The future of Water Modelling

The 'age of intelligent water networks' is fast arising – modelling has taken its first real steps into whole of water cycle modelling and is starting to become more established in the control room environment as **Dan Stevens** and **Emily Stevens** outline.

Water modelling has certainly come a long way in the past 30 years. Significant drivers for change have been ever-increasing customer expectations and legislative changes, catastrophic events (long-duration droughts, floods, terrorism) and more recently understanding and managing the effects of climate change on our infrastructure assets and communities.

We have seen remarkable advances in technology and computing power which have exponentially changed our expectations and ability to collect, process and analyse and present vast amounts of data with powerful visual tools. The age of "Big Data" is here and we are continually striving to develop "Intelligent Water Networks".

Our industry is getting smarter and we are seeing the evolution of a new generation of "tech-savvy" system managers and operators. As a result, modelling of the three waters is migrating from just the planning domain into the "real-time" operational environment.

As well as the emergence of Operational Modelling, we now have the computing power and software tools to support modelling of the whole water cycle in a single model. This presents an opportunity for a more holistic approach to three-waters modelling which will support planning of sustainable urban development and in particular urban regeneration and intensification.

So let's have a look at Live Operational Modelling and Whole of Water Cycle Modelling in a little more detail and touch on some other likely developments that we expect to see.

OPERATIONAL MODELLING

Essentially the architecture of a live operational modelling platform is to place a hydraulic model at the centre of a system which pulls together a wide range of real-time information, runs hydraulic simulations using the model and then interprets the results and makes future predictions. The results are presented digitally and graphically in model results files and potentially as a series of alerts/alarms to key stakeholders. An example for an operational model of a river catchment is shown in Figure 1:

In some cases, investing in operational modelling is hard

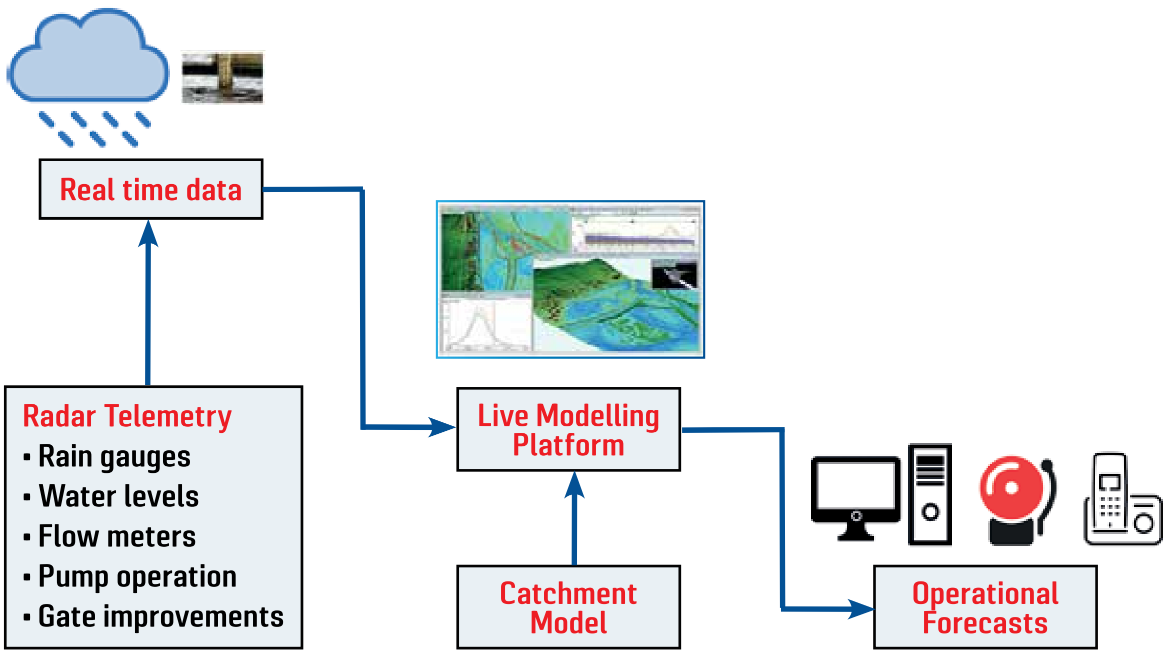

Figure 1: Operational modelling for a river catchment

to justify. The resources required to link models to SCADA, automatically run them and analyse the results may outweigh the perceived benefits. However, the case for operational modelling is often compelling and some early adopters have achieved an outstanding return on their investment.

In Australia, for example, South Australia Water (Adelaide) was an early adopter of operational modelling of water supply systems.

