PREDICTIVE AND OPERATIONAL CATCHMENT MODELLING – IS NEW ZEALAND READY?

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ABSTRACT

BACKGROUND

Hydrodynamic models are used every day to provide information on studies such as flood risk and water quality assessments, catchment resilience plans, and mitigation asset planning among many other uses. The typical current practice is to develop these 'static' models for a specific, suitable time-period, using design storms based on historical data and depending on the models use, only test the stability for a range of rainfalls. Additionally, they are generally calibrated to only a few historical events.

Although these models are historically very useful in aiding planning and development teams, they are a significant investment that help only part of an organisation, particularly when the needs of the operational teams and field crews are much more immediate, and a reactive approach can often restrict their services.

This is where a real-time and predictive decision support tool can leverage these investments already made and provide a more holistic experience. Unlike the planning hydraulic models, these dynamic models are kept up to date, utilise actual observed and forecasted rainfall, are continuously calibrated and must be stable for all rainfall volumes. Because of their nature, the benefits of predictive operational modelling include:

- ***Time*** - Having a continuous digitised representation of real-time and forecasted network performance will optimise the time to fix a problem should one arise. Be it 6 hours or 60 minutes prior, it still enables operators to get on the front foot to either prevent the problem, or to mitigate the extent of the problem's damage.

- ***Real time and forecasted knowledge of the network activity*** - Quantified outputs of the hydrodynamic network model's performance provide operators with detailed knowledge of 'what is going on' in the system, affording operational teams with vital knowledge, such as time of first spill over flood control infrastructure, which roads will be impacted by overland flooding and which assets should be flushed to mitigate a predicted storm event.

- ***Automated alert and warning systems*** - Alerts can be generated, with automatic pre-defined actions sent out, to alert teams when there is a potential problem observed in real time or forecasted ahead of time.

- ***Decision making support*** - Using a hydrodynamic model, the environment can not only provide early warnings on alerts in a catchment but also provide operators with the ability to identify the optimal solution to the predicted event using various 'what-if' scenario testing.

By utilising the power of the of the digitised representation of network assets in reality, the behavior of network operations changes from reactive to reliance on what may be described as a 'digital twin'.

KEY STAKEHOLDERS

It is important to understand the fundamentals of what is required to develop a 'Live' operational and flood forecasting system. First, there is the need to have calibrated hydrodynamic models suitable for capturing the operational areas of interest. Then there is the requirement for real-time and forecasted data feeds. These can be SCADA, Telemetry, and Radar data streams for example. And finally, we need to know what are the modes of operation? What are the goals and outcomes? What do we want to be alerted of? Who will receive the alerts, and will the outputs be results, graphs, maps, reports, or public facing social media updates? Essentially any questions that are outcomes driven.

TECHNOLOGY

Innovyze, an Autodesk company, has developed a flood forecasting and operational modelling tool that integrates with hydrodynamic models, SCADA historians, and weather forecast databases called ICMLive. ICMLive provides a near real time view of network performance and alerts teams to adverse events. The environment is designed to improve operations by automatically harvesting and quality checking data, send out instant alerts for action, perform what if scenario analysis and conduct powerful risk assessments for incoming rainfall events.

USE CASES

Predictive operational tools are not considered a new concept and while ICMLive is one of the more recently developed products by Innovyze, its previous derivations have been around for the last 20 years. Today many utilities and authorities around the globe are actively using the technology in countries such as the UK, USA, Belgium, Japan, and China to name a few, for real world applications including:

- Early warning systems for forecasting extreme rainfall and flood / emergency overflow
- Unforeseen event detection such as network blockages or asset failures
- Emergency response tool to inform where deployment of resources is required most, e.g., sending out emergency tanker trucks
- Evacuation route planning and road cut off times
- Support planned activity by generating future scenarios of asset maintenance operations
- Real time model calibration and continual verification

Given that spatial rainfall feeds are key to developing reliable forecasts, the Australian Governments' Bureau of Meteorology (BOM) recent improvements of data has now led to the viability of technology for use within Australia.

Initially service providers like Australia's South East Water (SEW) have developed these models in sewer catchments to assist the operational teams to identify potential blockages, pump failures and their impact on the network, provide warnings of potential future spills and planning to mitigate the effects before they occur[1].

Now the technology has been identified by the Tasmanian State Emergency Service (TAS SES) as a suitable option to continue their efforts in developing a statewide predictive flood management tool.

Following the severe flooding in 2016, it became clear how critical it is to have an understanding of Tasmania's flood risk and in turn effectively invest in recovery and improve the community's resilience to future flooding events[2].

This led to the development of the 'Tasmanian Strategic Flood Mapping Project' in partnership with TAS SES, WMA Water, Innovyze/Autodesk and Indicium Dynamics with the aim of producing a statewide flood model and flood behavior maps for a range of events. Part of the project's methodology was to develop the model so that input data can automatically be updated as the land profile and asset data changes over time and to prepare the region for a future flood forecasting tool that can be used in real-time with the latest data.

Last year, the significant flooding events in October 2022 saw TAS SES rapidly develop their flood predictive capabilities. The existing models were in operational use for three separate rainfall events in Tasmania during the month of October. For the initial flooding event, observed and forecast rainfall from BOM was used to verify the models and then deliver flood outputs for the three affected catchments, three hours after the first peak hit the town of Latrobe. Further forecast information from BOM was then input into the models to produce flood impact assessment maps for the succeeding peak events to target on-ground impact assessments and potential flood affected properties. Map results of the flood affected areas were then used to inform and aid state level recovery planning following the events. Meander was one such town that experienced two distinct peak events. Forecast rainfall was simulated in the model for the second event and the predicted extents, depths, hazards, and inundation times was provided to the emergency teams to target the critical areas and evacuate people who were still cleaning up after the first event.

While the models proved to be extremely useful and informative during these floods events, the TAS SES are now looking to set up an environment that automatically feeds in the real-time and forecast data and setup pre-determined alerts to develop suitable actions.

NEW ZEALAND CAPABILITY

While initial investigations are seen to be promising for viability of the product in New Zealand, further research needs to be conducted. The final presentation will aim to deliver the conclusions of this study.

REFERENCES

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KEYWORDS

Flood forecasting, Operational modelling, Radar rainfall