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Flat fee water charges still common in Europe

A new report from the European Environment Agency (EEA) has determined that flat-fee water charges, which are still common in parts of Europe, do not encourage efficient behaviour and advocates metering as the best solution.

The study, titled 'Assessment of cost recovery through water pricing', looks at the approaches taken in Croatia, England and Wales, France, Germany, the Netherlands, Scotland, Serbia, Slovenia and Spain.

The report argues that water is stressed in many parts of Europe, and that even in regions that usually have high levels of rainfall, abstracting and cleaning water can have a high economic and environmental cost. This means, the report says, that Europe needs to redouble its efforts to use water more efficiently to avoid undermining its economy.

To achieve this, the report says that water should be priced at a level that encourages efficient use and properly reflects its costs, including the costs of purification and transportation. In addition, environmental and resource costs, and the costs of pollution and depletion of resources, should also be internalised in water prices, the authors explain.

Such charges should factor in lost 'ecosystem services' that require water, such as wetlands that carry out water purification and flood prevention.

The report notes that although the Water Framework Directive called on member states to create incentives for efficient water use by 2010, it is unclear whether this has in fact resulted in any change in national policies.

Key findings include that households use around a third less water when they are charged for the amount they use, but flat-rate charging structures are still common in many countries despite the fact they are more expensive for most users and do not incentivise efficient use.

The report also notes that some uses, such as drinking water, are not significantly influenced by changes in price, but studies show that other uses such as water for gardening and swimming pools are much more responsive.

It also points out that some studies suggest charging for the volume of water used reduces the agricultural water take by 10% to 20%. Switching to volumetric charging is most successful when combined with modern irrigation technology and work to fix leaks.

In some countries, the report found that agricultural water use was also heavily subsidised, with the price covering as little as 20% of the costs in some instances. In Spain, where some regions are severely water stressed, agricultural water prices recover less than half of the cost.

The report warns that when the price of using water does not recover the full cost, some of the cost may be inadvertently passed on to others – for example, if an industry pollutes water and does not pay for it to be cleaned, the costs fall on society.

The report also points out that a 2012 Eurobarometer survey found that 84% of EU citizens agreed with the principle of being charged for the amount of water used. ● **LS**

See Analysis, p5

Acciona Agua begins deployment of Caceres smart water grid

Spanish water services company Acciona Agua is to deploy Spain's first smart water grid in Cáceres, a city in the west of Spain, to help detect leakage.

The company said in a statement that the works are part of the €10 million ($13.5 million) SmartWater4Europe research project, which aims to manage potable water networks and reduce leakage and costs. The project involves 21 participants and is led by Acciona, Thames Water Utilities and Vitens of The Netherlands.

Other participants include technology companies, universities – including the University of Lille – and research centres. There will be four demonstration sites across Europe in total.

The project will involve the use of software programmes, remote meter readers and sensors, which will be deployed in the city centre and old town to detect faults, jams and leaks as they occur, reducing the amount of time taken to locate and repair them. The remote meter reading will also detect unusual consumption patterns.

Vitens will lead the project in the Dutch province of Friesland, Thames Water in London and the University of Lille in Villeneuve d'Ascq. Acciona Agua chose to work with Cáceres, which is a member of the Spanish Smart Cities network. ●

Multilateral development banks deliver $27 billion in climate change financing

Multilateral development banks (MDBs) provided almost $27 billion worldwide, in financing to address the challenges of climate change in 2012, according to the second joint MDB report on climate finance. The report was released in line with the commitment by MDBs to enhance the transparency of their investments in climate change mitigation and adaptation.

The report analyses the financial commitments by the institutions to support climate change mitigation and adaptation, and the information provided has been expanded since the first edition to include better sectoral and regional breakdowns of MDB financing.

Of the total $27 billion in climate finance, 78 percent – or over $21 billion – was dedicated to mitigation, while 22 percent – or nearly $6 billion – was applied to adaptation. Of the total commitments, 8 percent – or $2 billion – came from external resources, such as bilateral or multilateral donors, including the Global Environment Facility and the Climate Investment Funds.

In terms of regional coverage, Latin America and the Caribbean received the highest share of MDB climate finance (18 percent of total funds), while the EU-13 countries received 11 percent. Sub-Saharan Africa received almost equal amounts of adaptation and mitigation finance (14 percent of total funds, representing 31 percent of total adaptation finance and 8 percent of total mitigation finance).