Driven by a significant investment programme as a result of connecting the new desalination plant to the transmission network and a need to optimise the network operation in the face of rapidly increasing power costs, SA Water has been able to achieve approximately $3 million worth of savings in its annual power consumption and in the order of $750,000 in other operational costs as a direct result of its investment in supply mix optimisation, optimising electricity consumption in line with electricity market prices and live operational modelling.

Expanding modelling from the planning domain into the operational environment is presenting a number of challenges, both at a technical and organisational level.

Modelling has traditionally been the responsibility of planning teams, as the operations teams are not experienced in model management. Frontline operators are simply not experienced modellers, and indeed many do not wish to be so.

Hydraulic modelling can be complex and the modelling software reflects this.

Software vendors have attempted to simplify operational modelling software but perhaps they haven't been able to do enough to make it truly user friendly to a busy operator who has multiple screens to monitor with multiple applications.

This presents a challenge that threatens to hold back the progress of operational modelling without careful handling.

With ever-increasing pressures on frontline operators, we see a growing need for the creation of a new role, the "Operator-Modeller", a technical support role located within the control room environment, working alongside and supporting the frontline operators. In some cases this will be a part-time role supplemented by other technical support duties such as compliance monitoring, reporting system performance and leakage management.

While many accept live operational modelling as a natural progression for the industry, recognising the potential benefits, it is fair to say adoption of the technology worldwide has been a little "patchy".

We have observed a range of different drivers that have encouraged the early adopters and leaders in this field. In Japan, for example, the focus for water utilities has been very much on operational optimisation of water and wastewater systems.

In the United States, it has been more the need to embrace technology to train and support the next generation of operators as experienced staff leave the industry. In Europe and Asia, there has been a take-up in operational models of river catchments which has not been reflected to the same extent in Australasia or the US.

So why has New Zealand been slow to adopt live operational modelling?

A few years ago, three-waters modelling in this country was at least tracking alongside or perhaps even ahead of Australia, but still a little behind the United Kingdom. Now, many Australian water suppliers have teams dedicated to identifying and introducing smart technologies as they strive to create "intelligent networks". This was driven to a certain extent by the "millennium drought" and the need to become more innovative and carefully manage an increasingly scarce resource.

Fortunately, we've not had such a challenge to date, even though undoubtedly live operational models linked real-time to the SCADA system would have been advantageous during the response to the Christchurch earthquakes, where planning models were used to support the operators as far as possible.

Beyond doubt, the Australian Water Industry has changed as a result of the drought and indeed the ongoing threat of another similar event, and we believe this has helped push them ahead of New Zealand in seeking out and adopting such smart technologies.

WHOLE OF WATER CYCLE MODELLING

In Australia, there is a significant focus on urban regeneration and intensification as cities such as Sydney and Melbourne experience sustained and significant growth. Planners have to understand and manage the whole water cycle within an area from stormwater management to water conservation and wastewater disposal.

Understanding the potential role of stormwater detention, rainwater tanks, sewer mining and permeable paving, for example, is becoming increasingly important.

In response to this growing need, Melbourne Water has recently run a pilot project to model the Whole of Water Cycle (WOWC) in a single model. The project team developed an integrated 1D potable water network, sewer network, stormwater drainage network and a 2D overland catchment model in InfoWorks ICM to replicate the water cycle down to an individual property level.

The proof of concept 1D/2D water cycle model has successfully been established at three distinct scales. These range from the local scale with 100 properties, to the precinct scale with 5000 properties and then the suburb scale with 27,000 properties.

Representing water, wastewater and stormwater in a single model is complex. Understanding the interactions between the processes is key to producing a meaningful representation of the integrated system.

This pilot project is a unique approach that leverages existing model tools in a way that has previously not been achieved. It opens the way to define new questions and measures for modelling water management that have up to now only been possible at a conceptual level or on a lumped or stochastic basis. By accurately replicating the physical characteristics of the urban water cycle, it is possible to provide definitive results that reflect the impact of integrated water management measures.

There is no doubt that this pilot model tested the software to the limit – and sometimes beyond, but this type of challenge is what drives development and improvement and propels our industry to the next phase.

