JUNE 2013
ISSUE 2 ■ VOLUME 9

water
asset management
INTERNATIONAL

PAPERS

IWA Publishing

water21 magazine of the International Water Association

Water Boards restructured to ensure financial viability

South Africa has restructured its Water Boards and reduced their number from 12 to nine.

Water minister Edna Molewa said the number of Water Boards has been reduced to ensure they are financially viable and can effectively develop the necessary infrastructure for bulk water services and support municipalities, 'particularly those that require immediate intervention'.

'I have approved the proposal to decrease the number of Water Boards from the existing 12 to nine to deal with non-viable ones whose functions, assets and staff will be integrated into the viable Water Boards,' Molewa said in parliament on Tuesday.

The restructuring of the Boards is part of an ongoing reform programme to strengthen the capacity of water agencies in South Africa and ensure access and equitable distribution of water.

Ms Molewa also told parliament that the country's National Water Act and Water Services Act will be amended to strengthen the capacity of the government to deliver on its water sector mandate. She said the amendments planned for June could lead to 'a combination of these two acts'.

She said the envisaged changes will remove 'obstacles for greater equity in water resource allocation, water governance such as the appointment process of the governing boards of water institutions, oversight over the institutions, and improved management of our water resources.'

In addition, the minister said the government is currently reviewing the National Water Resource Strategy (NWRS), which also addresses some of the same issues as the amendments of the two acts.

NWRS is a new policy guideline on sustainable protection, use, development, conservation and management of South Africa water resources.

'Following an intensive process of stakeholder consultation and public hearings, we have now consolidated the final inputs from all stakeholders and I intend to gazette the final NWRS-2 in June this year. During the review process we identified a number of gaps which will be taken forward in the policy review,' she said. ●

Insurance company report warns ageing assets putting water services at risk

Insurance broking and risk management company Marsh has released a new report which says that global water services are potentially at risk from the challenges associated with ageing assets and infrastructure as water companies struggle to balance budgetary constraints with the need for ongoing capital investment.

In Marsh's 2013 Water Industry Insurance and Risk Benchmarking Report, which analyses the risk and insurance trends of water companies across four continents, asset failure was ranked as the top risk facing water companies globally for the eighth consecutive year.

According to Marsh's report the average Total Cost of Risk (TCOR), which measures the performance of an organisation's risk management and insurance programme, experienced by the global water industry rose by 10% in 2012. Attributed to challenging insurance market conditions and self-insured losses in 2012, Marsh expects the average TCOR for the global water industry to decline in 2013 as a result of a more benign insurance cycle.

Simon Gaunt, Managing Principal in the Global Power and Utilities Practice at Marsh, commented: 'Asset upgrades are required globally to replace ageing systems, in order to manage the risks associated with extreme weather events more effectively and to deliver on community expectations of a secure and sustainable water supply. However, challenging economic conditions, especially in those territories that are dependent on government funding, are continuing to constrain the ability of water companies to fund infrastructure projects.

'In the absence of significant investment, water companies are adopting a risk-based approach to prioritising their asset management programmes and capital expenditure in order to protect the integrity of their supplies.'

Marsh recommends water companies embed these risk-based asset management programmes within their broader management systems. This approach can be complemented by enhancing security at critical locations and relocating moveable plant to reduce damage risk, it says, as well as emergency and disaster planning and training. ●

water
asset management
INTERNATIONAL

EDITORIAL

Editors

Dr John Bridgeman
j.bridgeman@bham.ac.uk

Professor Stewart Burn
stewart.burn@csiro.au

Mr Scott Haskins
scott.haskins@CH2M.com

Dr Shiv Iyer
shiv.iyer@ghd.com

Water Asset Management International is an international newsletter on asset management in water and wastewater utilities. The focus of the newsletter is on the strategic aspects of this developing field, providing utilities with international perspectives on infrastructure planning and maintenance as they seek to deliver cost-effective services to their customers.

Instructions for authors are available at:
www.iwaponline.com/wami/default.htm

Papers for consideration should be submitted to the editors or to:

Catherine Fitzpatrick
Publishing Assistant
cfitzpatrick@iwap.co.uk

PUBLISHING

Associate Publisher
Keith Hayward
khayward@iwap.co.uk

Publisher
Michael Dunn

Water Asset Management International is published four times a year (March, June, April, December) by IWA Publishing. Statements made do not represent the views of the International Water Association or its Governing Board.

IWA Publishing
Alliance House,
12, Caxton Street,
London SW1H 0QS, UK
Tel: +44 (0)20 7654 5500
Fax: +44 (0)20 7654 5555
Email: publications@iwap.co.uk
Web: www.iwapublishing.com

SUBSCRIPTIONS

Water Asset Management International is available as either a print or an online subscription.

2013 price (4 issues):
£265 / €400 / $528
(IWA members: £207 / €311 / $393)

Contact
Portland Customer Services
Commerce Way, Colchester,
CO2 8HP, UK
Fax: +44 (0)1206 79331
Email: sales@portlandpress.com

Or visit: www.iwaponline.com/wami/subscriptions.htm

Design & print
Original design: John Berbuto
Printed by Hobbs The Printers, UK

ISSN (print): 1814-5434
ISSN (online): 1814-5442

WEF reports warn of GDP losses from inadequate infrastructure

The World Economic Forum (WEF) has launched two reports on boosting strategic infrastructure in Africa, including water, with the main document warning that Africa may lose around 2% of gross domestic product (GDP) growth annually without adequate infrastructure.

'Strategic infrastructure in Africa: a business approach to project acceleration' focuses on regional projects in Africa, and a second report, 'Steps to prepare and accelerate public-private partnerships', provides an actionable framework and best practices for preparing public-private partnerships (PPPs) that could help bridge the infrastructure gap in Africa and other regions, WEF says.

Infrastructure development is one of the top political priorities in Africa, WEF notes. The lack of existing infrastructure and future investments is seen as a key factor hampering the continent's economic development, trade and jobs creation, it says.

Without an adequate infrastructure endowment Africa is at risk of sacrificing about 2% of GDP growth annually, the strategic infrastructure in Africa report reveals.

This report is a first result of an ambitious collaboration between the African Development Bank, World Economic Forum, the African Union Commission and the NEPAD Planning and Coordinating Agency that aims to speed up project preparation and implementation of the Program for Infrastructure Development in Africa, a portfolio of critical projects for regional infrastructure development.

The report introduces a methodology for identifying projects for private sector acceleration and gives an overview of potential new ways to finance infrastructure project acceleration. ●

Lyonnaise wins Rhone Ventoux water and sanitation contracts

The Rhone Ventoux syndicate has reaffirmed its agreement with Lyonnaise des Eaux, a Suez Environnement subsidiary, with a 12-year contract to manage its public drinking water and an eight-year contract to manage its sanitation, worth a total of €152 million ($197.3 million).

A steering committee will be created for the contract. Composed of elected Syndicate service representatives and Lyonnaise des Eaux representatives, it will examine the quality of the services, contractual commitments, contract accounts and user relations. There will also be a customer relations centre, two customer reception centres and a Proxibus mobile reception centre.

The company will also model groundwater to adapt to operating conditions at the resource level; launch a vulnerability study on pollution of the Rhone, construct a new water treatment plant on the main water resource, and develop a comprehensive system to detect and repair leaks. ●

Moody's warns totex approach will not resolve potential financeability issues

Economic regulator Ofwat's proposal to introduce total expenditure (totex) benchmarking, performance incentives and cost recovery mechanisms of water companies' cost submissions is not designed to address potential financeability concerns, says Moody's Investors Service in a report on the water sector published recently.

The new report, titled 'UK water sector: speed of money cannot address potential financeability concerns', notes that companies or the regulator could seek to modify the speed of cost recovery under the totex approach in a way that could offset the negative cashflow impact of reduced returns following a likely reduction in the allowed weighted average cost of capital.

However, Moody's warns that a company might use the resulting financial flexibility to enhance shareholder distributions at the expense of the economic value of the regulated business and future cashflow generation, which would increase leverage despite the appearance of healthy cashflow-based credit metrics, which would have negative credit implications if sustained.

Additional disclosure either by the companies or the regulator will be needed to enable the reconciliation of the accounting and regulatory perspective on the treatment of expenditure to determine whether a regulated business is out-performing or under-performing its expenditure allowances, the analyst says. ●

Budget keeps Great Lakes funds, but cuts money for sewer infrastructure

President Obama's 2014 fiscal plan promises continued support of $300 million for the Great Lakes Restoration Initiative, but will reduce funding to the Clean Water State Revolving Loan Fund, which makes low-interest loans to municipalities to upgrade sewer infrastructure.

The proposal allocates $1.095 billion for the fund, a 25% reduction on the 2012 budget. The budget also includes $63 million for Great Lakes projects run by the US Army Corps of Engineers, which have been focusing on dealing with the effects of low lake levels. ●

Asset control: improving wastewater transport system performance

The activities that Dutch waterboards carry out to operate and maintain their wastewater transport systems are often based on poor information from their monitoring systems. Due to a lack of quality information, wrong decisions are easily made. These inefficiencies in business operations cost the waterboards a lot of money. Here, Christoph Lubbers describes a case study in which more useful information led to effective measures to solve pump failure in a pumping station and how waterboards can carry out their work in a more efficient manner by using intelligent monitoring tools.

Christof Lubbers
Royal HaskoningDHV, Rotterdam,
The Netherlands.
Email: christof.lubbers@rhdhv.com

The majority of wastewater pressure mains have been designed to convey clean water, rather than sewage. As sewage can be a gas-solids-water mixture, all kinds of ageing processes can occur after commissioning of the transport system, such as:
- **Wear of the impeller, reducing performance**
- **Sedimentation in the pressure main**
- **Scaling of the pressure main, reducing inner diameter**
- **Gas accumulation at high points in the transport line**

Gas accumulation in wastewater transport systems in particular has been subject to studies, which showed that the flow velocity must be high enough to convey this gas to prevent gas accumulation in pressure mains (Lubbers and Clemens, 2005). Flow capacity is reduced when the water flow rate is not high enough to transport gas, causing gas accumulation at high points in the system. In the event of a gas pocket being present in a downward sloping pipe section, energy is lost, which results in a reduction in the capacity of the pump system (Lubbers and Clemens, 2006).

The simple, but economically unrealistic, solution would be to increase the flow rate to obtain a sufficiently high transport capacity of gas and solids. A more elegant solution is to monitor the transport system and only increase the flow rate when it is necessary. This way, energy consumption and the carbon dioxide footprint can be minimized. This, however, requires an intelligent monitoring system that is not present in today's transport systems. The gas accumulation problem is just one example of the many reasons to strive for better insight into the processes taking place in sewer transport systems.

The problem

The majority of pumping stations are ill-equipped with regards to instrumentation. Often, only a flowmeter is present to register and check the obligatory maximum discharge. The more advanced transport systems that do have instrumentation to record the operating processes register the signals into a passive database. No data analysis is carried out to yield information from the data, which is why current data-logging in wastewater transport systems

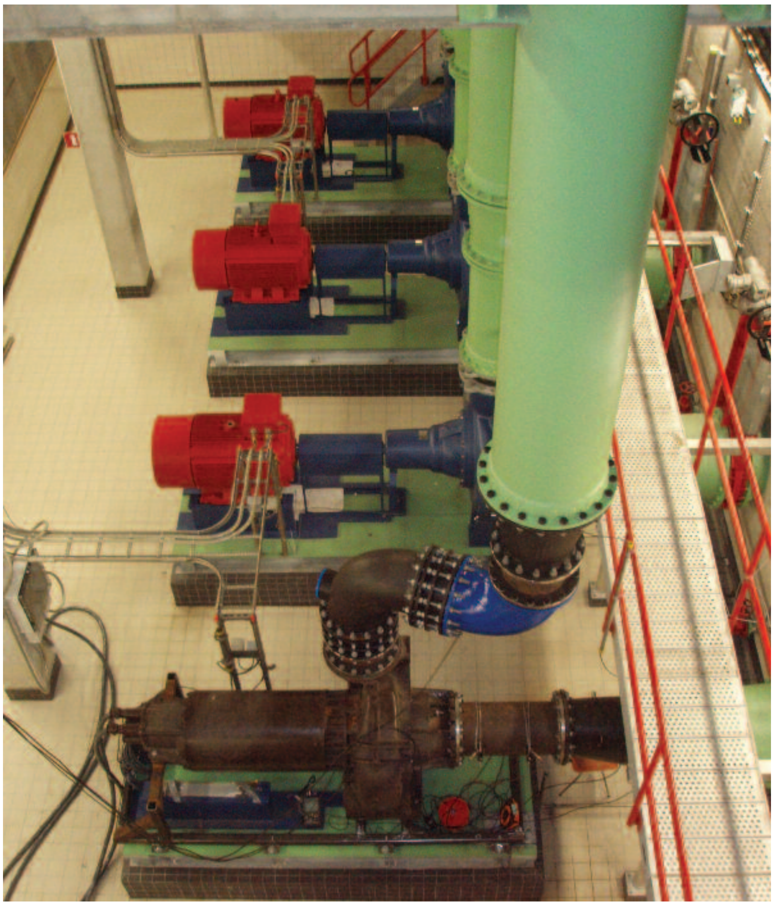


Figure 1
Four large pump units in an influent pumping station lift sewage to the wastewater treatment plant

