IMPROVING FLOOD FORECAST SKILL USING REMOTE SENSING DATA: MODEL / REMOTE SENSING DATA FUSION

V. Pauwels, J. Walker, S. Grimaldi, Y. Li, A. Wright

Monash University, Department of Civil Engineering, Clayton, VIC 3800

THIS PROJECT INVESTIGATES THE USE OF REMOTELY SENSED SOIL MOISTURE DATA AND FLOOD EXTENT/LEVEL TO IMPROVE HYDROLOGIC AND HYDRAULIC MODELLING FOR OPERATIONAL FLOOD FORECAST.

Floods are among the most common natural disasters in Australia, and cost the economy on average $377M per year. 1859 people have died in floods between 1900 and 2015 (*Haynes et al., 2016*[1]). In early June 2016, floods in East Australia and Tasmania claimed the lives of 5 people.

- Flood forecasting models are essential tools in managing floods. They consist of a hydrologic model, forecasting the flow volume in the river system, and a hydraulic model, converting this flow volume into water levels and flood extents.
- Forecast inaccuracies are mainly due to errors and uncertainties in the rainfall data and the model structure and parameters.
- Satellite remote sensing (RS) can provide excellent data sets that should be used to constrain these models.
- In this project, RS soil moisture values are being used to constrain the hydrologic model; RS water levels and flood extents are being used to constrain the hydraulic model.

STUDY SITES

The Clarence and the Condamine-Culgoa- Balonne (Fig. 1) have been selected based on:

- the relevance of historical flood events;
- the availability of RS data of flood extent/water levels.

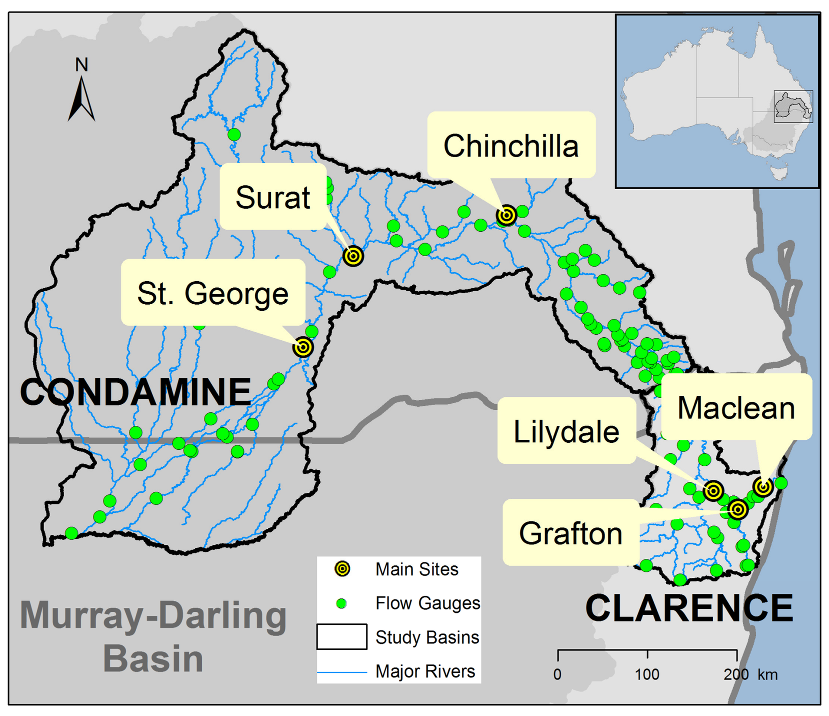

Fig. 1 The study basins

HYDROLOGIC MODELLING (*GRKAL*)

Synthetic assimilation of soil moisture

A synthetic experiment was conducted in the Condamine-Culgoa-Balonne catchment upstream of Warwick to test the impact of assimilating near-surface soil moisture on streamflow forecasting. The lumped GRKAL model was updated using:

- an ensemble Kalman filter (EnKF); and
- an ensemble Kalman smoother (EnKS).

Auto-regressive lognormal multiplicative errors were applied for rainfall, while Gaussian errors were applied for modelled and observed soil moisture.