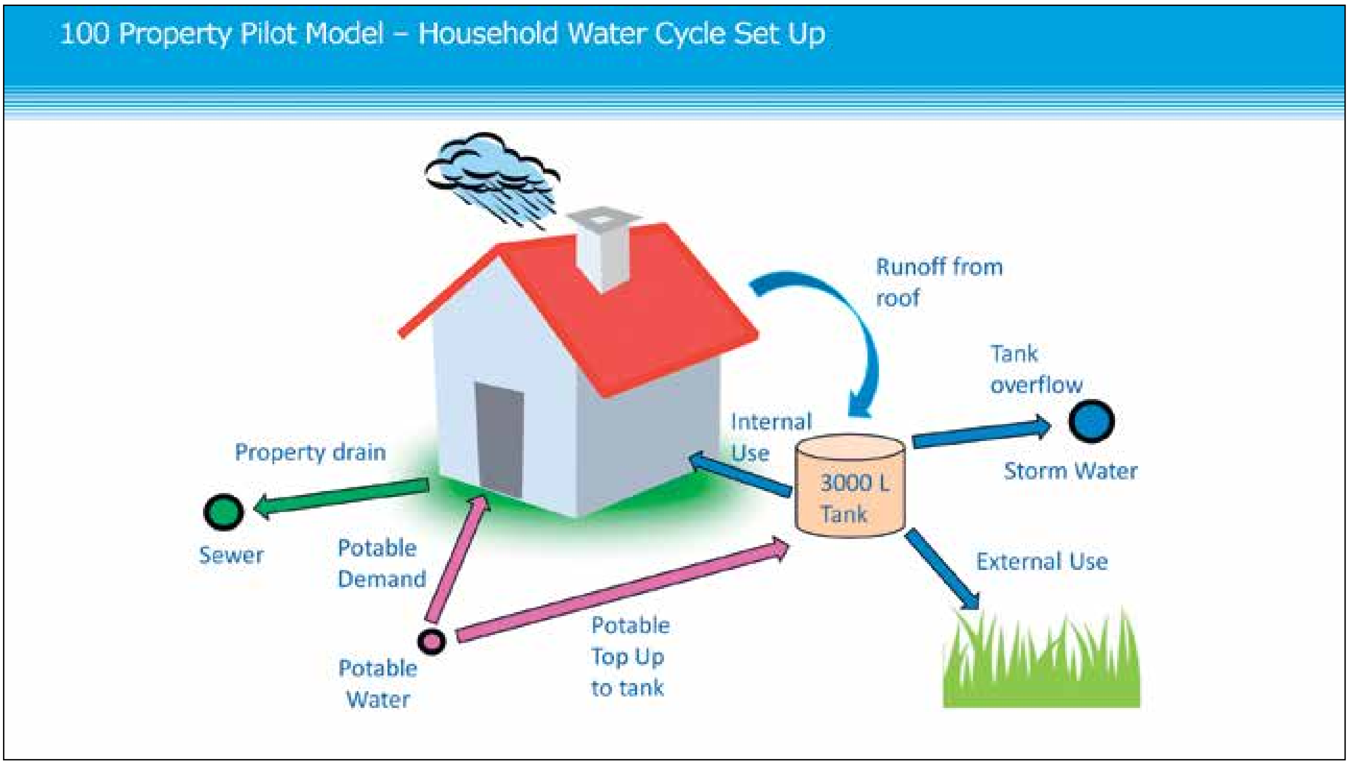

Figure 2: Whole of water cycle representation at a property level

OTHER RECENT DEVELOPMENTS

For a number of years, software vendors have been grappling with the best way to integrate modelling and GIS/corporate asset databases. Is there a way to have a "single source of data" that meets a range of needs?

We are seeing some significant software companies that have not traditionally been in the modelling space investing in developing ways to bridge the gap. It will be interesting to see what develops over the next five to 10 years and what level of integration is actually possible.

The technology is already in place for field operators to be able to run planning models on mobile devices in the field. Linking to live operational models is also possible but at this stage field operators are more likely to use portable devices with GIS capability with model results represented by GIS layers, giving them information on expected flows and pressures, or indeed which valves to close to isolate an area.

There are a number of smart technologies that have come into the market over the past few years such as smart valves and consequently the capability for dynamic DMAs. As live operational modelling becomes more widespread, we will see these technologies represented in the models and potentially with more automation based on model predicted results.

There is a growing interest in multi-species water quality modelling and we are likely to see some progress in this area in the next five to 10 years. Calibration of water quality models continues to be a challenge and progress has surely been slow up to this point.

The main challenge to date has been the collection of complex water quality information at a network level and an affordable price. However, there have been significant advances in this field and affordable monitors able to collect information on multiple parameters are now becoming available.

The "internet of things" will open up great opportunities in this area over the next decade and we will see significant advances in water-quality modelling as a result, most likely linked to operational modelling.

In summary, while the speed of future technologies and software development is hard to predict, we certainly see that modelling has taken its first real steps into whole of water cycle modelling and is starting to become more established in the control room environment. Undeniably, modelling will continue to play a key role in utilities planning and design, but we believe its role will become more central in integrating three-waters planning in the future, especially in urban intensification and regeneration projects. We see modelling becoming a more recognised and valuable tool for future generations of network operators, eventually being transformed into a key operational decision support tool linked to a wide array of real-time network information. **WNZ**

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