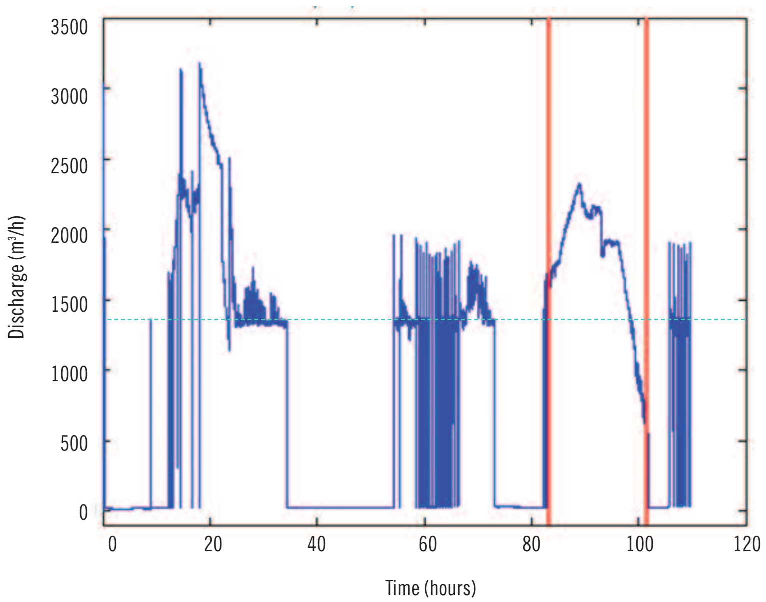


Figure 2
Time series of the flow rate during dry weather and storm weather flow

does a poor job of providing waterboards with the information they need to efficiently carry out their business activities. Clear and reliable information about the state of these transport systems is essential to make efficient and cost effective decisions on numerous business activities, such as:

- Decision making for new infrastructural assets
- Gather statistics for annual reports
- Assessing the efficiency of the operation of the system
- Assessing the efficiency of corrective measures
- Troubleshooting
- Maintenance

When a transport systems malfunctions, shows irregular behaviour or just when information is required from transport systems, dedicated information is not at hand. Often, administrators need to produce information ad hoc by investigating the available process signals in the monitoring system. As this is a cumbersome operation, if not to say often impossible, waterboards have a hard job finding solutions to problems and improving system performance. If the irregularities are not followed up, the transport system will work sub-optimally and may cause more combined sewer overflows (CSOs), increase energy consumption and increase the carbon dioxide footprint.

In practice, for all business activities described earlier, it is obviously essential that the correct decisions are made in order for them to be effective. This sounds straightforward, but making the decision itself is not hard when all relevant information is present, and that is what is lacking in the field. It is therefore important that the administrators of transport systems have proper monitoring systems, and more importantly, that data is translated into useful information by intelligent analysis tools. Only then can the right decisions with respect to asset management be made.

In the Netherlands, a commission investigated the wastewater sector and concluded that possible savings of €380 million ($494 million) on a yearly basis could be realised. It suggested that part of the efficiency improvements could be achieved by technical innovation.

In the following section, a case study is described in which a technical innovation is applied by adding intelligence to an existing data-logging system of a wastewater pumping station. By doing so, a severe pumping capacity problem was analysed and effectively solved by carrying out the right measures based on correct information. Furthermore, the energy consumption dropped drastically.

Case study: Pump failure resulting in decreased capacity

The pumps of the influent pumping station of a wastewater treatment plant in the south of the Netherlands shows problems during the commissioning period. Four frequency driven pumps each rated at 3200m³/h lift the water a few metres up to the inlet works of the treatment plant (Figure 1).

The Supervisory Control and Data Acquisition (SCADA) system shows that the pumps do not deliver their rated flow. An hour after pump start, the flow rate has decreased to 50% of the original flow, although the pumps run at a constant maximum speed. This problem does not always occur, only during rain events (storm weather flow – SWF). In dry periods (dry weather flow – DWF) the pumps operate at lower speeds. The pump control is based on the water level in the wet well; the higher the level, the higher the desired flow rate is. Figure 2 shows a time series of the discharge of the pump over a period of 120 hours in which three rain events occur. During DWF, the pump requires a reduced speed to control the level in the wet well. In the 20 hour period indicated between the red lines the discharge drops from about 2400 to 500m³/h. During SWF, the water level in the wet well rises and causes the pump to speed up to the higher set value of the flow rate. Because the set value is not reached, the pump will speed up until the maximum speed is reached. The pump control is set to a minimum flow rate of 1400m³/h (blue dotted line). Figure 2 shows that the discharge drops far below the minimum flow rate of 1400m³/h.

For the waterboard, it was not clear what caused the discharge drop. It could be an increase of the resistance in the pressure main due to gas pockets or solids accumulation or due to malfunctioning of the pump. The latter was deemed not likely, since the system had been operating for less than a year. Since the waterboard was not able to derive relevant information from the data, it was not able to solve the problem.

The consequences of the malfunc-

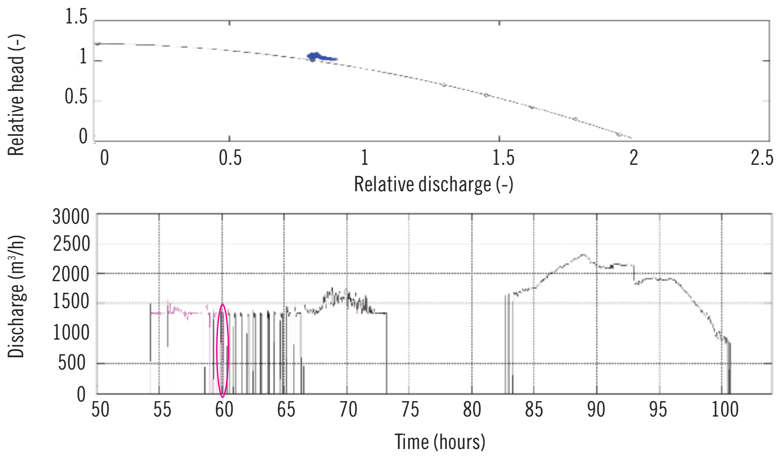


Figure 3
DWF time series of flow rate and associated duty points of the pumps

tioning system are large, as the wet well of the pumping station receives urban water from a several surrounding cities. Not being able to convey the water to the WWTP means that the waterboards fail their obligation to transport the guaranteed flow rate (interceptor capacity) of wastewater from the municipalities. The excess water that is not conveyed to the WWTP causes untreated water to run into receiving water (CSO spill). Furthermore, there is increased energy consumption and associated carbon dioxide emissions that according to the EU Water Framework Directive regulation should be reduced.

The waterboard has to cope with two problems: analyzing the cause of the problem, defining corrective measures and implementing them; and dealing with the excess water entering the pumping station until the problem is solved.

The waterboard undertook several studies to find the cause of the problem. These studies were based on gut feeling rather than data from the SCADA system. In the months of troubleshooting temporary pump units had to be hired to cover the capacity reduction. The cost of the units and the manpower involved was over €100,000 ($130,000).

The aim of this paper is not to describe the cause of the capacity drop, but rather to focus on the importance of reliable system information. Due to a lack of useful information, it took too long to find a solution. This paper stresses the need for tools to analyse any problems and provide information based on which effective corrective actions can be taken.

Data analysis

The current data-collection system of the waterboard recorded basic data such as flow rate and water level of the wet well, which was subsequently stored in a database. At the location of the pumps a monitor and pointer device gave access to the stored signals. There was no option to export data from the database to a data file and the monitoring system was only able to show the process history of an object on a monitor, rendering the system inadequate to analyse the data.

To facilitate analysis of the process data, a secondary data-acquisition setup was installed, registering all necessary process signals to analyse the performance of the transport systems. Over a period of weeks in which DWF and SWF occurred, the process data was stored on an external data acquisition system. The obtained dataset was then analysed to assess the possible cause of the pump capacity drop.

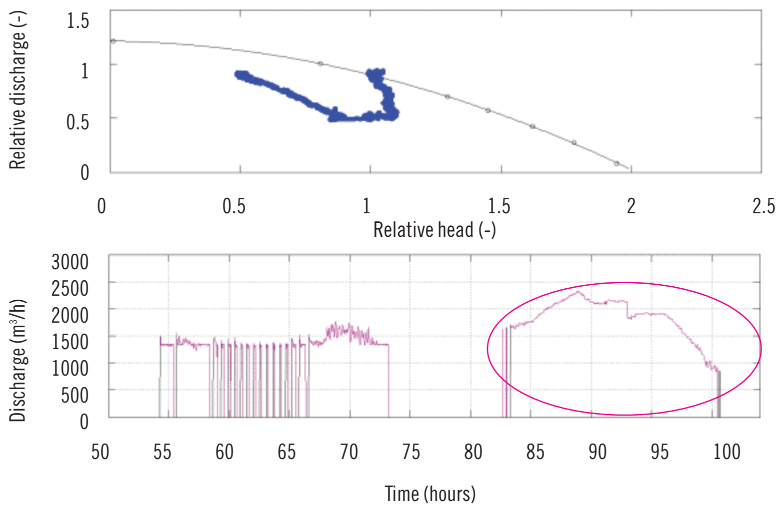


Figure 4 SWF time series of flow rate and associated duty points of the pumps

The analysis of the dataset was carried out by the iWATT analysis tool (iWATT stands for Intelligent Water Transport, a Royal HaskoningDHV analysis tool for intelligent systems throughout the water chain). The iWATT algorithms carry out calculations and perform mathematical operations on the dataset. The result is a graphical representation of how well the components (e.g. pumps or pressure main) of the transport systems behave. In this case study, it turned out that the pump itself showed varying performance levels. If a pump is installed according to the guidelines of the manufacturer, all duty points lie on the pump curve. This curve characterises the relation between flow rate and head and is fixed for a constant speed of the impeller. When the speed of the impeller varies, the pump curve changes according to known relations, called the pump affinity rules. One of the iWATT modules presents the duty points of the pump and shows the deviation from the pump curve.

So, the analysis method is to use the process signals recorded by the monitoring system and transform these signals to component related information. This information is judged against design values and deviations are interpreted to find the cause of problems.

Analysis and results

Figure 3 shows the flow rate registration and the duty point information during DWF. The red ellipse shows the pump period for which the duty points are determined. The duty points show normal pump behaviour during DWF.

Figure 4 shows flow rate registration and the duty point information during SWF. The red ellipse shows the pump period for which the duty points are determined. The duty points show a large deviation from the pump curve for SWF. This deviation occurred for all SWF conditions.

The duty point information showed that pump failure only occurred during rain events. Every time the pump was manually stopped for a short period of time and turned on again, the duty point started on the pump curve and then gradually deviated. Because the duty point started on the pump curve, it was concluded that mechanically the pump was sound. A hypothesis was adopted [Lubbers et al, 2010] that the combination of aerated rain water, higher impeller speed, and the specific impeller shape caused the low pressure in the impeller to degas the

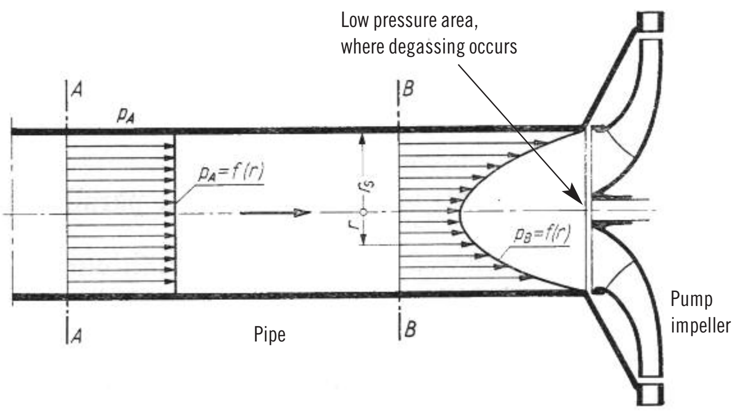


Figure 5 The local pressure drops towards the centre of the impeller

water (see Figure 5). It was further assumed that a gas pocket could grow in the impeller, causing the decay of the performance of the pump.

From other tests and analyses described in that paper with similar pump impellers and pumps with deviating impeller shape, it was concluded that the impeller shape was the cause of the capacity drop (Lubbers et al, 2010). Figure 6 shows results for a pump with a different impeller shape that did not suffer from deviation of the duty points. The left graph shows the times series of the discharge and the right graph shows the duty points corresponding to the second period indicated by the two vertical red lines. The problems were solved by installing pumps with a different impeller shape.

Discussion

Over a period of nine months the waterboard conducted several studies to solve the problem. During these attempts, the flow rate values were read from the monitor and written down on paper for further analysis. The signals by themselves did not provide information about the pump's (mal)function. As a result, the company did not succeed due to a lack of useful information obtained from the SCADA system.

The time from the first sign of pump problems to determine the cause of the problem took almost a year. In that period a lot of money was spent on fees for hiring the temporary pump units and manpower to investigate the problem and find the cause of the capacity drop.

For the case study, an asset control tool was developed that analysed process data from the pumping stations and pressure main and provided the dedicated information that the waterboard needed to solve its problem. It illustrated the fact that without the right information, problems can linger for a long period of time. Waterboards can save money and time by setting up a better information system that professionalises their business operations. For the administrators of transport systems and policy makers of waterboards, this means ideally that the real time status of all pumping stations and pressure mains must be available. This would answer questions regarding when to carry out maintenance activities, replacement of pump parts, cleaning of pipes, etc., but also provide information regarding the availability of extra capacity so that investments for extension of the transport system or expansion of capacity is phased in over time in the most economical way.

The asset management system provides information about the way the transport system functions, which was not possible with the original SCADA system. By defining the information needed in order to be able to analyse a problem, an analysis system was designed that gave insight as to which component of the transport system was causing the capacity reduction. The cause of the problem lay in the type of the pump impeller, which caused a malfunction of the pump during rain events with high gaseous water. Instead of a trial-and-error process, iWATT enabled the administrator to pinpoint the cause.