In regards to sector coverage, 36 percent of adaptation finance went to the infrastructure, energy and built environment sector, while 34 percent went towards increasing the agriculture sector's resilience to climate change. Renewable energy took by far the largest share of mitigation finance, with 36 percent. The discrepancy between mitigation and adaptation finance is greatest in the EU-13 and other European and Central Asian regions: 96 percent of total climate finance commitments were applied to mitigation measures in the EU-13 countries; while 94 percent of the total funds were applied to mitigation in other European and Central Asian regions. ●

Atkins releases 2050 vision for UK water sector

Atkins has released its 'Future Proofing the UK Water Sector' report, which examines four possible future scenarios to determine how drivers such as climate change and population growth could affect the UK water sector over the next 40 years.

The scenarios are constructed around the cost and availability of energy and the value customers place on natural resources. Other key drivers considered include population and urbanisation, climate change, finance, workforce and regulation.

The four scenarios for 2050, which were developed by Atkins with consultants Decision Strategies International (DSI), are named the Graphene Era, the Wood Economy, the Steel Squeeze and the Concrete Jungle.

The Graphene Era scenario imagines a future where the UK has adapted effectively to the severe effects of climate change and the economy is buoyant, high-tech and green, while the Wood Economy explores a society where foreign sourced energy costs are high, water is scarce and customers prefer to turn to local or DIY solutions.

In contrast, the Steel Squeeze scenario looks at a world where people are squeezed by a high cost of living and little concern for the environment, leading to an expectation that government should fully regulate water quality and cost.

Lastly, the Concrete Jungle is a future dominated by the resurgence of traditional UK manufacturing, where consumer consumption is high and society trusts that we will invent our way out of any future climate or environmental problems. ●

Lyonnaise des Eaux renews sanitation contract with Anglet and Biarritz municipalities

The Côte Basque Adour Urban District has decided to renew its contract with Lyonnaise des Eaux for a further ten years, in order to manage the public sanitation service for the Anglet and Biarritz municipalities. The contract involves collecting both towns' wastewater, and treating Biarritz's wastewater. The new contract will begin on 1 January 2014.

The Basque coast experiences heavy rainfall, which amounts to 1483mm on an annual basis, although the French average is 700mm. This unusual feature means that increased vigilance and preventive measures need to be taken in order to reduce the inconvenience for users in the event of heavy rain.

The contract provides for the implementation of a dynamic sanitation network management process. This so-called 'smart' solution enables flooding to be prevented and the host environment to be protected thanks to weather forecast data, hydraulic network models and managing the storage infrastructure in real time.

All the facilities are modelled on and connected with Lyonnaise des Eaux's remote control centre, which is based in Anglet. In the event of a weather warning, the engineers will be able to operate all the infrastructure involved in real time, e.g. open or close the rain water storage basin gates.

The Côte Basque Adour Urban District has also decided to equip the Biarritz treatment centre with a so-called tertiary disinfection process that uses ultraviolet light and enables an optimal discharge quality to be guaranteed, hence protecting bathing water. ●

REGULARS

FEATURES

Cover photo credit: pressmaster / Shutterstock.com. See feature p12.

Arcadis venture to design and rebuild New Jersey wastewater systems

Global engineering and consultancy firm Arcadis has announced that the Nassau County (New Jersey) Department of Public Works has chosen a joint venture of Arcadis and Hazen and Sawyer to provide programme management services to stabilise, design and rebuild its wastewater collection and treatment systems, which received significant damage and flooding during Superstorm Sandy in October, 2012.

The $2 billion programme includes already-completed emergency response and repair work, which took place immediately after the storm. Arcadis expects gross revenues for this contract to be in the region of €30 million ($40.5 million).

Arcadis and its jv partner, who were already on site when the storm hit, worked with the recovery and repair team non-stop in the six following weeks to assess damage to major electrical systems, pumping facilities and processes that were flooded and partially submerged with salt water.

By 14 December, the team had met all of its milestones for the emergency actions and had successfully restored the Bay Park wastewater treatment plant to full secondary treatment capacity.

For the next three years, Arcadis and its partner will provide consulting, preliminary design, pre-construction, construction and post-construction services to mitigate the effects of future storms across five wastewater treatment plants and over 30 pump stations within the Nassau wastewater system. This includes extreme weather hardening designed to endure a storm event with a 500-year return period. ●

Asset plan promises completion of Zambezi water project

The Zimbabwe government has set out an ambitious list of infrastructure projects in its latest economic blueprint including the much-delayed National Matabeleland Zambezi water project, whose aim is to end the city of Bulawayo's water shortage.

