REAL-TIME FLOOD FORECASTING – YOU PROBABLY ALREADY HAVE WHAT YOU NEED

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Aims

Large scale flooding in recent years has led to the requirement, and indeed expectation, that Government Authorities be better prepared for impending flooding. Part of this is the need to understand the implications of impending rainfall, in real-time.

Traditionally, the complex nature of flood forecasting has meant that forecasts are often only provided by centralised agencies such as the Australian Bureau of Meteorology. However, these forecast services are often limited to longer natural response catchments, and usually only provide expected peak flood levels at a handful of locations in a catchment.

However, the general community increasingly expects those tasked with responding to floods to be able to manage potential floods that fall outside of the above scope.

The aim of this paper is to demonstrate, through case studies in Australia of both flash and longer response catchments, that effective flood forecasting systems which both complement and expand on centralised forecast information can be developed using datasets that are readily available to most Local Authorities responsible for managing flood emergencies.

Method

The core components of a real-time flood forecasting system are:

- Rainfall: actual and/or forecast
- Hydrology: converting rainfall into flows
- Hydraulics: converting flows into water surfaces
- Flood Intelligence: what will the outcome mean for infrastructure and the community

Fallen rainfall can be readily extracted from existing gauge networks, with the natural catchment lag providing some lead-time to respond to the impending flooding. However, for flashier catchments, including forecast rainfall in the system effectively “buys time” for response efforts, even if included as part of a “what if” analysis.

Various agencies provide time-varying forecast rainfall spatial products “off the shelf”. These products, whether from government or private enterprises, cover both flash flooding and longer duration flooding at differing scales. Depending on the vendor and resolution required, some existing forecast rainfall products extend out to 7 days, which can significantly lengthen available response time.

Traditional approaches to routing rainfall on a catchment into flows in waterways such as hydrologic modelling can be effectively employed in real-time, with typical run times in the order of seconds. Alternative approaches such as hydrologic interpolation/lookup tables, upstream release flows (dams/weirs), or integrated hydrology/hydraulics (such as “rainfall on the grid”) may be equally valid, depending on the catchment. Forecast flows are then generally available at many locations in the catchment (often gauges). In some cases, external agencies may also make forecasts available (eg the Australian BoM).

The hydraulic component of a forecasting system converts forecast flows (or levels via rating curves) at these discrete locations into a continuous water surface covering the entire floodplain. Rapid approaches such as hydraulic interpolation libraries or “closest surface” libraries provide widely-used means of quickly creating this continuous surface. Real-time hydraulic modelling provides an alternative, but at the expense of significantly longer processing-times.

For the end user, the most important part of a flood forecasting system becomes available once the forecast water surface has been created. By simply integrating the forecast surface against a range of spatial datasets, the likely *affectation* associated with the impending flood can be readily determined. This is achieved through the creation of *flood intelligence.*

Targeted flood intelligence can be readily created to suit the varied needs of a response agency. Some examples include integrating the forecast flood surface against:

- LiDAR/DEM: to derive flood extent and likely flood depths
- Property Floor Levels: to determine dwellings likely to be affected above floor
- Evacuation routes: identifying what routes will be cut and when
- Critical infrastructure: eg depth over transformers at an electricity sub-station to determine whether power will be available
- Uncertainty: differing flood surfaces based on an uncertainty in forecast rainfall quantifies the *implications* of forecast flood variability

Results

On completion of a typical flood study, a Local Authority typically has the following datasets available: a Digital Elevation Model, flood surfaces for a range of flood magnitudes, and the hydrologic and hydraulic model setups used in the analysis.

A simple flood forecasting system can be built using the following minimum datasets:

- Peak flood surfaces for a range of flood magnitudes
- A Digital Elevation Model
- A forecast level at a location in the catchment (eg from an external agency)

In such a simplistic system, the end user may be limited to obtaining forecast flood extents, levels and depths across the catchment. As more information is required, varying degrees of sophistication in creating forecasts and likely outcomes can be incorporated into a system as required, such as:

- Actual/forecast rainfall
- Real time hydrologic modelling
- Creation of targeted flood Intelligence

Without realising it, most authorities have the datasets required to setup a real-time flood forecasting system. Where forecasts are not provided by an external agency, approaches to converting forecast rainfall into likely flood levels can be readily developed from existing datasets (such as the hydrology models used in the flood studies).

Case Studies

Two Councils in South East Queensland have leveraged outputs from flood studies to build effective flood forecasting systems: Ipswich City Council (flash and mainstream flooding), and Toowoomba Regional Council (mainstream flooding). The base datasets that were used to construct these systems are:

- Digital Elevation Model
- Peak flood level surfaces from flood studies
- Time-varying forecast rainfall grids (provided by the BoM)
- Real-time hydrologic modelling
- Rainfall/river gauge network

References

Druery C, McConnell D and Adair L "*Real-Time Flood Risk Management – Putting Certainty Into the Uncertain*", Proc 5th Victorian Flood Management Conference, October 2007

Druery, C, McConnell, D, (2014), *Forecasting Flash Floods – What Can You Do?,* Proc. 2014 New Zealand Stormwater Conference, Christchurch, New Zealand.