The application of the asset management system for this particular capacity problem uses data that can also provide information on:

- Energy use and thus carbon dioxide emissions
- Energy efficiency of the pumps
- Growing hydraulic resistance in the pressure main that decreases discharge capacity
- Optimal pump control parameters
- Overall validation of the design of the transport system

The first three points are directly related to Water Framework Directive goals that demand the reduction of energy consumption and carbon dioxide emissions. When problems are quickly solved and the transport system operates optimally, the discharge capacity conforms to design values and the number of CSO spills is reduced.

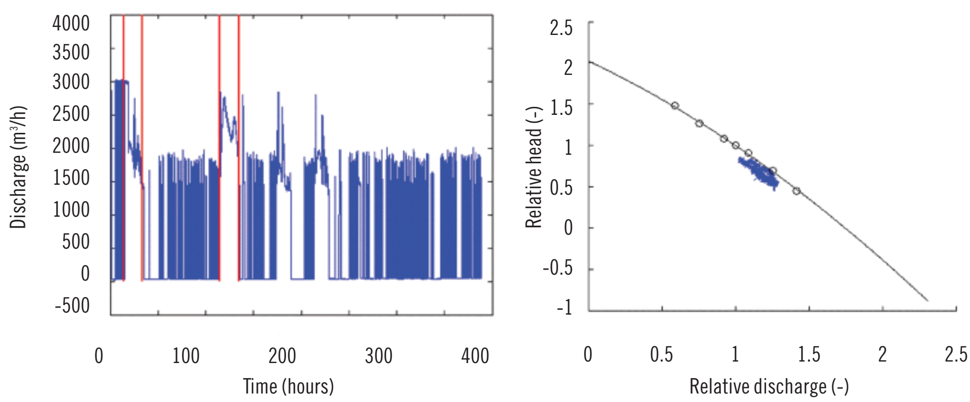


Figure 6
Left: Discharge time series with the new impeller shape. Right: The corresponding duty points

Conclusion

The majority of wastewater pumping stations are poorly equipped with data-logging systems. Without any intelligence to obtain information from these data, transport systems can operate sub-optimally over a long period without being noticed by an administrator. Not knowing how the systems functions gives rise to unreliable systems and unnecessarily large consumption of energy and associated emission of carbon dioxide. By adding intelligence to the system and visualizing the obtained information for the administrator in a comprehensive manner, mitigating actions can be undertaken. This leading edge technology yields better system performance, quickens response time to problems and will cut down energy costs.

The case study showed that due to a lack of information in the early stages, ineffective decisions can easily be made, resulting in additional costs until the problem was solved. This is a general problem; any decision maker requires reliable information to make a good judgement.

The wastewater sector includes the transport of wastewater to wastewater treatment plants. Waterboards require reliable information from these transport systems in order to make decisions. These decisions may be related to:

- Maintenance
- Operations
- New investments
- Policy making

In other words, intelligent monitoring systems such as iWATT provide administrators and policy makers with real-time information, which enables them to make quicker and more effective decisions. ●

References

Lubbers, CL and Clemens, FHLR (2005), 'Air and gas pockets in sewerage pressure mains'. Water Science and Technology, 3, Volume 52, pp37-43.

Lubbers, CL and Clemens, FHLR (2006), 'Breakdown of air pockets in downwardly inclined sewerage pressure mains'. Water Science and Technology, 11-12, Volume 54, p233-240.

Lubbers, CL, Boersma, J and Van Geffen, A (2010), 'Zijn Meerkanaalswaaiers toepasbaar in de afvalwaterwereld', H20 nr 22, pp 27-29.

Selection of the best rehabilitation solution using multicriteria decision analysis

This paper presents the application of a Multiple Criteria Decision Analysis (MCDA) framework to help select the best rehabilitation solution for a water network, using a Portuguese case study. Nelson Carriço, Dídia Covas, Maria do Céu Teixeira de Almeida and Helena Alegre consider two external scenarios, four rehabilitation alternatives and six evaluation criteria and use the ELECTRE III technique to rank the rehabilitation alternatives.

Nelson Carriço
Instituto Superior Técnico (IST), Lisboa, Portugal.

Dídia Covas
Instituto Superior Técnico (IST), Lisboa, Portugal.

Maria do Céu Teixeira de Almeida
Laboratório Nacional de Engenharia Civil (LNEC), Lisboa, Portugal.

Helena Alegre
Laboratório Nacional de Engenharia Civil (LNEC), Lisboa, Portugal.

Most of Europe's water and wastewater infrastructure was built several decades ago. Now, it is facing the natural and inevitable process of degradation. Therefore, infrastructure asset management (IAM) is of utmost importance for water utilities.

IAM is defined as the corporate strategy and the corresponding planning, systematic and coordinated activities and practices through which an organization optimally manages its assets and their associated performance, risks and costs over their lifecycle (Alegre et al., 2011a). Regardless of the complexity and maturity level of the water utilities, IAM involves three planning levels: strategic, tactical and operational. At each planning level, performance, risk and cost should be taken into account (Alegre and Covas, 2010; Almeida and Cardoso, 2010). At the strategic level, the direction of the corporation in terms of IAM for the long-term (10-20 years) is defined. At the tactical level the direction in the medium-term (three-five years) is defined, establishing intervention priorities and selecting solutions. Finally, at the operational level, the solutions selected at the tactical level are implemented considering short-term periods (one-two years), defining and scheduling the set of actions to be carried out (Alegre et al., 2011b).

A novel integrated approach for water supply and wastewater IAM was developed under the framework of the Advanced Water Asset REhabilitation (AWARE) project. The procedure articulates the three decisional levels (strategic, tactical and operational) and the main knowledge competences involved (engineering, management and information), based on the capability to take informed decisions through continuous and standardized evaluation of the systems. Each level is composed of different stages (see Figure 1) and tasks. The three different dimensions – cost, risk and performance – are incorporated in each level of planning to better support decision-making, particularly at the tactical level.

Generally, increasing performance and reducing risk and cost are conflicting objectives. Aggregation of criteria from different dimensions for decision making configures a Multiple Criteria Decision-Aid (MCDA) problem (Carriço et al. 2011).

The main objective of this work was the application of MCDA to select the best rehabilitation solution under the framework of the AWARE project. Multicriteria decision analysis was performed using six criteria from the three assessment dimensions and was applied to a case study in Portugal.

Problem formulation

In IAM, after the establishment and design of different rehabilitation solutions, the selection of the best solution should be based on the balance between the referred three assessments – performance, cost and risk – for the whole period of analysis. This means that the assessments should include the time dimension. The evaluation can typically be made by comparing each solution with the status quo situation (i.e., the alternative corresponding to maintaining the current operation and maintenance (O&M) practice).

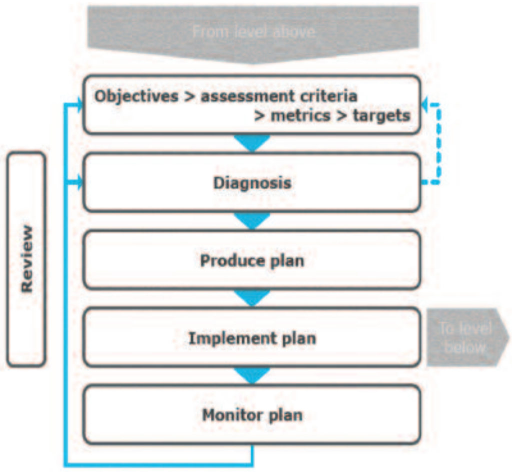
Scenarios (i.e., user-defined events that affect decision) can be used to project time evolution (e.g., demand evolution). Solutions should be assessed for one or more scenarios. The decision needs to consider multiple criteria and the AWARE framework allows balancing the three assessments. This brings MCDA into play. The main purpose of the MCDA methods is to help finding solutions for real-life problems, often problems with conflicting points of view (Vincke, 1992).

The current paper focuses on the selection of the best rehabilitation solution, taking into account different criteria established for the assessment of performance, cost and risk. This selection can be treated either as a choosing or a ranking problem. In this paper, the comparison of the different rehabilitation solutions is treated as a ranking problem.

ELECTRE family methods

ELECTRE (ELimination et Choix Traduisant la RÉalité) methods are a family of MCDA techniques developed in France in the 1960s. ELECTRE methods have been widely used in many real-world decision problems (e.g., energy, transportation, environmental and water manage-

Figure 1
The AWARE IAM planning process



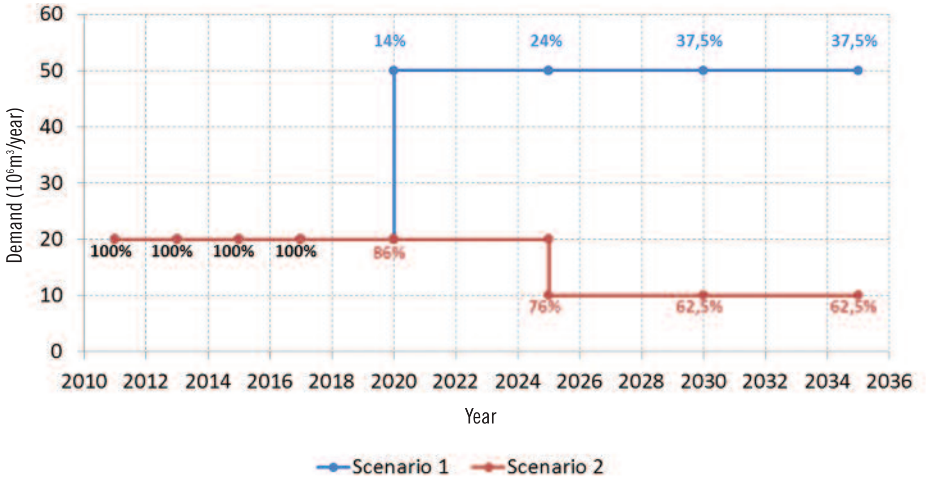


Figure 2
Scenarios of demand evolution

ment) and proved to be suitable for situations where at least five decision criteria are involved (Figueira et. al., 2010). The main advantage of these methods is the possibility of evaluating actions (or alternatives) using ordinal scales (similar or different) for assessing different criteria and not having to normalise results. The ELECTRE family includes several methods distinguished by the type of problems involved, such as choice, ranking or sorting.

In this paper, the comparison of different rehabilitation alternatives is treated as a ranking problem and the ELECTRE III method is used for the aggregation of criteria. The ELECTRE III method starts with a pairwise comparison of each alternative to the remaining one in order to accept, reject, or, more generally, assess the credibility of the assertion 'alternative a is at least as good as alternative b' (Almeida-Dias et al., 2006).

Case study

The case study is an industrial water trunk main that comprises a water treatment plant at an elevation of 70m, a gravity pipe around 10km long with diameters varying from 1000 to 1500mm and a 50,000m³ storage tank at an elevation of 53m. The pipe material is reinforced concrete, except in the valve chambers (four in total) where the pipes are made of steel with smaller diameters. Local site inspections have shown that most structural condition problems are located in these valve chambers.

The industrial park was built over 30 years ago with a high potential for future growth, so the system is currently overdesigned. The decision process began with the possibility of a new large industrial consumer settling in the industrial park, which will increase the current demand by three times, and may compromise the system's capacity. In addition, other concerns of the water utility are: the lack of redundancy of the system; the bad structural condition of the infrastructure (evaluation based on known age and useful life of reinforced concrete pipe), the customers' sensitivity to water supply interruptions and the possible lack of hydraulic capacity for future demands.

In order to address these problems, two demand scenarios were considered. Scenario 1 corresponds to a continuous increase of demand in the period of analysis (2011-2035), and Scenario 2 presents a reduction in the middle of the period of analysis which corresponds to end of the contract with the industry (see Figure 2).

Four rehabilitation alternatives were considered:

- Alternative A_0 – the status quo (i.e., keeping the current O&M practice) (no investment cost)
- Alternative A_1 – the implementation of a set of systematic repairs to the existing pipe (investment of €2.5 million ($3.3 million))
- Alternative A_2 – the construction of 25hm³/year of new pipe plus rehabilitation of the existing pipe network (investment of €15.1 million ($19.7 million))
- Alternative A_3 – the construction of 60hm³/year of new pipe and abandoning the existing pipe network (investment of €11.7 million ($15.3 million))

The decision-maker (a panel of specialists from the water utility) chose six criteria from the three assessment dimensions to evaluate each rehabilitation alternative: two risk assessment criteria – risk of pipe burst (R_1) and risk of lack of hydraulic capacity of pipes (R_2); three performance criteria – real water losses (P_1), exceeding pipe capacity (P_2) and the Infrastructure Value Index (IVI) (P_3) and one cost criterion – total cost (C_1).

Risk

In engineering, risk is traditionally valued as the product of the likelihood of an event by the associated consequences. These consequences can be evaluated under different dimensions.

Risk of pipe burst (R_1)

This criterion intends to estimate the risk of a burst event in the industrial water trunk main. The likelihood of a burst event can be estimated using the repair records history from the water utility, assuming that all bursts in pipes are registered. If the water utility does not have historical records, the likelihood can be valued using expert estimates. In this case study, the likelihood was valued using the historical repair records from another utility, which has similar pipes made of reinforce concrete and with diameters between 750 and 1200mm. The repair data were a set of 29 records taken between 1998 and 2010. Pipes with no burst events were also included to evaluate the likelihood. Commonly, the consequences considered relevant by the utility engineers result from a water supply disruption. These consequences are the impacts to the system's operation and maintenance, disturbances to consumers from the service interruption and disturbances to third parties (e.g., floods and disturbances to traffic and accessibility). The dimension consequence considered herein was the water supply disruption to the industrial park expressed as the percentage of volume of water needed and not supplied when a burst occurs in the pipe. This criterion is given by Equation (1).

$$R_1(t) = C(t) \text{ x } P(t) \qquad (1)$$

where R_1(t) is the risk of pipe burst at time t (-); t is time (year); $C(t)$: is the consequence at time t (-); and $P(t)$ is the likelihood at time t (-).