Tanzania pledges to complete most water projects in 2015

The Tanzanian government has pledged that 95% of current water projects will be completed in 2015. The country's water minister, Professor Jumanne Maghembe, told a meeting in Dar es Salaam that a number of projects countrywide are progressing well despite some emerging challenges. The joint water sector review meeting, convened to evaluate the performance of the water sector development programme, heard that at least $125 million will be needed to finish pending works before a proposed second phase of the project begins.

American Water subsidiary buys north Virginia utility

The American Water Works Company has announced that its Virginia American Water subsidiary has completed the purchase of Dale Service Corporation, a wastewater utility company in northern Virginia. The total value of the transaction is around $27.7 million. The utility has a customer base of some 50,000, and the deal marks Virginia American's entry into the wastewater services market.

Chicago set to spend $50 million on green stormwater management

Chicago's mayor, Rahm Emanuel, has announced that $50 million from current spending on the city's water and wastewater infrastructure over the next five years will be focused on investments in green stormwater management, with the aim of reducing the pollutant burden entering the Chicago river and lake Michigan.

ADB provides funding for Kolkata water and sanitation improvements

The Asian Development Bank has agreed a $400 million loan for the fast-growing Indian city of Kolkata to expand and improve its water and sanitation systems in its periphery, where services are lacking.

Commission agrees infrastructure contract

Saudi Arabia's Royal Commission for Jubail and Yanbu has agreed two contracts worth SR300 million ($80 million) to develop infrastructure in the Mardooma Quarter. The first contract, which has been won by the Al Harbi Trading and Contracting Company, involves constructing potable water, drainage and wastewater networks, drinking water and wastewater treatment plants, and a new pumping station for irrigation.

AfDB approves investment in infrastructure fund

The African Development Bank has approved a $20 million equity investment in the ARM-Harith Infrastructure Fund, a new private equity fund based in Nigeria with a target fund size of $250 million. The fund will invest, through equity, in infrastructure projects and companies across West Africa, with a focus on Nigeria, as well as a range of infrastructure sectors including energy, water and utilities.

water utility management INTERNATIONAL

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Utility reform and achieving efficiency are central themes of the publication, encompassing topics such as benchmarking, investment planning, consolidation, public / private sector roles, leadership, IT, and human resources. Other regular themes include financing, regulation, charging policies, procurement, corporate governance and customer issues.

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Water pricing in Europe: achieving cost recovery

The European Environment Agency's report on achieving cost recovery through water pricing looks in-depth at the challenges around water pricing in Europe. **LIS STEDMAN** spoke to the report's lead author, **GORM DIGE**, about cost recovery and metering of supply.

How to charge appropriately for water has long been a contentious and much-researched issue around the world. The European Environment Agency's (EEA) latest report, 'Assessment of cost recovery through water pricing', provides a snapshot of the situation and challenges around Europe, and concludes that only volumetric charging – which implies metering – is the only real answer.

Gorm Dige, Project manager – Territorial environment, policy & economic analysis at EEA and the report's lead author, spoke to Water Utility Management International and said: 'From the results of our analysis we can see that water pricing schemes are mostly based on hybrid models with fixed and volumetric components. As metering is introduced, you can base cost recovery for water services on volumetric pricing, which will also lead to more efficient use of water.'

In most of the countries examined in the report, operation and maintenance costs are largely recovered, he added, but noted: 'The data is not homogenous. It is difficult to get access to consistent information due to Article 9 of the Water Framework Directive, which is not very clear in its definitions, for example of water services. You could say this is a barrier.'

There is also inconsistent reporting and cost recovery, he noted. 'Some countries have a narrow definition of water services that is limited to traditional drinking water and sewage services, like in Germany. Some countries have a wider definition that includes all man-made changes in the hydrological system that serve a given water use – for instance, a dam built for generating hydropower is viewed as a water service provided to the electricity company.'

Mr Dige observed that these inconsistencies have a price: 'It makes it very difficult to obtain consistent data, but you can't say it's the fault of the countries per se – Article 9 is not clear what water services consist of.' Despite the many issues, he felt it should be possible to arrive at options.

The report also calls for the internalisation of external costs, which is a contentious issue in markets where the utilities are privatised – for instance in England and Wales, pressure from public opinion, government and regulators has caused most companies to make statements confirming that they intend to apply for price rises below the rate of inflation.

