HAZARD NOTE

bushfire&natural HAZARDSCRC

ISSUE 29 MAY 2017
TOPICS IN THIS EDITION | FLOOD | FORECASTING | HYDROLOGY | REMOTE SENSING

REMOTE SENSING OFFERS BETTER FORECASTING OF RIVERINE FLOODS

▲ **Above:** THE RESEARCH TEAM USES A RIVERSURVEYOR ACOUSTIC DOPPLER PROFILER TO MEASURE THE TOPOGRAPHY OF THE CLARENCE RIVER UPSTREAM OF GRAFTON. PHOTO: STEFANIA GRIMALDI

ABOUT THIS PROJECT

This research is being conducted as part of the *Improving flood forecast skill using remote sensing data* project, which is increasing Australia's capacity to understand, forecast and monitor flooding.

AUTHORS

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SUMMARY

Accurate flood predictions are critically important for limiting the damage caused by floods. Flood forecasting systems are based on models that require large volumes of data, such as rainfall forecasts, detailed measurements and high-resolution topography. However, flood forecasts are prone to uncertainty due to a lack of detailed measurements, and possible errors or oversimplifications in the models and/or data sets. Remote sensing is the science of obtaining information about objects or areas from a distance, typically from aircraft or satellites. This research is integrating this type of data on soil moisture and flood extent with rainfall and runoff models, which will lead to more accurate flood predictions. It will develop a remote sensing-aided methodology that can eventually enable forecasting models that predict the volume of water entering the river network to be applied anywhere in Australia.

CONTEXT

Flood forecasting systems require large data sets, some of which are scarce or unavailable in the large Australian river basins (for example, detailed precipitation or bathymetric data). The project is investigating how remote sensing data are best used to solve this issue and produce better flood predictions.

BACKGROUND

Flood forecasting systems consist of two parts: i) a hydrologic model that predicts the volume of water entering the river network, and ii) a hydraulic model that computes flood extent and water level. At the start of the project in May 2014, the Bureau of Meteorology operated hydrologic models for about 100 catchments, but was not yet applying hydraulic models. The models were not using remote sensing data. The team is developing hydrologic and hydraulic models and algorithms to integrate soil moisture and flood extents from remote sensing data, which will be incorporated by Geoscience Australia into its Water Observations from Space product.

BUSHFIRE AND NATURAL HAZARDS CRC RESEARCH

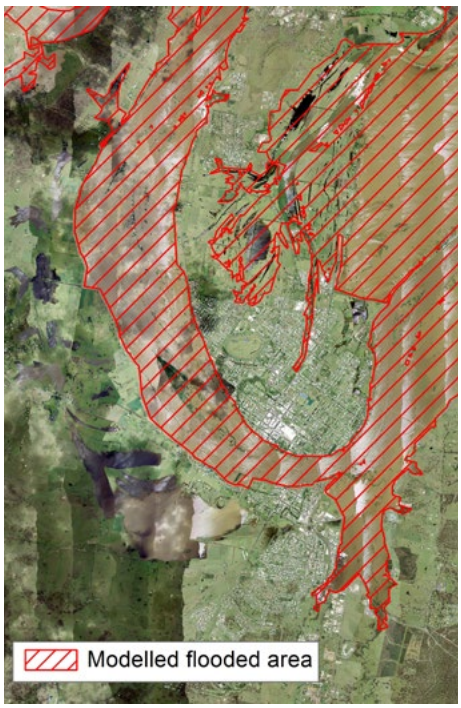
The team set up a forecasting system for two test basins: the Clarence in northern New South Wales and Condamine-Balonne-Maranoa in southern Queensland. Both areas were chosen because they are prone to frequent flooding. The researchers have determined the parameters of the hydrologic model using discharge data and remotely sensed soil moisture data and are developing strategies to correct model outputs automatically. The hydraulic model calibration and incorporation of remotely sensed data is ongoing. Specifically, the project is developing a method to determine effective river cross-sections because it is difficult to measure the river bathymetry (riverbed topography) in a detailed way for large basins. The team has acquired river cross-section data in strategic locations on two field visits.

RESEARCH FINDINGS

For the hydrologic model, it was found that joint calibration using discharge and soil moisture leads to more robust results than traditional calibration using only discharge data. In other words, the model degraded slightly during the calibration period but improved during the validation period. Including soil moisture in the calibration improved the simulations for the ungauged sub-basins.

Because rainfall is highly uncertain, streamflow data was used to estimate the rainfall volumes for the duration of the flood.

The team have also completed a preliminary analysis of a proposed new method for improving the detection of flooded areas in densely vegetated catchments. It involves using simplified river geometries that are based on a combination of limited field data sampled at strategic locations, global databases and remote sensing data.



▲ **Above:** MODEL SIMULATIONS SHOWING THE EXTENT OF FLOODING IN THE GRAFTON AREA FOR JANUARY 29, 2013. PHOTO: NSW LAND AND PROPERTY INFORMATION.

HOW IS THIS RESEARCH BEING USED?

A workshop at Geoscience Australia was held in October 2016, streamlining the use of the remote sensing techniques developed in this project for the Geoscience Australia Water Observations from Space product. Geoscience Australia will use the method developed in this project to classify the areas monitored as being flooded or not flooded. This will start in the second phase of the project, from July 2018. The research team will meet regularly with the end-users to ensure that the outcomes continue to address their needs. The Bureau of Meteorology will also use the project's recommendations in their operational system.

By improving real-time flood prediction, this research is expected to improve the accuracy of flood warnings, resulting in a decrease in flood damage and potentially loss of life.

FUTURE DIRECTIONS

The researchers are completing phase one of the study and have a broad program planned for phase two. It includes a comparison of different remote sensing-based, soil-moisture products, such as surface soil-moisture retrievals and root-zone, and soil-moisture analysis, for hydrologic model updating. The team will also develop a model-data fusion algorithm for a hydrologic forecasting system to optimally use both remotely sensed soil moisture and stream-flow measurements.

The project will validate rainfall estimations using remotely sensed soil-moisture observations. It will also develop a remote sensing-aided methodology to derive effective river-transect data for large catchments, and to improve the accuracy of digital elevation models for large catchments. This methodology will eventually enable hydraulic models to be applied anywhere in Australia.

END-USER STATEMENT

This research will provide a way to help predict the magnitude and timing of flood peaks to enable Geoscience Australia to better target satellite image acquisitions. It will also fill the gaps in satellite coverage and flood extent determination where satellite images are either unavailable or obscured by clouds.

– Norman Mueller, Emergency Response Coordinator, Geoscience Australia

The project will provide a vehicle to test the utility of now increasingly available remotely sensed data in predicting flood movement. Improved remotely sensed data with much improved latency and better spatial and temporal resolution, such as from the Himawari-8 satellite, will allow the Bureau to look at ways to improve its flood forecasting capability in areas where sufficient ground observations are not available. The hydrologic and hydraulic modelling capacity being developed will complement the current capabilities.

– Soori Sooriyakumaran, Manager Flood Policy Unit, Bureau of Meteorology

FURTHER READING

Grimaldi S, Li Y, Pauwels VRN, Walker JP (2016), Remote sensing-derived water extent and level to constrain hydraulic flood forecasting models: opportunities and challenges, *Surveys in Geophysics*, **37**(5), pp. 977-1034.

Li Y, Grimaldi S, Walker JP, Pauwels VRN (2016), Application of remote sensing data to constrain operational rainfall-driven flood forecasting: a review, *Remote Sensing*, **8**(6), 456, doi:10.3390/rs8060456.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.