Risk of lack of hydraulic capacity of pipes (R_2)

In this risk criterion the likelihood is estimated using the likelihood associated with the occurrence of the annual water demand of each scenario (as Figure 1). These values were assigned by a panel of specialists from the water utility. The consequence considered for this risk criterion was the disruption to water supply, measured by the ratio between the water demand for a given time and the maximum hydraulic capacity of the pipes for the analysed alternative. The risk of a lack of hydraulic capacity of the pipes is estimated according to Equation (2).

$$R_2(t) = P(t) \text{ x } \left(\frac{Q(t)}{N(t)}\right) \qquad (2)$$

where $R_2(t)$ is the risk of lack of capacity of pipes at time t (-); t is time (year); $P(t)$ is the likelihood at time t (-); $Q(t)$ is the maximum hydraulic capacity of the pipes at time t (m³/year); and $N(t)$ is the water

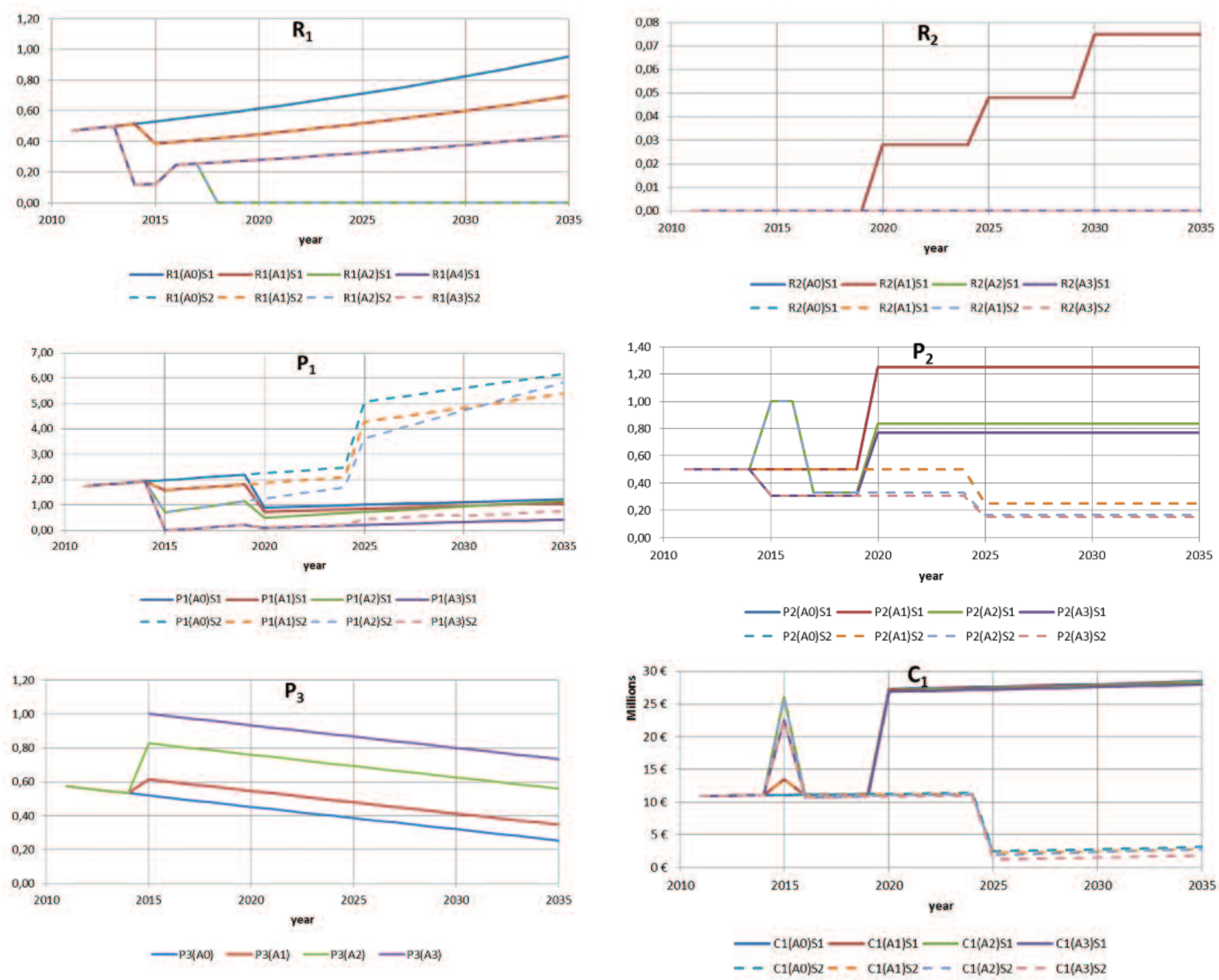


Figure 2
Time evolution for six assessment criteria: risk of pipe burst (R_1); risk of lack of hydraulic capacity of pipes (R_2); real water losses (P_1); exceeding pipe capacity (P_2); infrastructure index value, IVI (P_3);and total cost (C_1)

demand at time t (m³/year).

Performance

Real water losses (P_1)
This performance indicator was estimated using the methodology presented in Laven and Lambert (2012). The methodology is based on statistical data collected over 15 years in 25 countries. This performance indicator can be assessed using Equation (3).

$$P_1 = 0.1029 \text{ x } a \qquad (3)$$

where P_1 is the real water losses indicator ((m³/year).km⁻¹); and a is the average age of the pipe that can be determined from the pipe condition (years).

Exceeding pipe capacity (P_2)
This indicator measures the ratio between potential water demand transported by a pipe in a given time and the maximum flow that can be transported by the pipe. Equation (4) shows the formula to obtain this indicator.

$$P_2(t) = \left(\frac{N(t)}{Q(t)}\right) \qquad (4)$$

where P_2 is exceeding pipe capacity at time t (-); $N(t)$ is the water demand at time t (m³/year); t is time (year); and $Q(t)$ is the maximum hydraulic capacity of the pipes at time t.

If P_2<1 the pipe is overdesigned in terms of hydraulic capacity, if P_2=1 the pipe hydraulic capacity matches demand and if P_2>1 the pipe is under-designed.

Infrastructure value index – IVI (P_3)
This is a performance index that represents the ratio between the current costs and the replacement costs of the infrastructure. IVI is assessed by Equation (5).

$$P_3(t) = \frac{\sum_{i=1}^{N}\left(rc_{i,t}\cdot\frac{r_{i,t}}{u_i}\right)}{\sum_{i=1}^{N} rc_{i,t}} \qquad (5)$$

where P_3 is the IVI at time t (-); t is time (year); N is the total of assets (-); $rc_{i,t}$ is the replacement cost of asset i at time t (€); $r_{i,t}$ is the residual life of the asset i at time t (years); u_i is the useful life of the asset i (years). IVI should ideally be near 0.5 (Alegre and Covas, 2010).

Cost

Total cost (C_1)
The total cost is the sum of the tangible costs associated to each alternative.
The tangible costs considered were the investment cost, the annual operation and maintenance cost, the annual water acquisition cost from other utilities and the annual treatment cost. Equation (6) shows the total cost formula.

$$C_1 = IC + \sum_{i=1}^{m}\left(C_{O\&M}+C_A+C_T\right) \text{x} \frac{1}{(1+t_a)^i} \qquad (6)$$

where C_1 is the total cost (€); IC is the investment cost (€); $C_{O\&M}$ is the operation and maintenance cost (€); C_A is the water acquisition cost from

Table 1 - Attributes, weights and preference direction of the criteria

	R_1 (-)	R_2 (-)	P_1 (%)	P_2 (-)	P_3 (-)	C_1 (M €)
A0	0.91	0.01	1.85	0.36	0.42	192.54
A1	0.48	0.01	1.61	0.36	0.50	192.76
A2	0.25	0.00	1.39	0.32	0.68	203.76
A3	0.12	0.00	0.62	0.26	0.87	195.98
Weight	10	8	1	1	2	10
Preference direction	⇓	⇓	⇓	⇓	⇑	⇓

other utilities (€); C_T: treatment cost (€); t_a: discount rate (–).

The investment cost includes the costs associated to the construction of tanks and pipes. In this paper the annual operation and maintenance cost is 1% of the investment cost. The utility needs to buy water from another utility whenever demand is greater than 25 hm³/year. But the contract with that utility establishes that despite demand reaching the 25 hm³/year or not they have to buy a minimum of 10 hm³/year. The water acquisition cost includes the real water losses in the system. All water that enters the system is treated and, therefore, has additional costs that should be taken into account.

Criteria aggregation

The main question was how to aggregate different criteria considering multiple demand scenarios along the whole period of analysis. This question introduces complexity in the analysis since using the ELECTRE III method to rank the alternatives only considers one value per criterion and per alternative.

The first step to solve the problem in this case study was the aggregation of each criterion along the time dimension. For the risk criteria, the maximum value along the period of analysis was assumed. For the performance criteria, except for IVI, the average value in the period of analysis was considered. Finally, for the cost criteria, the global value assumed was the sum of all annual present costs.

The aggregation over time of the criteria leads to two global values per alternative and per criterion, one for each scenario. The second step is to deal with the scenarios. There are two ways to do it: the first is to use the ELECTRE III method for each scenario and to compare the results obtained; and the second is to aggregate the scenarios. In the case study presented in this paper the second method was used. The scenarios were aggregated using the value of a criterion and weighting it with the likelihood that the utility engineers gave for the demand in each scenario at different time steps (see Figure 2). Equation 7 shows the formula used to aggregate the scenarios.

$$g(t) = \frac{1}{m} \sum_{i=1}^{m} [\, g_i(t) \cdot p_i(t)] \qquad (7)$$

where $g(t)$: global value of the criterion g at time t; $g_i(t)$: value of the criterion g in scenario i at time t; $p_i(t)$: likelihood of demand assigned to scenario i at time t; m: number of scenarios.

Results and discussion

Results obtained along the period of analysis for the six assessment criteria (R_1, R_2, P_1, P_2, P_3 and C_1), for the four alternatives and for the two scenarios considered are presented in Figure 3.

The results for time evolution for the risk criteria R_1 show that there is a decrease of pipe burst risk after the rehabilitation intervention. Afterwards, the risk will increase over time because of pipe ageing. For alternative A_2 risk will be null after 2017 since the new pipe is in service and is estimated that in this year the existing pipe will be placed into service after rehabilitation intervention. Results for each alternative for R_1 are similar for both demand scenarios.

R_2 is null in Scenario 2 for all rehabilitation alternatives because pipes always have enough hydraulic capacity and, therefore, the consequence is always null; in the case of Scenario 1, for rehabilitation alternatives A_0 and A_1, the risk R_2 increases with time, starting from null to moderate risk level at the end of the period of analysis.

The performance criteria P_1 and P_2 are demand-dependent. The higher the performance indicator P_1, the lower the demand. The real water losses rate is the same in both scenarios, but percentages are more expressive for lower demands. This is the reason why P_1 is higher in Scenario 2 than in Scenario 1. P_2 is the ratio between water demand and pipe capacity and, therefore, it will be higher for Scenario 1 than Scenario 2.

The results obtained showed that only criterion P_3 does not differ per scenario. This is because IVI is independent of demand and decreases over time because of pipe ageing.

The total costs of alternatives are higher in Scenario 1 than Scenario 2 because the water acquisition cost from other utilities and the treatment cost are higher when demand is higher. Cost differences between alternatives are very small, less than 2% in Scenario 2 and 7% in Scenario 1.

To evaluate the four rehabilitation alternatives with the selected criteria, the ELECTRE III method was used. In this method, criteria, alternatives and thresholds are defined. If the decision-maker argues that the different criteria should not have the same relative importance, weights can be used. The attributes, the weights and the preference direction of the criteria are shown in Table 1.

According to ELECTRI III, the rank order is A_3, A_0 in ex aequo with A_1 and A_2 when considering all six criteria. However, when the total cost criterion is neglected in the analysis or a lower weight is assigned to this criterion, the rank is A_3, A_2, A_1 and A_0.

The results are consistent since the alternative A_3 has the best attributes for at least five criteria (R_1, R_2, P_1, P_2 and P_3). When the criterion C_1 is considered in the analysis, alternative A_2 is penalized. The reason for that is because this alternative is the most expensive and the criterion is considered as very important relatively to the others. Alternatives A_0 and A_1 are quite similar, but alternative A_1 shows a slight improvement in performance P_1 and P_3 and reduction of risk R_1 comparatively to A_0.

Conclusions

The maximization of performance and minimization of risk and cost are conflicting objectives. The aggregation of criteria from these three dimensions for decision making can be formulated as a MCDA problem. ELECTRE methods are a family of MCDA techniques distinguished by the type of problems involved, such as choice, ranking or sorting. The selection of the best rehabilitation solution taking into account different criteria established for the assessment of performance, cost and risk can be treated either as a choosing or a ranking problem. In this paper, the comparison of different rehabilitation solutions is treated as a ranking problem and for that the ELECTRE III method is used for the aggregation of criteria.