This of course creates obvious tension with the report's finding of a need to include externalities into the costs, but at heart the issue is simpler, Mr Dige explained: 'The main problem here is that water prices do not reflect the true costs – since in many cases only the operation and maintenance costs are recovered from water users, and not the environmental and resource costs.

Reducing demand

He said that in terms of the best way to ensure prices are set correctly, 'we would say it is very important to have volumetric or increasing block rates. Fixed rates do not provide an incentive. If water pricing has to provide an incentive to reduce water use, we think metering is indispensable.'

If there is a genuine desire to increase water efficiency for households and industry, Mr Dige noted that a combination of volumetric and increasing block rates 'is probably the way forward for many countries.' A substantial part of the water bill should be variable, he added, with, for example, the luxury part of household water demand being more price sensitive than the necessity element.

Rates, or the rules for calculating them, should be determined in a transparent way, preferably by an independent body, he added, and the rates should be high enough for water service suppliers to invest in efficient and environmentally-sound improvements, innovation and expansion. Regional variations in water scarcity and other relevant conditions should also be reflected in water prices, he suggested.

He also advocates unwinding cross subsidies, noting: 'If prices do not reflect full costs or benefits – there is a risk of market and/or policy failures. When government interventions distort the market from, for example, subsidies, taxation policies, price controls or regulations, policy failures happen.'

Mr Dige added: 'In several member states uncertainty remains concerning possible hidden subsidies linked to preferential access to financial resources given to water service operators. It should be noted that there are also several hybrid systems – for example, with a single charge for water use, sewage and wastewater treatment, and that in several member states the costs of certain water services are covered by the general budget rather that by specific water-pricing mechanisms.'

Affordability

The authors have already presented the report to a meeting of the EC Common Implementation Strategy of the WFD working group on economics. Mr Dige reported that 'some countries were a bit sceptical – they see water pricing as a barrier and are afraid of social and affordability issues.'

He argued: 'In England and Wales, and other countries as well, there is an attempt to hold water prices low. The political reason for this is to meet the social concerns connected to higher water prices, that is, the affordability issue. In each of the examined member states affordability was taken into account. But a variety of systems were found. Water authorities in some member states perform periodical pricing studies, which integrate ratios that compare the average family income to the expense allocated to the water bill. While some member states clearly specify the means to achieve affordability, other countries have left this question unaddressed.'

In France there are no social tariffs and the affordability of water services is dealt with through separate social policy, Mr Dige noted. 'However, keeping water prices at an artificially low level, as requested in the UK, is not the best way to ensure the affordability of water services to low-income households. It may create a vicious cycle of underfunded service providers, collapsing infrastructure, and so on.

There are as yet no plans to make a fuller assessment of the way that Water Framework Directive principles have been translated by member states into real water pricing policies, although the report recognises that this is needed. Mr Dige noted the difficulties with the lack of consistent data, but added: 'If there is a policy demand for this we will take it on board.' ●

Building a water network GIS service from scratch in Nha Trang, Vietnam

The Khanh Hoa Water Supply and Sewerage Company (KHAWASSCO) of Nha Trang in Vietnam has been working to improve the management of its water supply network and construct a sewerage network, with the help of the French government and the World Bank respectively. Over the past two years a GIS service has been implemented to manage KHAWASSCO's activities, control leakage and optimise network extension and rehabilitation work, which involved an audit of the utility's workflow processes, communication and data management. **KEVIN NIRSIMLOO** and **CAMILLE EGAL** explain the process of integrating GIS into the utility's system, training personnel and expanding KHAWASSCO's asset management capabilities.


Nha Trang, Vietnam

Located in the centre of Vietnam, the province of Khanh Hoa and the city of Nha Trang have a pleasant microclimate that creates considerable potential for tourism. The local government's development objectives are ambitious: a doubling of accommodation capacity between 2011 and 2020 to facilitate ten million tourists a year by 2020. To meet these goals and mitigate the increased stress on water resources, the city must implement sustainable solutions and plan for the future.

For sanitation, a Coastal Cities Environmental Sanitation project funded by the World Bank is currently under implementation. This will result in the construction of a sewerage network, a wastewater treatment plant and a waste disposal facility.

For drinking water, a €524,000 ($713,000) French-funded grant was approved to implement a GIS service within the water supply company, with the aim of improving the management of the water supply network.