Results

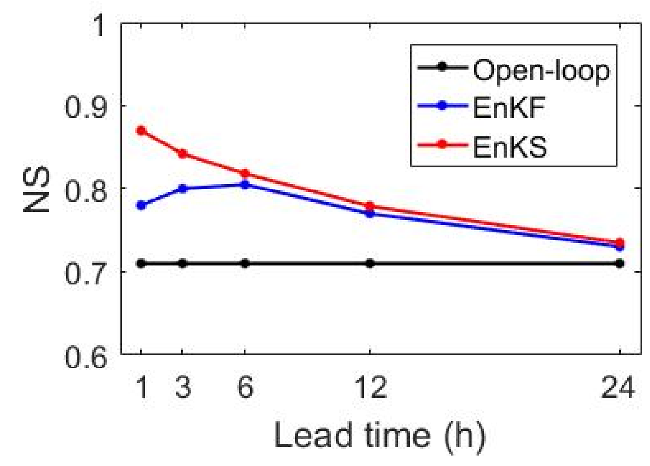

Fig. 2 – Nash-Sutcliffe efficiency coefficient of streamflow predictions (01/2011 – 06/2014)

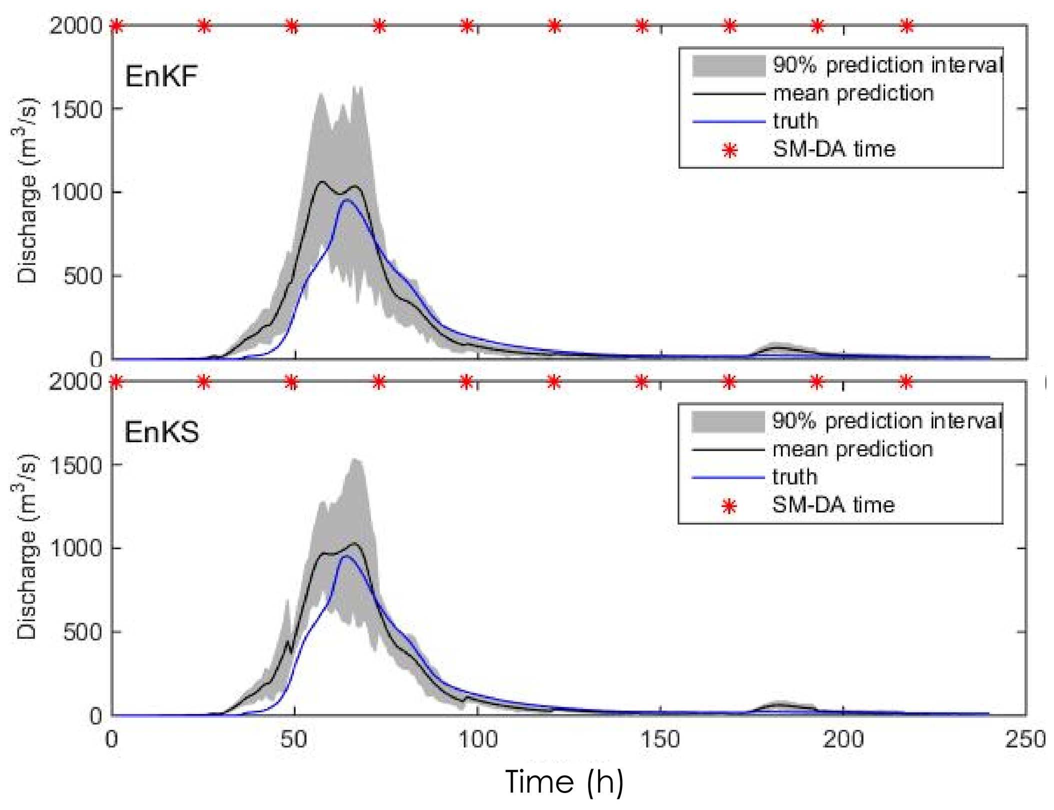

Fig. 3 – Ensemble streamflow prediction after data assimilation for an event in 2011

The results indicates that

- assimilation of near-surface soil moisture led to improved streamflow forecasting;
- the benefit of the EnKF reached the maximum after 6 hours of assimilation;
- the EnKS outperformed the EnKF in flow forecasting, but the difference between the two algorithms decreased with the increase of the lead time (up to 24 hours).

HYDRAULIC MODELLING (*LISFLOOD – FP*)

Effective representation of river bathymetry for flood forecast

Accurate modelling of river flow dynamics is essential to simulate floodplain inundation. Bathymetric data are critical to the application of hydraulic models. A field campaign was organized in May 2015 to measure the bathymetry of the Clarence River (Fig. 4).

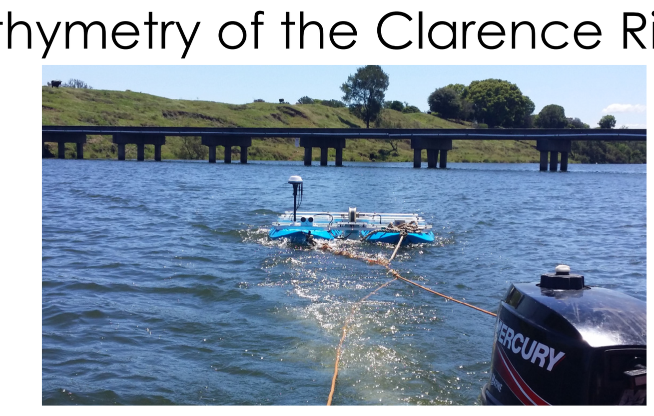

Fig. 4 – Clarence river, field data collection

However, it is impossible to measure river bathymetry along the total river length, especially in the large Australian basins.