A possible way to aggregate each criterion along the time dimension is by using for the risk criteria the maximum attribute, for the performance criteria (except for IVI) the average attribute over the period of analysis and for the cost criteria the global attribute results from the sum of all annual present costs. The scenarios can be aggregated using the attributes of a criterion and weighting them in different time steps. The results obtained in this study showed that the best alternative is A_3, which consists of the construction of a new pipe for 60hm³/year abandoning the existing pipe. When the cost criteria have a lower weight, or is not considered in the analysis, the ranking order will change but keeping as best alternative A_3. ●

Acknowledgements

The authors acknowledge the European Financial Mechanism (EEA Grants) for supporting this work within the AWARE-P project as well to the project team members. A special acknowledgement to the participating water utilities AdP Serviços, SA and Águas de Santo André, SA.

Reference

Alegre, H, Almeida, MC, Covas, DIC, Cardoso, MA and Coelho, ST (2011), Infrastructure Asset Management in urban water systems: an integrated approach. Encontro Nacional de Saneamento Básico (ENaSB). Porto, Portugal.

Alegre, H, Almeida, MC, Covas, DIC, Cardoso, MA and Coelho, ST (2012), An integrated approach for infrastructure asset management of urban water systems. Water Asset Management International, 8.2, pp10-14.

Alegre, H and Covas, D (2010), Infrastructure asset management of water services. An aproach based on rehabilitation (in Portuguese). Technical Guide n.16. Lisbon, ERSAR, LNEC, IST.

Almeida, MC and Cardoso, MA (2010), Infrastructure asset management of wastewater and stormwater services. An approach based on rehabilitation (in Portuguese). Technical Guide n.17. Lisbon, ERSAR, LNEC.

Almeida-Dias, J, Figueira, JR and Roy, B (2006), The software ELECTRE III-IV: methodology and user manual (version 3.x). Paris (France), LAMSADE, University Paris-Dauphine.

Carriço, N, Covas, D, Almeida, MC, Leitão, JP, Alegre, H (2011), Prioritization of rehabilitation interventions for urban water assets using multiple criteria decision-aid. Water Science and Technology, Vol. 66, No. 5, pp1007-1014.

Figueira, J, Greco, S, Roy, B and Slowinski, R (2010), ELECTRE Methods: Main Features and Recent Developments. Zopounidis, Constantin e Pardalos, Panos M. Handbook of Multicriteria Analysis. 103, 51-89. Springer Berlin Heidelberg.

Laven, K and Lambert, AO (2012), 'What do we know about real losses on transmission mains?' IWA Water Loss 2012.

Vincke, P (1992), Multicriteria Decision-aid. Chichester, John Wiley & Sons, Inc.

This paper was presented at LESAM 2011 – the Leading Edge conference on Strategic Asset Management, held 27-30 September 2011, Mülheim an der Ruhr, Germany.

The 'Mapping the Underworld' project – industry / academic co-operation delivers dramatic new developments for water networks

Jo Parker
Director at Watershed Associates Ltd.

UK Water Industry Research identified the management of buried assets, i.e. sewers and water mains, as a key priority. The maintenance of these assets is often carried out in a reactive way and the short-term minimum direct cost approach is far from the optimum solution for the economy, society or the environment.

Through working with the academic funding body EPSRC the research project 'Mapping the Underworld' (MTU) was initiated. Jo Parker describes the MTU initiative and the four projects which have led to the development of techniques such as pipe tagging and a web-based records database to improve water network management.

Beneath the network of roads and pavements are a network of pipes and cables delivering utility services to properties and servicing the road network itself. In the UK it is estimated that there are 396,000km of water mains, 353,000km of sewers (England and Wales only) 275,000km of gas mains and 482,000km of electricity cables. In addition, there are cables for communications, street lighting and traffic control as well as surface water drains. It is estimated that the total length of buried assets is around five times the total length of the road network (Mahon, Evans and Burtwell, 2005).

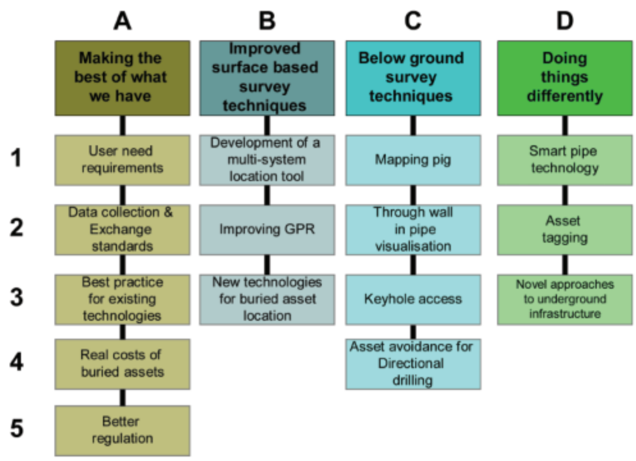


Figure 1
Minimising Street Works Disruption Programme

Installing and maintaining these buried assets requires extensive activity from the owners, the utility organisations and highway authorities. In 1997 it was estimated that on average four million holes are dug every year on UK highways and footpaths by utilities in order to install new services or repair and maintain existing ones (AA, 1997). Since that time the amount of buried assets has increased as additional communications networks have been installed and maintenance programmes for the gas, water and sewer networks have increased.

In 2004, Transport for London estimated that one million excavations a year are undertaken in the capital alone (Cullen, 2005). There is a need for those people working on the street to access information about their own and other organisations' assets easily and quickly. At present, although there are codes of practice such as that issued by the Highways and Utilities Committee (HAUC), these are not clear as to the whether the levels of accuracy are absolute or relative, and methods of recording the information can include paper, microfiche (microfilm) and a variety of digital formats.

Currently, every time a hole is dug, there is the risk of hitting and damaging other utilities' buried plants and equipment. This is a particular problem for water utility assets, which generally lie beneath the other networks such as gas, electricity and communication cables. A significant number of holes excavated to repair leaks are 'dry' i.e. the equipment is not found. Every time a hole is dug in the road, it impacts on traffic and the local environment.

Traditionally, work on buried plants and equipment involves digging a trench, doing the work, and reinstating the filled hole. In recent years, far more use has been and is being made of trenchless technology, which reduces the number and extent of excavations, helping to reduce, in particular, the level of indirect cost.

Whichever method is used – trench or trenchless – there is an absolute need to understand the nature of the underground environment about to be disturbed when planning new installations and when excavating to maintain existing infrastructure. What pipes and cables are there? Where are they? How deep are they?, and so on. Historically, the location of underground plants and equipment has been based on records held by utility companies on two-dimensional media, supported by on-site trial hole investigations. Some of the water networks in the UK date back over 100 years and the owners have been through numerous restructurings, reorganisations and changes of ownership. Even where organisations have endeavoured to keep records meticulously, some historical events such as the two World Wars have led to repairs and diversions being made without records being maintained and excavations can lead to unexpected problems.

Figure 2
A close up of a utility marking tag developed by Oxford University

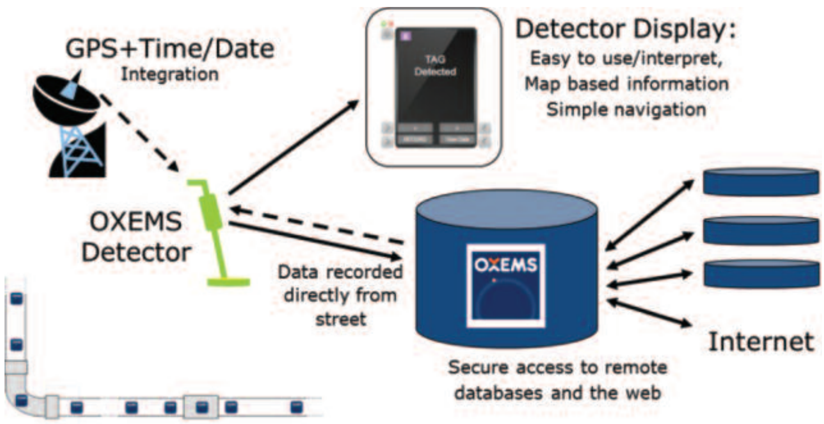


Figure 3
The OXEMS Asset Management System

UK Water Industry Research's response to the challenge

In 2004 UKWIR (UK Water Industry Research) identified research into the management of buried assets, i.e. sewers and water mains, as a key priority, with 15 key projects as detailed in Figure 1 (Burtwell et al, 2003; Overton, 2004).

As part of this programme it promoted a new approach with the academic funding organisation EPSRC. This initiative, known as the 'Ideas Factory', identified funding in advance and brought together 30 leading members from industry and academia to develop research proposals in a three-day seminar. Whilst some of the attendees were leading figures in the area of buried asset management, others were new to the area, coming from such disciplines as archaeology and medicine. This ensured that new perspectives were brought to bear on old problems, such as how to locate buried assets more accurately and how to reduce the disruption caused by work on buried assets. Thus, the collaboration on work identified at this seminar grew out of industry academic co-operation from the outset.

Delegates at the seminar developed a number of project proposals, which were costed and prioritised as part of the work of the seminar, and the final programme of work was entitled the 'Mapping the Underworld' programme, (Parker, 2006). This comprised four research projects as well as the establishment of an industry network with regular dissemination seminars. This network, in addition to ensuring that the industry was fully engaged with the projects, formed a means to promote better communication across the owners of utility and road networks, and in itself has been the foundation for a number of other initiatives that are described later in this paper. All four projects have delivered new technology, which is either fully implemented or being further developed using follow-on funding (Rogers et al, 2008).

The original 'Mapping the Underworld' projects

Oxford University electro-magnetic tags

One project carried out by Oxford University developed an entirely new method of locating plastic pipes. The approach uses resonant frequencies produced by a metal reflector encased in plastic to produce a type of bar code attachment, or 'tag', to indicate the owner, type of fitting and any other information such as date of installation, manufacturer, etc. (Figure 2). The attachment requires no power and therefore has the same life as that of the pipe itself. This work was carried out over three years with a further year's development grant being obtained.

The idea was patented and the University of Oxford sought commercial backing in order to launch the device as a new product. The water industry was particularly interested in the idea as it offered an opportunity to identify joints and fittings on newly

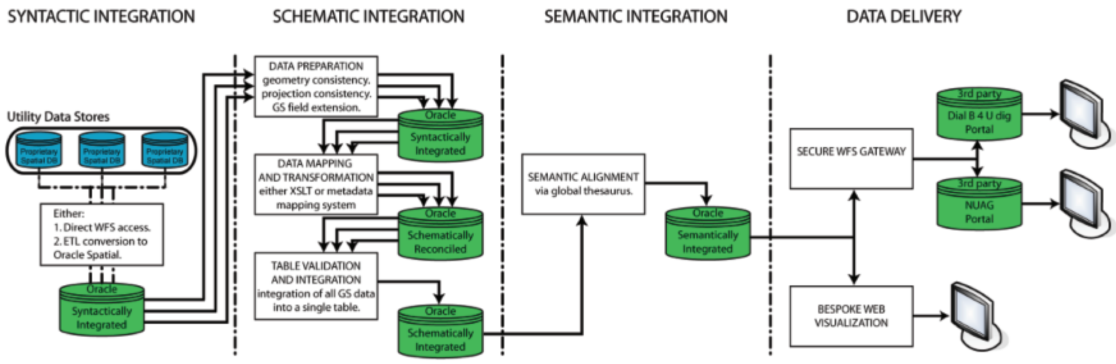


Figure 4
The integration approach developed for use in London and Scotland

installed polyethylene pipe, which were the most likely to develop leaks in the future. Trials carried out by UK water companies have been successful and funding was obtained to launch a new company, OXEMS, to market the product.

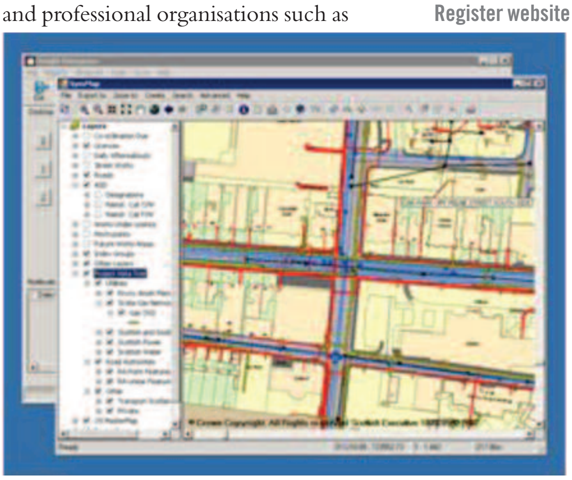
Further work on the deployment of the tags has developed the system into a comprehensive asset management system linking to GIS and maintenance records (Figure 3). The 'tags' are now being installed on new water mains by a number of water companies in the UK.

The collection and exchange of records

A further two projects worked on methods to improve how buried asset information is collected and exchanged. In 2005, a successful proposal was submitted under the then DTi Technology Programme for a multi-utility project to develop these two projects to field trials. The project started on 1 January 2006 and was completed at the end of 2009.

The project involved over 20 organisations, including utilities supplying gas, water, sewerage, electrical and communications services, highways authorities, consultants working in the field of buried asset records, surveying equipment manufacturers, installation contractors and professional organisations such as the Institution of Civil Engineers and the Pipeline Industries Guild. Two of the universities who were also part of the Mapping The Underworld (MTU) programme provided the majority of the research input.

Figure 5
An example screen from the Scottish Road Works Register website



Leeds University continued the work initiated by MTU and developed a means to integrate and display varied asset information. This used web technology and a standard database or schema which all the utility partners agreed to. The system is shown in Figure 4.

