data. Use of **RS-derived river width, flood extent and wet/dry boundary points** for implementation and evaluation of **hydraulic models.**
3. Use of SAR (Synthetic Aperture Radar) for inundation monitoring	NUMERICAL ANALYSIS	✓ The proposed algorithm has been tested on three SAR images acquired over the 2011 flood in Condamine-Balonne catchment (2 CosmoSkyMed and 1 Alos Palsar).	Testing of the proposed algorithm for the analysis of Sentinel-1 data of the 2017 floods in the Fitzroy catchment.	Detection of flooded vegetation using SAR data.







IMPROVED MODELLING and MONITORING OF INUNDATION DYNAMICS



Use of the outputs

	SPATIAL SCALE OF APPLICATION	PRIMARY END-USER and HOW THIS RESEARCH OUTPUTS COMPLEMENT THE CURRENT CAPABILITIES	A POTENTIAL WIDER COMMUNITY OF USERS
IMPROVED MODELLING CAPABILITIES	✓ Two test sites:  ✓ **ROADMAP** for the use of Remote Sensing data to improve flood forecast skill. → Potential application to all the Australian catchments.	**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." *– Chris Leahy, Soori Sooriyakumaran*	❖ State Emergency Services. ❖ Councils. ❖ Irrigation and water management companies. ❖ Environmental and ecosystem management and protection agencies. ❖ Consulting companies.
IMPROVED MONITORING CAPABILITIES	✓ Tested on a number of SAR images acquired by different sensors. → Potential application at the continental scale. → Potential use of new satellite missions.	**Geoscience Australia** "Current flood extent detection capabilities are based on optical data (e.g. Water Observations from Space). This project has developed an automated method to map floods using SAR acquisition and data products available for whole of Australia. 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*	

Potential use of the outputs

OBJECTIVE	DELIVERABLE I = immediate impact L = long term impact	END-USERS	MONASH'S CONTRIBUTION	SUGGESTED COLLABORATORS (*) preliminary conversation	RESOURCES NEEDED (TIME applies to all!)
A) Testing of the developed modelling and monitoring methodologies to other study areas.	More robust and viable methods to enable application at the continental scale (L) .	• Geoscience Australia • Australian Bureau of Meteorology	Algorithm for the analysis of the SAR data; RS-constrained modelling capabilities.	Geoscience Australia; Australian Bureau of Meteorology; councils	• Validation data.
B) Enhancing the understanding of the interactions between floods and **urban planning**.	Maps of the potential impacts on buildings(I).	• Home owners • Urban planners and developers • Insurance companies	RS-constrained models: modelled flow depth and velocity in a number of scenarios (e.g. dry/wet floodproofing).	"*Cost-effective mitigation strategy for flood prone buildings*"(*) "*Urban planning for natural hazard mitigation*"	• Data on urban areas: buildings location, geometry, and materials.
C) Optimal planning of **evacuation routes**.	Manual for the planning of evacuation routes (L).	• Land management agencies • SES	RS-constrained models: inundation dynamics in a number of scenarios (e.g. bridge overtopping).	"*Enhancing resilience of critical road infrastructure*"	• Data on infrastructures: location, geometry, and materials.
D) Risk maps for case studies and framework for the delivery of **risk maps**.	Risk maps (I). Manual (L).	• Councils and state agencies • SES • Insurance	RS-constrained models: inundation dynamics.	"*Improved decision support for natural hazard risk reduction*"	• Socio-economical evaluations of the areas at risk.
E) Increasing the awareness of the dangers of **entering flooded waters**.	Educational videos (I).	Community: pedestrians (<16; 16+); drivers; riders.	RS-constrained models: data of flow velocity and water depth.	"*Flood risk communication*"	• Advice from social scientists. • Media capabilities.

RESEARCH TEAM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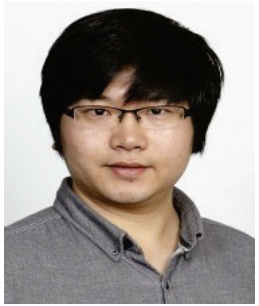
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Thanks for your kind attention!

END USERS

Australian Government
Bureau of Meteorology

Australian Government
Geoscience Australia

SES
NSW STATE EMERGENCY SERVICE