Started in June 2011, its main objectives were:

- Improving current utility operations, based on precise knowledge of the infrastructure
- Managing and controlling leakage and network performance
- Optimisation of network extension and rehabilitation works, by implementing an advanced GIS-based asset management strategy

The project was supported throughout its duration by a resident engineer from G2C who worked in Khanh Hoa Water Supply and Sewerage Company's (KHAWASSCO) offices, and was in permanent contact with the project management and technical support staff. In addition, several expert missions by different specialists were carried out at critical phases of the projects.

Needs assessments and technical specifications

The project began with a three-month audit of the water supply company's organisation and workflows. Interviews with all the heads of departments and staff in charge of creating, using and updating data were undertaken. The existing methods and processes were described and discussed with the people in charge to identify inadequacies and possible improvements.

An important lack of communication between departments, and a lack of data sharing, were identified. Needs and expectations for the project were listed. As GIS is a very new tool in Vietnam, it was not easy for KHAWASSCO to identify its real needs, to understand the benefits of the GIS and to avoid confusing computer-aided design (CAD) and GIS goals and tools.

During this phase, all the existing data on the water supply network were gathered, analysed and qualified. The department in charge of the network management created a CAD network map that contained most of the information about the pipes and the main equipment on the network, such as material, diameter and date laid. Nevertheless, this data was topologically wrong and geographically incorrect, as it had been drawn on a cadastral map (register of the boundaries of an area) that did not properly fit with the coordinate system used in this province.

By the end of the first project phase,

technical specifications had been written and approved by both parties.

Implementation and data acquisition

Creating a GIS unit and software adaptation

Before the project began, the water supply company was organised into 11 departments, of which four were directly concerned with data management:

- The Survey and Design department created the data from land survey and technical studies
- The Construction department used the data and updated as-build documents after construction works
- The Network department managed the daily network operation and maintenance. This department was home to the repair team.
- The Technical department supervised all the works and studies

In October 2011, a five-strong GIS unit was created within the network department. The objective of the second phase of the project was to provide training, tools and methods to this unit to improve data management and place data and the GIS at the centre of a circle of network management improvement.

The GIS installed in KHAWASSCO is a ready-to-use application developed by G2C and designed by the company's water supply and sanitation engineers for water utilities. The water-dedicated tools are designed to fit daily O&M processes and facilitate network management.

In terms of the technical specifications, the software database and tools were adapted to comply with the local context and needs. The first step was to translate the software interface to English, and to adapt the database's chart code so that it would accept Vietnamese fonts. Attributes and characteristics were added to the existing data structure at the request of KHAWASSCO.

The second step was to add a reporting tool to extract data from the GIS using a predefined layout and an attached document tool to link files to objects and share them among the GIS users. As the definition of detailed needs and precise technical specifications was not easy for KHAWASSCO to carry out, the tools provide the ability to adapt templates and contents, or to create new ones.

Software installation and data integration

Installation and data integration were carried out in two phases, corresponding to the goals of the IT and GIS experts. In November 2011 the software's IT setup was undertaken, which involved installing a map server based on ArcSDE technology and the GIS software Cart@jour Desktop on the five PCs in the GIS unit.

By then, the existing CAD map of the network had been converted to a topologically-correct geodatabase: all the objects drawn as broken lines were recreated as points, and the network pipes were created as a proper network graph that respected hydraulic rules. This buffer project was used for training and trials over a three-month period that enabled the GIS unit to become acquainted with the software and the database structure. This phase also enabled priorities for the next steps of the project implementation to be identified and missing information to be collected.

KHAWASSCO requested that the newly installed software should be able to geographically display information on water supply customers. Until this project, this data had been managed and stored in the Water Billing System (WBS) – dedicated customer management software based on the SQL server technology. This additional functionality would improve the management, calibration, opening and closing of water meters by making it easier to locate them and to make operational queries based on geographic parameters. In November 2011, a feasibility study was carried out to identify technical options to link the GIS database with the WBS database.

In February 2012, a second mission implemented the solution chosen for the link between the GIS and WBS databases. Given the volume of data available in the WBS system – seven years of data, 88,000 customers and monthly consumption data – the response time of the link between the SQL server databases had not been satisfactory.

The solution identified was to create SQL server procedures that would import only the relevant data from the WBS database to the GIS. At the beginning of each month, data about the customers' contracts, their water meters' characteristics and their water consumption for the previous year is automatically updated in the corresponding GIS layer.

At that time, the data integration process was undertaken. A GIS database was created for the entire network (over 750km of pipes and 9000 equipment items), with the project layers divided into two groups.