In addition, a new web-based records exchange system was trialled in three locations, two in central England and one, led by Scottish Water within Scotland. As a result of this last trial a further extended trial was carried out that gathered information for a cost benefit analysis, which supported the introduction of the system for the whole of Scotland. The web-based records system became operational in March this year so any members of the Scottish Road Works Register, i.e. local authorities and utilities, can now log on to the Register's website and download the records from any participant who has digital asset records; a world first (Figure 5).

Nottingham University expanded its research to find ways of extending coverage of the satellite geospatial positioning technology. In addition, Nottingham University built on an earlier project that developed a portable field system to display buried asset locations using virtual technology. Although the system has not been used by the utility industry, the field work has helped survey equipment manufacturers to develop specialist menus for surveyors collating as laid records so that GIS systems can be updated in a few days, rather than the many weeks it used to take.

Mapping the Underworld phases 1 and 2

The final project developed new ways of locating buried assets of key importance to the owners of water and sewer networks, which generally lie below all other networks (Atkins et al, 2008; Metje et al, 2007). This project had the ambitious target of locating every asset under the ground. Approaches included developments in GPR and acoustic methods to help locate small diameter pipes such as service connections, pot-ended cables and other hard to locate services. One method is illustrated in Figure 6.

The initial project (phase 1) proved all four new location techniques in phase 1 and gained follow on funding, the largest academic funding, of this type in the country, requiring six universities to work together.

The technology is now being combined with new data merging approaches to further improve the accuracy of the asset location. Trials have been carried out in co-operation with a UK water company, which shows that the different technologies can be combined, and a prototype machine has been developed that is being refined in preparation for the final project seminar, which will be held in December of this year (see Figure 7).

New approaches to managing academic research projects

Apart from the novel approach to initiating this research discussed above, this research project introduced a number of other new approaches for academic projects. An industry liaison manager was funded by UKWIR to maximise the impact of the research work for the water industry. She ensured that the relevant members of UK water companies were kept informed of progress as well as helping to locate water company facilities that could be used for the research.

In addition, the funding of a network to promote communication ensured that industry awareness of the project was maximised. This included regular seminars with both industry and academic contributions so that they gained a reputation for providing a way to learn of the latest relevant technology, and each one was attended by over 100 people. The approach of regular seminars was continued with MTU phase 2.

The network and the project steering groups also provided the foundation for representatives from different utility industries to meet and identify where further alliances were required. Several groups have now been established, including the National Underground Assets Group (NUAG), which is developing a unified records system for the whole country similar to that in Scotland. The Buried Assets Centre of Knowledge provides a register of all projects working in this area. The Underground Mapping Association is working to improve and regulate the niche area of underground asset surveying and mapping and are participating in the development of a national standard, supported by the British Standards Institute.

Questionnaires helped to shape the specifications for the research outputs (UKWIR, 2007) to ensure that future research is focused on areas that are needed by the industry. In addition to encouraging active participation by industry, this has given research funders, particularly in the government, more confidence in the support that initiatives will gain from industry.

It is unusual to have so many universities working together with a wide range of disciplines, and a full time project manager was employed for the overall programme, which ensured that the focus was maintained on the original objectives. Regular meetings between researchers allowed the crossover of developments, e.g. integration techniques developed for combining different buried asset record systems were also used to integrate the outputs from the different buried asset location methodologies.

In addition, the usual requirement to publish papers was waived in one case to ensure that the outputs could be patented and commercially exploited.

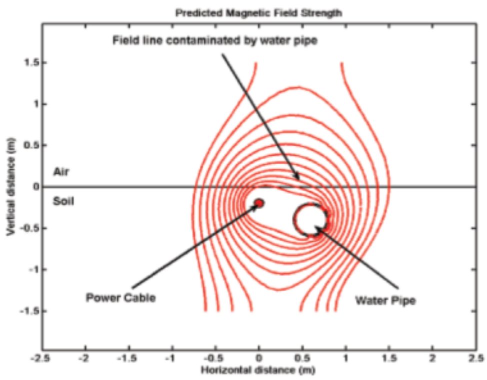


Figure 6
Use of passive magnetic fields to identify the presence of an adjacent water service pipe

Conclusions

The Mapping the Underworld programme introduced a number of new approaches to initiating and developing academic research in the UK, which not only led the way in water network research, but has also changed the way scientific and engineering research is managed generally. As a multi-disciplinary, multi-university project it serves as an important example of how a coherent research strategy can lead to an acceptable solution, but only as long as it is not treated as a single, stand-alone research project, as so many classically academic research projects are. A holistic approach is required to address the complex problem of water distribution management, which requires collaboration between disciplines, other research projects and, most importantly, with the stakeholders intended to benefit from the research.

Every individual project within the overall programme has produced major technological developments that are having a substantial impact on the efficiency of managing water networks in the UK. In particular it allows for polyethylene pipes and joints to be accurately located from the surface, record drawings for the extensive mains renewal programmes in the UK to be prepared quickly and accurately, and integrated buried asset information to be easily accessed via the web in a downloadable format. This in turn will reduce the cost of installing, managing and renewing water mains as well as reducing the impact on the environment and society (Brady, 2001; McMahon et al, 2005; Thomas, 2006).●

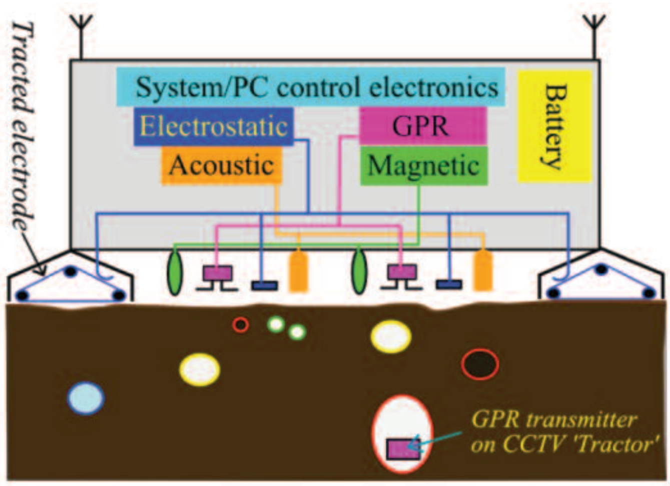


Figure 7
Design of combined utility location tool

Reference

Automobile Association (1997), Digging up the roads. From a survey – Living with the Car.

Atkins, PR, Brennan, MJ, Chapman, DN, Lim, HM, Machell, J, Metje, N, Muggleton, JM, Parker, J, Pennock, SR, Ratcliffe, J, Redfern, MA, Rogers, CDF, Saul, AJ, Shan, Q, Swingler, S and Thomas, AM (2008), 'Mapping the Underworld: Sensor Technologies - Review and Progress' UKWIR report 08/WM/12/21 London.

Brady, KC, Burtwell, M and Thompson, JC (2001), 'Mitigating the disruption caused by utility street work'. TRL Report 516.

McMahon, W, Burtwell, MH and Evans, M (2005), 'Minimising Street Works Disruption: The Real Costs of Street Works to the Utility Industry and Society'. UKWIR Report 05/WM/12/8. London.

Burtwell, MH, Faragher, E, Neville, D, Overton, C, Rogers, CDF and Woodward, T (2003), 'Locating Underground Plant and Equipment – Costed Proposals for a research programme'. UKWIR report 03/WM/12/5 London.

Cullen, M (2005), Use of a common framework for positional referencing of buried assets. ICE 2005.

Metje, N, Atkins, PR, Brennan, MJ, Chapman, DN, Lim, HM, Machell, J, Muggleton, JM, Pennock, SR, Ratcliffe, J, Redfern, MA, Rogers, CDF, Saul, AJ, Shan, Q, Swingler, S and Thomas, AM (2007), Mapping the Underworld – State-of-the-Art Review. Tunnelling and Underground Space Technology, Vol. 22, 568-586.

Overton, C (2004), Minimising Street Works Disruption, Stakeholders Forum 21 June 2004 UKWIR report reference number 04/WM/12/6.

Parker, J (2006), 'Minimising Streetworks Disruption: Progress 2002-2006'. UKWIR report 06WM1210 London.

Rogers, CDF, Zembillas, N, Thomas, AM, Metje, N and Chapman, DN (2008), 'Mapping the Underworld - Enhancing Subsurface Utility Engineering Performance', Transportation Research Board 87th Annual meeting, Washington DC, January 13-17.

Thomas, AM, Metje, N, Rogers, CDF and Chapman, DN (2006), 'Underground utility infrastructure: improving sustainability through improved detectability – the stakeholders' perspective'. Proc. of 24th International No-Dig Conference and Exhibition, Brisbane, Australia, 29th October-2nd November.

UKWIR (2007), 'Outcome of the ORFEUS Questionnaire', Report 07/WM/12/18, UK Water Industry Research Limited, London.

Asset management in small and medium utilities – the AGS experience

Asset management is assuming a greater relevance in utilities' short- and long-term management, but there is a need to develop better planning processes and a more sustainable way of managing capital expenditure in the long-term.

AGS, a Portuguese private operator with contractual responsibilities in 17 concessions and public-private partnerships, has been taking part in the AWARE-P infrastructure asset management project in order to develop planning and decision tools to support asset management across its utilities. João Felliciano, Rita Almeida, Helena Alegre and Dídia Covas describe AGS' involvement in the project and the results achieved.

João Felliciano
AGS – Administração e Gestão de Sistemas de Salubridade,S.A., Portugal
Email: jfeliciano@ags.pt

Rita Almeida
AGS – Administração e Gestão de Sistemas de Salubridade,S.A., Portugal
Email: ralmeida@ags.pt

Helena Alegre
Urban Water Division, Hydraulics and Environment Department, LNEC – National Laboratory of Civil Engineering, Portugal. Email: halegre@lnec.pt

Dídia Covas
Instituto Superior Técnico (IST), Portugal. Email: didia@civil.ist.utl.pt

Water utilities have a high dependence on long life assets that must be sustained at an adequate service level at an optimal cost (operational costs and rehabilitation investments). Managing these assets must ensure their economic and financial sustainability.

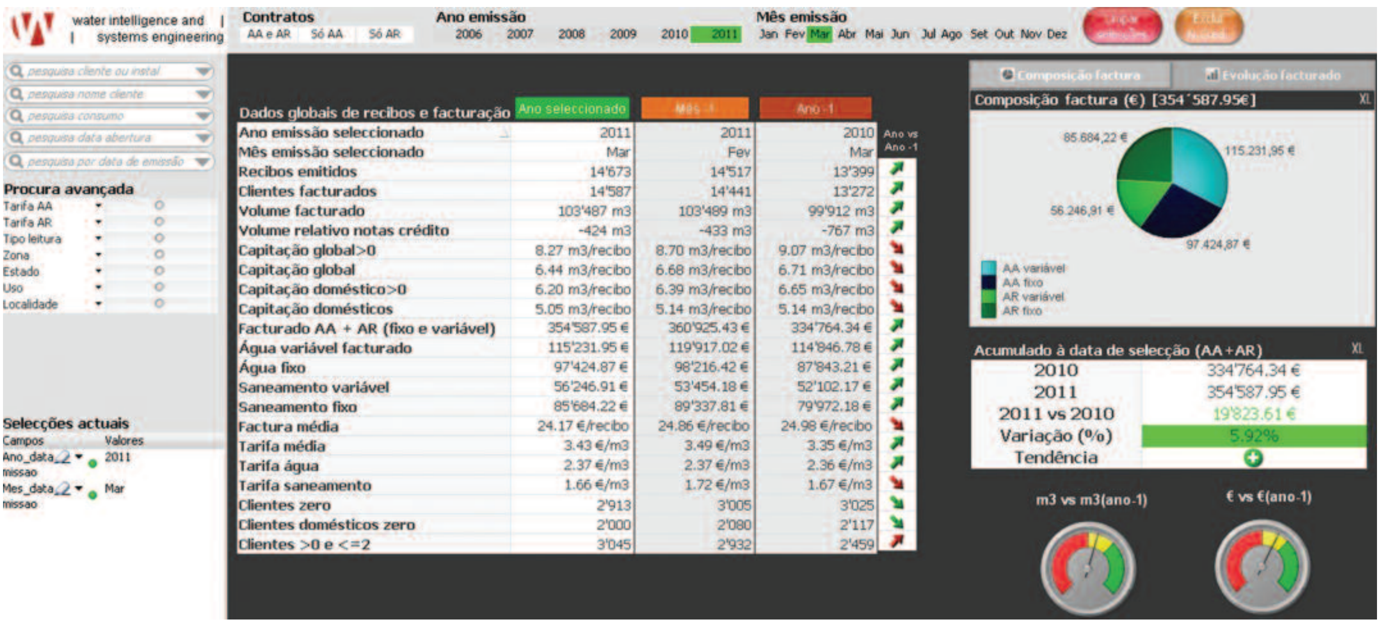
According to a recent Portuguese decree law (Decreto-Lei n.º 194/2009), supported by the National Water and Solid Urban Waste Services Regulator's (Entidade Reguladora dos Serviços de Águas e Resíduos – ERSAR) technical guides (Alegre and Covas, 2010; Almeida and Cardoso, 2010), water and wastewater utilities serving more than 30,000 inhabitants were required to promote the development of asset management plans by the end of 2012. This requirement is an important driver towards a 'new way' of managing water services, where a methodology must be followed in order to provide a proper long-term balance between cost, performance and risk at strategic, tactical and operational levels, concerning three different perspectives: engineering, information and management (Alegre, 2008).

