The lead story reports on optimisation software being used to connect Adelaide's water infrastructure. Also included are articles on climate change models, a Victorian utility winning an international award, a scripting service for pipe software and a new product.

Optimisation tools help connect desalination plant to Adelaide's network

The North-South Interconnection System Project will enable water from the Adelaide's southern area – including water from the desalination plant – to be used by customers throughout the Adelaide Metropolitan Water Network.

Currently, Adelaide's water supply network is roughly split into a northern system and a southern system, supplied independently via the River Murray and local reservoirs.

Interconnectivity of the network will allow SA Water to transfer water across these systems, providing additional water supply contingency and improved operational flexibility to handle any network disruptions.

Many options were identified, involving combinations of new and existing network infrastructure (such as pipelines, pumps, valves and tanks) that could have provided the desired interconnectivity. However, all exhibited complex tradeoffs between different aspects, including network operability, and impact on water quality, existing assets and the community during construction. The project team, comprising SA Water, Optimatics, United Water and the University of Adelaide, developed an innovative process to arrive at an optimal approach for connecting the Adelaide Metropolitan Water Network while meeting multiple objectives.

The optioneering process combined Genetic Algorithm optimisation of the Adelaide Metropolitan Water Network using Optimizer WDS software with multi-criteria analysis.

This process included:

- Developing a broad range of feasible solutions using Genetic Algorithm optimisation.
- Screening the feasible solutions based on hydraulic criteria with consideration of water quality and asset management criteria.

Usefulness of climate change models questioned

The reliance on climate change models to forecast the impact of global warming on water resources was questioned in a paper presented at the Practical Responses to Climate Change National Conference 2010 in Melbourne last month.

Dr Anthony Kiem and Dr Danielle Verdon-Kidd from the Environmental and Climate Change Research Group at the University of Newcastle said the models were designed to examine climate change processes at the global or continental scales, and are not detailed and accurate enough to examine particular areas of Australia.

"Even with sophisticated downscaling techniques, serious questions remain as to the applicability of climate model outputs to quantifying the risk of hydrological extremes," the paper said.

In their paper, titled "Water resource management in a changing climate – can we afford to wait for the climate models to give us the answer?", the authors outlined some of the shortcomings of current climate models, such as the Predictive Ocean Atmosphere Model for Australia and General Circulation Models. They include:

- Climate models fail to simulate observed synoptic patterns that drive rainfall extremes.
- Climate models do not satisfactorily simulate the majority of the large-scale physical processes known to be important for driving Australia's rainfall variability.
- Very little is known about how the various climate drivers interact to drive Australian hydroclimatic variability.
- Some models forecast increases in Australian precipitation by the end of the 21st century while others predict decreases.
- None of the climate models, used in hindcast mode, reproduce the Big Dry autumn drying trend that has occurred across southeast Australia since the mid-1990s.
- Climate model output is delivered in coarse grids, hundreds of kilometres across, and is of limited use in simulating regional hydrology and water resources processes.
- Some climate models can replicate annual and seasonal statistics, but at the monthly and sub-monthly scale the output is "associated with significant biases".

The paper called for "a focus on development of climate-informed but not climate-model-reliant, regionally-specific, practically useful scenarios that incorporate impacts associated with both natural climate variability and anthropogenic climate change". While it agreed that work on improving the models should continue, it said that the outputs should be treated with caution.

The conference was organised by Engineers Australia, its National Committee on Water Engineering and the Victorian Water Engineering Branch, with support from the Planning Institute of Australia.

- Identifying a list of criteria to assess and compare the possible solutions.
- Modelling, data collection and technical evaluation to enable each feasible option to be scored against criteria. This included gathering information on asset condition, water quality and hydraulics.
- Evaluating and comparing solutions, including uncertainty analysis.
- Quality control through regular reporting, communication with stakeholders and review of the inputs and outputs of the process.

Environmental sustainability issues were taken into consideration throughout the optioneering process through:

- Identifying infrastructure locations and routes that would minimise environmental impacts during construction and operation.
- Incorporating energy costs, including greenhouse gas emissions, within the optimisation process.
- Identifying potential ways of energy recovery (eg hydro power turbines).
- Including environmental criteria in multi-criteria analysis.

Whole-of-life costs were taken into consideration in both the Genetic Algorithm optimisation and the multi-criteria analysis.

Optimisation and multi-criteria analysis have been utilised globally in various domains. However, this is the first known joint application for an optioneering process. The combination of techniques enabled the strengths of each to be fully utilised and an overall preferred feasible option to be identified for concept design.