A numerical experiment based on the hydraulic model LISFLOOD-FP and field bathymetric data allowed the formulation of a data parsimonious methodology for the representation of river bathymetry. The simplified representations of river geometry (Fig. 5) were based on remote-sensing data; a global database and limited field data.

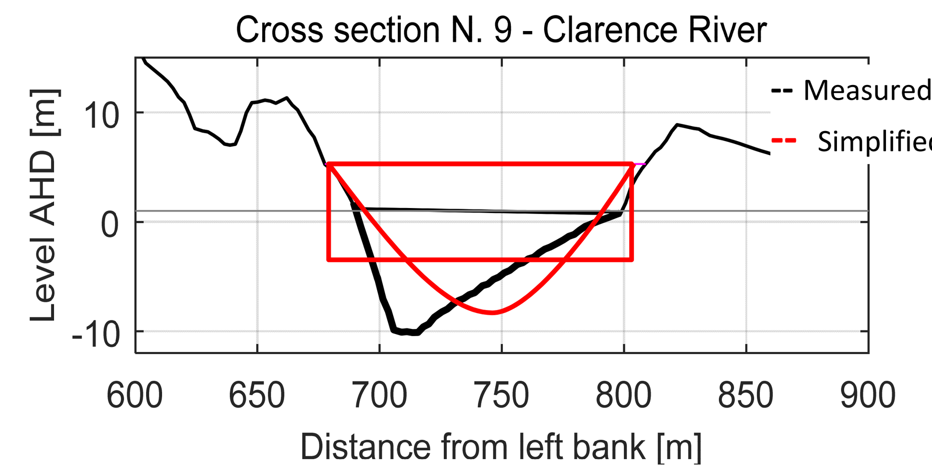

Fig. 5 – Field data and simplified geometries

The use of simplified geometries could reproduce the water levels predicted by the data rich model (Fig. 6).

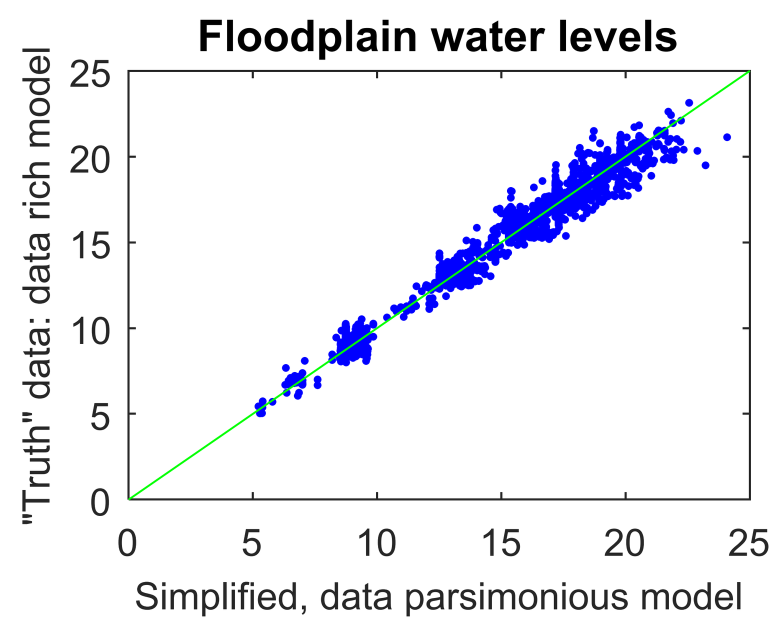

Fig. 6 – Comparison of the results of data rich model with the results of the simplified model

REFERENCE: *[1]Haynes, K., Coates, L., Dimer de Oliveira, F., Gissing, A., Bird, D., van den Honert, R., Radford, D., D'Arcy, R, Smith, C. (2016). An analysis of human fatalities from floods in Australia 1900-2015. Report for the Bushfire and Natural Hazards CRC*

END-USERS STATEMENTS

This research will enable Geoscience Australia to better target satellite image acquisitions. It will also fill the gaps in flood extent determination where satellite images are unavailable or obscured by clouds. ***– Norman Mueller, Emergency Response Coordinator, Geoscience Australia***

The remote sensing constrained hydrologic and hydraulic modelling capacity being developed will complement the current flood forecasting capabilities of the Bureau of Meteorology. ***– Soori Sooriyakumaran, Manager Flood Policy Unit, Bureau of Meteorology***

Australian Government Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme
MONASH University Engineering
Australian Government Bureau of Meteorology
Australian Government Geoscience Australia