AGS' presentation and purpose

AGS is a Portuguese private operator that manages 14 utilities in Portugal and three in Brazil, under concession and public-private partnership contracts. AGS's obligations typically run for a 20 to 35 years period, so it therefore assumes a long-term perspective with full responsibility for the entire cycle of water and wastewater systems. Both operation and maintenance activities and investments in new infrastructure must be assured in order to fulfil service level requirements and to generate predicted contractual revenues. This responsibility covers both the extension of new systems and the rehabilitation of old ones. Regarding these concerns, AGS supports different research activities and has participated in several European projects, such as CARE-W (Computer Aided Rehabilitation of Water Networks) and AWARE-P (Advance Water Asset Rehabilitation - Portugal).

AGS has been developing

Figure 1 waterWISE example dashboard



engineering methods and tools to support all organisations within the group, filling gaps and errors in the process of establishing consistent asset management plans, supported by validated and standardised procedures.

The purpose of this paper is to present AGS' experience as part of the AWARE-P project (www.aware-p.org), the methodology's dissemination to all utilities in the group, and the future steps of promoting further planning and decision tools.

AGS' AWARE-P participation

AGS' participation in the AWARE-P project as a utility project partner with a concession as a case study promoted the implementation of an asset management policy within the AGS group (Feliciano, 2012). The process was very fruitful as many areas were studied and reviewed, such as collecting data processes, re-analysing information systems (IS) and linkages between different IS, and acknowledging data and information reliability problems.

Sharing experiences with other national utilities was also very important. It made possible the ability to compare organisations at different maturity levels using a range of different dimensions.

Some key steps were identified. The first step was the change in the approach to data and information handling; from 'having' data to 'using' data. This change was possible thanks to the asset management planning process requiring the acknowledgment of each AGS concession's point of view, which drove AGS to focus on where alignment was needed. The second step was the customisation of existing IS in order to provide information to feed the asset management methodology.

The final step consisted of the development of a dynamic platform (waterWISE) (Figure 1), which provides the link between different IS.

Once the methodology and supporting tools were created there was the human factor to consider, namely the ability to undertake long-term planning, to perform different decision making processes, and properly balance costs and performance.

Managing 14 utilities in Portugal and three in Brazil obliged AGS to define a strategy in order to manage them in an aligned way. With this level of diversity it is natural to identify cultural differences, different general manager's academic backgrounds, different contractual contexts and different staff's technical consistency. Over the past seven years the majority of methodologies, tools and reports have been standardised, even though general management maintains some differences. Regarding the above points a change was needed – promoting the internal development of a new tool (Waterchallenge) and the dissemination of knowledge transfer processes from the holding company to its utilities.

AGS' participation in the AWARE-P project also prompted it to consider other areas, such as data and information collection, quality, reliability and accessibility. All information processes were re-visited in order to meet the needs of infrastructural asset management (IAM). Another major issue was how knowledge could be transferred in order to have an efficient and rigorous implementation of an aligned IAM policy in all of AGS' utilities.

Asset management policy in a multi-utility group

Concepts such as IAM, as described in ERSAR's technical guides (Alegre and Covas, 2010; Almeida and Cardoso, 2010), are relatively new in Portugal. New concepts are neither easily spread nor assimilated. To address these concerns Laboratório Nacional de Engenharia Civil (LNEC) promoted a national asset management collaborative project that was followed by AGS in a parallel initiative under LNEC's authorisation.

AGS studied its knowledge transfer approaches with regards to its concerns around the standardisation of IAM methods in all of the utilities it controls. The approach by Nonaka and Takeuchi (1995) was followed, regarding tacit and explicit knowledge, which exists in all organisations. For example, methods taken from the AWARE-P project and ERSAR's technical guides (Alegre and Covas, 2010; Almeida and Cardoso, 2010) and used by AGS's engineering teams is a form of explicit knowledge, and the operational experience of the different utilities' teams are a form of tacit knowledge. The initiative must interact with both knowledge forms and grow spirally (Nonaka and Takeuchi, 1995) (Figure 2).

Whilst looking at AGS' concerns around knowledge transfer, even taking into account the participation in an initiative where all the utilities were present, it was felt the knowledge transfer process was not particularly effective.

There is a kind of cognitive dissonance in transferring methods from an expert community, in an explicit form, to a technical community that normally deals with tactical knowledge. Also, even if this problem can be solved easily, communication is between an external community (the engineering support team) and the utilities' middle management that subsequently is responsible for the internal transfer process in a 'middle-up' and 'middle-down' process within their organisations.

In order to have a tool that could be used as a bridge between tacit and explicit knowledge, Waterchallenge was developed.

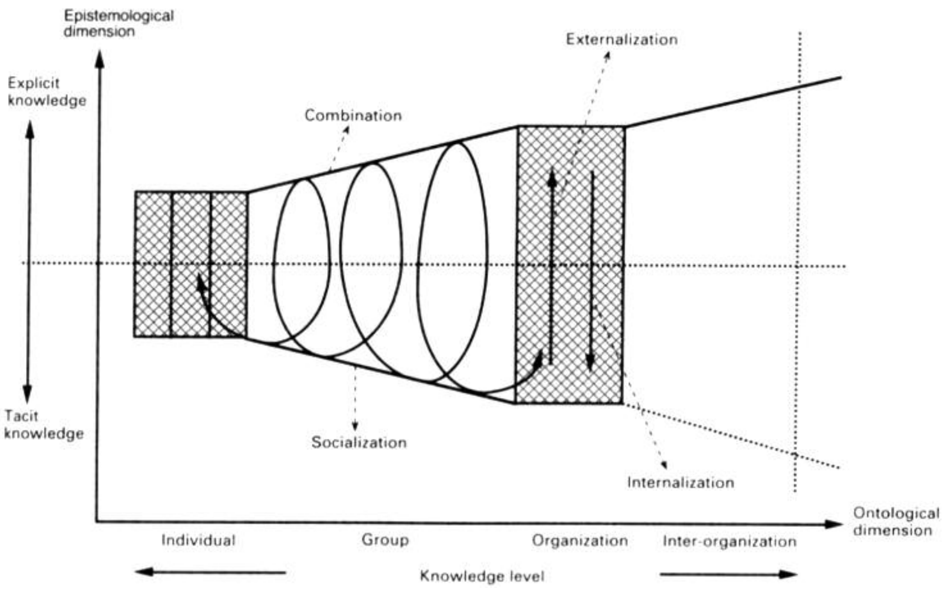


Figure 2
Spiral of organisational knowledge transfer (Nonaka and Takeuchi, 1995).

A bridge between tacit and explicit knowledge – Waterchallenge

Waterchallenge was developed under the scope of a research programme and has different objectives at different stages related to asset management methodology. It is: an assessment tool to understand decision making trends and patterns between different users; an educational tool regarding the utility's own use of it; and part of a national initiative, where different utilities can be challenged to be the best 'team' in terms of finance and

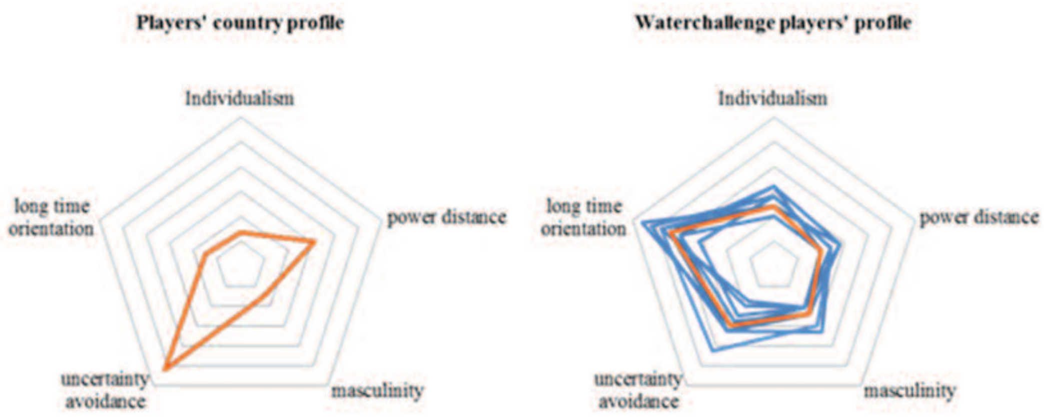


Figure 3
Analysis according to Hofstede (1991), (a) Player's country profiles (b) Waterchallenge players' profiles.

performance, starting from the same given scenario.

A different issue was how to disseminate a new asset management method. Innovative ideas, methods and tools are difficult to spread in an organisation where people have a mix of tacit and explicit knowledge. This concern drove the need to understand the method behind the collaborative initiative in order to develop a more efficient knowledge transfer approach.

Direct and indirect results of participation in the AWARE-P project included: the development of tools like the standardised dynamic data and information analysis platform waterWISE; the collaborative project 'AGS asset management initiative', regarding a standardised asset management policy for the 17 group's utilities; and the long-term decision simulation model, Waterchallenge, for the comprehensive analysis of decision trends and patterns, in different utilities, considering different users in different cultures.

Waterchallenge is able to assess different management profiles by utilising an economic and financial model with the capability to compute several key performance indicators (KPIs) for each year, developed from IWA and ERSAR materials (Cabrera, 2011; ERSAR, 2011).

The model's goal was the evaluation of the management staff's ability and the trends and / or patterns in the decision process in each utility. The model was translated into a 'game', where users could experience general management, including its financial and performance perspectives, over a modelled 21-year period from a given initial scenario.

This means each user can interact with the model across seven rounds, with each round corresponding to a three-year period. In each round, users are asked to input several variables in three different perspectives – costs, performance and risk – with their results concerning service level and financial performance carried through from round to round.

The users must complete a form containing a professional background survey and a Hofstede (1991) based questionnaire. The form and analysis of the decisions made can help to perceive the impact of cultural patterns on the decision making process.

According to Hofstede (1991), people have 'mental programmes' that are developed and reinforced through their experience. In these 'mental programmes' there is a component of national culture that can be explained using five dimensions: power distance; uncertainty avoidance; individualism and collectivism; masculinity and femininity; and long-term orientation. These five dimensions symbolize the basic elements of cultural structure in countries. Therefore, these analyses can form an important framework to study national culture, and also help us to understand the effects of cultural differences on management decisions. In the AGS initiative different 'players' were challenged to take on roles throughout the utility.

Waterchallenge's first initiative, which started in late January, have 30 participants with different profiles, from both academic and professional backgrounds.

According to the analyses undertaken, 64% of the players have an engineering background. Regarding their professional backgrounds 68% have technical experience, 25% have management experience and 7% have financial experience.

Cultural profile according to Hofstede (1991)

The Hofstede dimensions are as follows:

- Power distance expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally.
- Uncertainty avoidance is the extent to which members of an organisational society feel threatened by and try to avoid future uncertainty or ambiguous situations.
- Individualism and collectivism describes the relationship between the individual and the community that is reflected in the way people live together.
- Masculinity and femininity explain the extent of role division between sexes; the emphasis on work goals and assertiveness as opposed to personal goals and nurturing.
- Long-term orientation can be interpreted as dealing with society's search for virtue. Societies with a short-term orientation generally have a strong concern with establishing the absolute truth. In societies with a long-term orientation, people believe that truth depends very much on situation, context and time.

The Waterchallenge profile's result is shown in Figure 3a. The blue line represents each player's profile and the orange line represents the player's average, regarding the five dimensions.

With this sample we can perceive a strong trend towards long-term orientation. The maximum and minimum value can diverge from 120 to 24, and the sample provides a long-term orientation average of 86, with a maximum and minimum value of 112 and 56 respectively. These dimensions show an ability to adapt traditions to changing conditions, a strong propensity to save and invest with prudence, and perseverance in achieving results.

Regarding the Hofstede profile for Portugal we can see a different behaviour across the five dimensions (Figure 3b).

Comparing the Hofstede profiles, the only similarity is in the dimension of power distance that expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally.

Conclusions

In summary, direct and indirect results of participation in the AWARE-P project included the development of waterWISE; the collaboration across AGS' utilities; and the development of the long-term decision simulation model Waterchallenge.

Further steps will reveal the assertiveness of a method where knowledge transfer can be more efficient with the use of tools such as Waterchallenge.

The interaction of middle management with the Waterchallenge tool and integrating financial and service level performance indicators should provide an environment where knowledge, in this case IAM methodologies and related concerns, can be transferred efficiently and effectively within and between organisations. ●

References

Alegre, H and Covas, D (2010), Infrastructure Asset Management of Water Services. Technical Guide n.16. ERSAR, LNEC, IST, Lisboa, 472 pp. (ISBN: 978-989-8360-04-5).

Alegre, H (2008), Gestão patrimonial de infra-estruturas de abastecimento de água e de drenagem e tratamento de águas residuais (Drinking water and wastewater infrastructure asset management), LNEC, (374 pp.). Series (Teses e Programas de Investigação LNEC), LNEC, Lisbon, ISBN 9789724921341.

Alegre, H, Covas, D, Coelho, ST, Almeida, MC and Cardoso, MA (2012), An integrated approach for infrastructure asset management of urban water systems. Water Asset Management International, 8.2. pp10-14.

Almeida, MC and Cardoso, MA (2010), Infrastructure asset management of wastewater and stormwater services. Technical Guide n.17. ERSAR, LNEC, IST, Lisboa, ISBN 9789898360052.

Cabrera Jr, E, Dane, P, Haskins, S and Theuretzbacher-Fritz, H (2011), Benchmarking water utilities. Guiding water utilities to excellence. Universidad Politecnica de Valencia, Lisbon, Portugal. ISBN 9781843391982.

Decreto Lei n.º 194/2009 (Portuguese Decree Law 194/2009), Diário da República, 1.ª série, n.º 161, de 20 de Agosto de 2009.