The aim of using Genetic Algorithm optimisation technology was to develop feasible solutions which achieved SA Water's objectives (interconnectivity, utilisation of existing assets, maintaining water quality, customer service levels, security of supply) within budget constraints. The optimisation considered solution cost (capital cost of new infrastructure and operating costs for pump stations) and solution performance (pressure, tank levels, velocity within pipes, flow reversal within pipes) as it searched for the best combination of new infrastructure and system operation using a hydraulic model of the entire Adelaide Metropolitan Water Network.

The optimisation technology allowed a range of different "what if" scenarios to be considered which resulted in 32 possible infrastructure solutions.

The use of distributed computing and on-line computing resources enabled the extensive optimisation task to be completed within the available timeframe. In-house computing resources at SA Water and Optimatics, as well as the remote Amazon Elastic Cloud technology were used to complete the optimisation runs.

The iterative multi-criteria analysis approach adopted to assess the 32 options identified by the optimisation phase considered a broad range of issues including water quality, operability, constructability and the impact on assets and the community. The originality of the approach was the inclusion of uncertainty analysis. Uncertainty in the quantitative and qualitative scores assigned to each of the option criteria, category weightings and criteria weightings were included in the analysis using Monte-Carlo Simulation, which gave increased confidence to the stakeholders

An overview of the elements of the North-South Interconnection System Project to connect northern and southern portions of Adelaide's water supply network.

in the final ranking of options.

The delivery of the preferred feasible option on time and on budget enabled the Waterlink SA concept design team to commence work as scheduled in March 2010. The delivery timelines were a critical factor for SA Water, as all works have to be constructed and commissioned by 2012.

The Waterlink SA concept design team conducted an independent review of the optioneering process and the final preferred feasible option.

This project has considered how water produced by the desalination plant can best be utilised in the short and the long term, whilst also considering future demand scenarios, water resource utilisation and security of supply for facility outages or drought. Each of the solutions developed was able to meet the projected water demands in the Greater Adelaide Region to 2050 as well as provide operational flexibility for the management of water resources. ●

This article is an edited version of a submission prepared by SA Water, Optimatics, United Water and the University of Adelaide for Engineers Australia's South Australia Division Excellence Awards 2010. The project received a commendation in the research, development and information category.

Water supply model wins award

Victorian water corporation Westernport Water has won international acclaim at Bentley Systems' Be Inspired Awards held in Amsterdam in October.

Westernport's paper "Integration of SCADA data in water model calibration" was declared the winner of the water, wastewater and stormwater networks category. Westernport Water's systems engineer Dean Jagoe presented the winning paper to an international group of industry experts at the event.

Westernport Water originally purchased Bentley's WaterCAD water modelling software in 2001. In 2003 the software was upgraded and calibrated at a cost of $80,000. In 2009/2010 Westernport upgraded to the Bentley WaterGEMS product and also purchased the associated SCADAConnect and CAD-interface products.

The corporation sought a high-performing automated system that would deliver cost savings and contribute to the effective operation and management of water assets, valued in excess of $43 million.

The approach identified was intergrating Bentley's WaterGEMS water model with Open Spatial's geographic information systems (GIS) and Control Microsystems' supervisory control and data acquisition systems (SCADA).

Jagoe used the CAD-interface product to access water pipe data directly from the GIS. In this process, a single source of asset data (the GIS) is used and updated. Updates to the GIS are now easily added to the water model.

With support from Bentley's Victorian office, Jagoe successfully completed the SCADAConnect integration. SCADAConnect allows WaterGEMS to access real-time flow and pressure SCADA information from selected points in the water supply system.

Since SCADAConnect can utilise both historical and real time data, the water model is constantly up-to-date, but also contains tables of previous values for trending and projections. The result was an asset accurate, real-time model of the entire water supply network.

"This up to date and accurate model will give engineering design and operational personnel the best possible platform for decision making," said Westernport Water's general manager of operations Steven Porter.

Previously Westernport Water engaged external contractors to manually upgrade asset information and calibrate its water model. The SCADAConnect technology with real-time updates will save money for Westernport Water, Porter added.

Westernport Water systems engineer Dean Jagoe (centre) received the award from Bentley global marketing director for geospatial Richard Zambuni (left) and solutions leader for water and wastewater Jack Cook.

Using WaterGEMS, Westernport Water seeks to obtain savings in non-revenue water) losses. It is aiming to achieve reduce water losses by 25% and recover water with a retail value of up to $85,000.

"The integration of these systems will provide unprecedented scope for managers, engineers, operational and maintenance personnel to understand on a real time basis how the water network is performing," Porter said. "The level of integration being achieved is expected to set benchmarks in informed decision making for Westernport Water."

Software company Bentley Systems has been running the awards annually since 2004. The aim is to encourage innovation in infrastructure projects and promote the work of engineers, architects and geospatial professionals. This year, a panel of jurors selected the winners from 55 finalists. Projects were chosen by jurors from 325 nominations submitted by 249 organisations in 45 countries. ●