Feliciano, J, Almeida, R, Ganhão, A, Beleza, J and Santos, A (2012), Gestão Patrimonial de Infra-estruturas. Experiência da AGS (Infrastructure Asset Management of Water Services – AGS Experience). ENASB 2012.

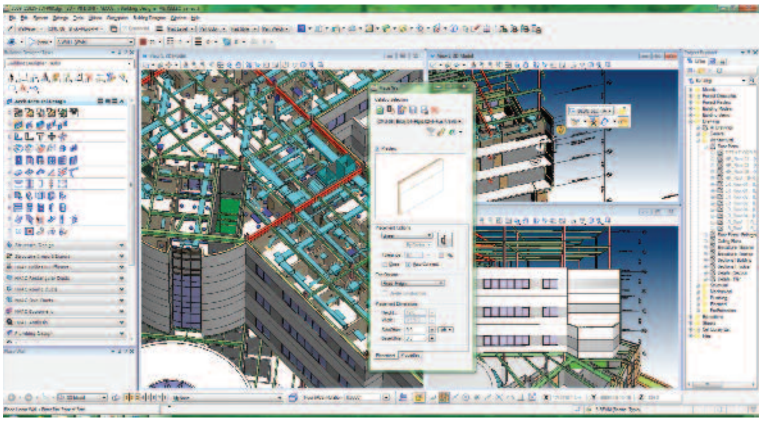
ERSAR (2011), Guia de avaliação dos serviços de águas e resíduos prestados aos utilizadores, 2ª geração do sistema de avaliação (Service level assessment of water, wastewater and urban waste services, 2nd generation assessment system). Lisboa.

Hofstede, G (1991), Cultures and organizations: Software of the mind. McGraw-Hill, London. ISBN 9780077074746.

Nonaka, I and Takeuchi, H (1995), The Knowledge-Creating Company: How Japanese Companies create the dynamics of innovation. New York: Oxford University Press.

This paper was presented at the IWA Asset Management for Enhancing Energy Efficiency in Water and Wastewater Systems conference, which took place 24-26 April 2013 in Marbella, Spain.

3D future for Bentley Systems



At the recent Wasser Berlin exhibition in April, Bentley Systems, Incorporated exhibited its infrastructure management software, with a particular focus on its move towards the use of 3D modelling to assist decision making.

Dr Tedo Tavkhelidze, Industry Sales Manager South Eastern Europe, said that he saw 3D as being the future of infrastructure modelling and that Bentley had already invested in including this technology as part of its range of solutions.

'You can manipulate this information… and create new objects,' he said. 'It's opened up completely new workflows. For pumps, for example, you could ask: 'Can I put this pump into this system? Is it too big, too small, etc.

'Interest in 3D is huge,' he continued, 'but it costs money and time; it was the same as GIS (geographic information system). It needs time [to catch on] as work with 2D is very easy – if you construct in 3D you need to take more time because you need more information and you need to think in 3D. You need better devices. It possibly needs two or three years and then there will be a boom.'

A function of particular interest, he said, was the ability to import a 3D model into Google Earth so decision makers can see how a planned facility for example will fit into the landscape.

'For some people they think it is a game and not business,' said Tavkhelidze, 'but I feel [this will gain in popularity], the same as mobile phones did.' ●

www.bentley.com

3M launches new pipe renewal liner

UK company 3M has launched a specially formulated resin pipe liner. The Scotchkote Pipe Renewal Liner 2400 is an in situ liner formulated using aliphatic polyurea chemistry which, according to 3M, helps to minimise water absorption and extend service life.

According to the company the liner can span voids up to 8mm and gaps up to 5mm in order to help minimise water loss and reduce operational costs and it is currently approved for use in 20 countries. It is also suitable for BS:EN ISO 11295:2010 Class D (non-structural) linings and can also be applied at specified lining thicknesses to help provide structural enhancement in excess of Class B (semi-structural) requirements for potable water pipe lining applications. ●

www.3M.co.uk

Unitywater announces contract with TaKaDu

Australian water utility Unitywater has announced an initial contract with Israeli water network monitoring technology provider TaKaDu.

Unitywater has been focused on improving its network efficiency, reducing water losses and saving costs. TaKaDu's software-as-a-service (SaaS) solution will enable Unitywater to take control of its network by providing real-time knowledge and alerts about inefficiencies and water loss, in addition to other concerns about water distribution assets, says the company.

'The TaKaDu solution uses existing meter and sensor readings, advanced statistical algorithms and easy to use web application to detect, accurately identify and report network abnormalities, such as leaks, bursts and pressure problems 365/24/7,' said TaKaDu Founder and CEO, Amir Peleg.

Unitywater's water supply network is comprised of 5542km of water mains pipes, 108 water reservoirs and 79 water pump stations across the Sunshine Coast and Moreton Bay regions in Queensland.

Unitywater CEO, George Theo stated: 'TaKaDu's product provides us with visibility to the network, and enables the most cost-effective way of undertaking this valuable analysis, in being able to locate hidden leaks that do not come to the surface.

'The principle advantage of the TaKaDu system, which has been used in a number of water utilities around the world, is that the software will "learn" how our system operates and will then identify unusual trends or anomalies within the water supply network. A monitoring report in real time will allow us to proactively track and respond to changes as quickly as possible.'

By using TaKaDu's solution, Unitywater can anticipate cost savings through the reduction of water lost through leaks and bursts and improvement in the performance of its water supply network. Further savings will also be realised through increased energy efficiency. ●

www.takadu.com

Oracle software improves system performance at Yarra Valley Water

Australian utility Yarra Valley Water (YVW) has implemented an Oracle Engineered Systems infrastructure to provide a standardised IT architecture aimed at helping the utility to improve business systems performance, achieve a better return on investment and enhance customer service, Oracle has announced.

Owned by the Victorian State Government, YVW is the largest of Melbourne's three water retail businesses. It provides water supply and sewerage services to over 1.7 million people and over 50,000 businesses in Melbourne's northern and eastern suburbs, including some recycled water and trade waste customers.

The water provider is using Oracle Exalogic Elastic Cloud and the Oracle Exadata Database Machine to consolidate its core systems and run its Oracle software. This includes Oracle Utilities Customer Care & Billing, which helps YVW manage 700,000 customer accounts, as well as Oracle's Primavera Enterprise Project Portfolio Management, Oracle Business Intelligence Enterprise Edition 11g, Oracle WebCenter and Oracle WebCenter Content for its website and intranet portal.

Significant performance gains have been achieved, says Oracle. The deployment of the Exalogic platform for YVW's business critical billing and customer management application has helped with reduced application response times from up to nine seconds, to below a second.

In the data centre, as a result of the use of Exadata, regular overnight re-indexing of the data warehouse, which previously took eight hours, now takes around one hour; and a complete re-indexing / re-build, which covers six applications, now takes around 3.5 hours instead of 24 hours. This was assisted by moving it onto the new platform, with no code change required, helping translate into a significantly lower cost of ownership for YVW, and eliminating the need for onsite management overnight, says Oracle. ●

www.oracle.com

Whitewater signs MoU with Brown and Caldwell

The global technology provider of water network management software solutions to utilities and industrials, Whitewater Technologies (WWT), has announced the signing of a cooperation agreement with Brown and Caldwell (BC). The agreement will help to drive network efficiencies and teams from both WWT and BC are currently working together on opportunities, team development, training and certification.

OwnThe agreement will combine WWT's product and data-driven technology with BC's process and procedural knowledge and IT management experience to generate improvements to workflow management, knowledge sharing, operational optimization, total water quality monitoring, and critical security awareness according to WWT's CEO Issey Ende. ●

www.w-water.com
www.brownandcaldwell.com

Innovyze releases next generation of InfoSurge

Innovyze has released its V10 Generation of InfoSurge. InfoSurge is a flow analysis tool for pressure surge analysis and the modelling of the effects of pump station power failures, pump startups, valve closures, rapid demand and pump speed changes. Its SurgeAnimate module enables users to create live animations of pipe profiles and see and experience model transient activities in real time.

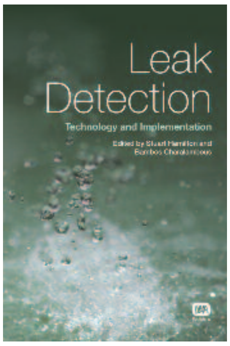
The new version offers the option of using dynamic friction factors and can model turbines, flow and pressure regulating valves, hybrid (open-closed) surge tanks, hydraulic surge anticipation valves, electrical surge anticipation valves, and multicomponent reservoirs. It can also model pump stations and valves as PID controllers. Using InfoSurge V10, utilities can specify depth/area profiles for all types of surge tanks as well as variations in pressure during transient simulations at reservoirs, fixed heads and well nodes. ●

www.innovyze.com

Leak Detection

Technology and Implementation

Editors: Stuart Hamilton and Bambos Charalambous



Ageing infrastructure and declining water resources are major concerns with a growing global population. Controlling water loss has therefore become a priority for water utilities around the world. In order to improve efficiencies, water utilities need to apply good practices in leak detection.

'Leak Detection: Technology and Implementation' assists water utilities with the development and implementation of leak detection programmes. Leak detection and repair is one of the components of controlling water loss. In addition, techniques are discussed within this book and relevant case studies are presented. The book provides useful and practical information on leakage issues.

IWA Publishing July 2013
112pp. Paperback
ISBN: 9781780404707
Price: £75.00 / US$135.00 / €101.25
IWA members price: £56.25 / US$101.25 / €75.94
To order, visit: www.iwapublishing.com

Research Digest: Decision Analysis / Implementation Guidance Asset Management Tools Development

WERF Report SAM1R06e

Author: Duncan Rose

This research digest summarizes five asset management support tools developed as part of the Strategic Asset Management (SAM) Challenge. These tools are available in SIMPLE (WERF's online Asset Management Knowledge Base) and are also available in stand-alone versions by downloading them from SIMPLE. The report presents an overview of the concept, description, purpose, and benefits of each tool, an organizational diagram, examples of the 'core tool', cases of task related text, and worked examples.

The tools covered in this guide are: level of service tool; condition assessment scoring tool; business risk exposure tool; capital investment tool – validation; and capital investment tool – prioritization. To achieve maximum capital investment process effectiveness, the two capital investment tools have been combined into one tool.

IWA Publishing July 2013
80pp. eBook
ISBN: 9781780400495
Price: TBA
To order, visit: www.iwapublishing.com

Predicting the Remaining Economic Life of Wastewater Pipes: Phase 2 Development of a Robust Wastewater Pipe Performance Index

WERF Report SAM3R06a

Author: Sunil K Sinha

Accurate prediction of wastewater pipe structural and functional deterioration plays an essential role in asset management and capital improvement planning. The key to implementing an asset management strategy is a comprehensive understanding of asset condition, performance, and risk profile. The primary objective of this research is therefore to develop protocols and methods for predicting the remaining economic life of wastewater pipes.

This report presents a development of a robust performance index for wastewater pipes, including physical / structural, operational / functional, environmental and other parameters, for not only the pipe, but also the entire pipe system.

IWA Publishing November 2012
250pp. eBook
ISBN: 9781780400464
Price: £80.34
IWA members price: £67.98
To order, visit: www.iwapublishing.com

A Review of Advanced Sewer System Designs and Technologies

WERF Report INFR4SG09d

Authors: Sybil Sharvelle and Larry Roesner

This document seeks to collect into one place current and new technologies about, or related to, sewerage system design. The document organizes the information found in the 266 documents that were reviewed for this study into six subject areas: advanced on-site technologies; alternative wastewater collection system designs and technologies; gravity sewer system design and technology; infiltration detection and control technologies; sewer construction / rehabilitation technologies; and pipe materials and joints. Each of the six subject areas are further subdivided into three technology levels: established technologies; proven technologies; and experimental and foreign technologies.

The descriptive section contains information on how the various designs and technologies work, their cost and performance, advantages and disadvantages, locations where the design or technology is in use, and identification of the manufacturer of certain descripted technologies.

IWA Publishing November 2012
180pp. eBook
ISBN: 9781780400259
Price: £80.34
IWA member's price: £67.98
To order, visit: www.iwapublishing.com

A listing of upcoming asset management-related events and conferences. Send event details to WAMI for inclusion.

Water Market Reform: Preparing for PR14 and the Competitive Market
3 July 2013, London, UK
Web: http://marketforce.eu.com

7th International Conference on Sewer Processes and Networks
28-30 August 2013, Sheffield, UK
Web: www.shef.ac.uk/spn7

12th International Conference: Computing and Control for the Water Industry: Information for Water Systems and Smart Cities
2-4 September 2013, Perugia, Italy
Web: www.water-system.org/ccwi2013

5th IWA-ASPIRE Conference and Exhibition
8-12 September 2013, Daejeon, Korea
Web: www.aspire2013.org

LESAM 2013 - IWA Leading Edge Conference on Strategic Asset Management
10-12 September 2013, Sydney, Australia
Web: www.lesam2013.org

International Water Week 2013
4-8 November 2013, Amsterdam, The Netherlands
Web: www.internationalwaterweek.com

Junior Scientist Workshop: Sewer Processes and Networks - Sewer Asset Management
20-22 November 2013, Delft, The Netherlands
Web: www.sspwg.org

Water Loss 2014
30 March - 2 April 2014, Vienna, Austria
Web: www.iwa-waterloss.org/2014

IWA European Utility Conference
14-17 May 2014, Oslo, Norway
Web: www.IWA-EUC2014.org

IWA World Water Congress & Exhibition 2014
21-26 September 2014, Lisbon, Portugal
Web: www.iwa2014lisbon.org