Water supply layers are native layers of the GIS application, predefined to describe water supply network pipes and equipment. The information about those layers is shared among two databases: the geodatabase, which contains geographic information and basic object descriptions, and the dedicated water supply layer, which contains detailed attributes. The GIS automatically manages synchronisation between them.

The second group, basemap layers, are classic GIS layers, and the GIS administrator can freely define their structure. The only dedicated database for these layers is the geodatabase.

Once the initial GIS database was created, a process of data verification was implemented area by area so the GIS unit could progressively correct inappropriate data and inaccurate locations that had been generated because an incorrect initial cadastral map was used in the CAD system. This four-month phase provided the opportunity for the GIS unit to put all the training into practice, and to improve the methods to fit the daily processes. By the end of July 2012, the overall data had been integrated and verified. Detailed data input then began, and will be carried out continuously by the GIS Unit – this involves details of connecting objects and joints, water meters, and so on.

Providing the basemap data

As a partner in the project, IGN France International, a spin-off of the French National Geographic Institute, was in charge of providing the basemap for the GIS database in Nha Trang: this consisted of a satellite image, cadastral map and a graph of the roads. One of the GPS expert's first missions was to survey the geodesic points that were used to orthorectify the satellite image provided (removing the effects of perspective and terrain so features are represented in their true position). Technical information describing the official VN2000 coordinates system was gathered, and a geo-referenced Worldview1 image was provided, covering an overall area of almost 600km^2.

Based on this image, a graph of the roads within the city and its surroundings was created. The road place names were surveyed in the field to enable easy location of addresses in the GIS. As the current address system in Nha Trang is only correct within the city centre, the description of the street was reduced to its


Gathering data at street level

name, the numbers at the beginning and end of the street, its characteristics and an estimate of the traffic level.

Although a project to improve the data for the cadastral map was being implemented in the province, the initial data quality was low and the source of the pre-existing data difficult to identify. Parts of a puzzle had been gathered, but the further the distance from the city centre, the worse the quality of the data geo-referencing. In addition, the data structure was inappropriate. As the city is rapidly evolving, the objective was not only to provide up-to-date data, but also to provide KHAWASSCO with a way of continuously updating it. One GIS expert mission consisted of cleaning the overall map and training the technical staff to do this, as well as to update it.

Capacity building for long-term mastery of the software

Training for the GIS unit members began immediately after the software was installed. The format for the training sessions – length, content and practices – had to be re-evaluated and adjusted to fit the staff's level of competence and involvement. Each session was generally repeated twice at one-week intervals so all the notions were fully understood and mastered. Practice had to be undertaken on the project database in real working conditions, as theoretical and abstract examples were not well accepted. Over 30 training sessions were carried out in total on the GIS system.

Two GPS devices were provided for the project. A GPS expert undertook additional training to ensure the correct use of the GPS with relation to the GIS system. As the aim is to continuously update the database, data on the water supply network and its surroundings can be exported from the GIS database to a GPS device. During site surveys, the accuracy of this data – both geographic and that of attributes – will be verified and improved then synchronised with the existing database. The compatibility of the GIS and GPS software and the use of a dedicated synchronisation script ensure the data structure is maintained.

Workflow improvement and support for change management

The main project challenge was to ensure that the GIS's tools were mastered and integrated in the company's workflows. Indeed, the objective of the GIS is not only to provide an accurate picture of the existing infrastructure, but also to create a history of all the events and maintenance of the network that then helps to explain its current state and assist future asset management. This mostly involves keeping a record of all the construction work undertaken on the network – extension and rehabilitation – as well as interventions and maintenance operations.

The latter two are stored differently in the GIS as they are triggered by different causes: maintenance is preventive, and can be planned in advance, while interventions cure problems. A dedicated menu enables interventions to be managed, providing information about the origin, follow-up actions and operations performed on the objects involved. A report creation tool allows existing information on the area where the incident happened to be printed out. Based on this information, the repair staff will match the data to the reality, undertake the intervention, and later input feedback from the field into the geodatabase and update its content. This workflow was implemented in KHAWASSCO, and the pre-existing repairs report adapted to the local context. It has been in use since December 2011.

Before the project, the various departments working on the data did not communicate properly. Design documents were created by the Survey and Design department, which would update its own map of the network based on its surveys. Once construction work was finished, the as-built document, which may have been updated during the works, was given to the Network department to update their own network map. This data was then shared among several maps and departments, with an obvious lack of communication. This process was analysed in detail to highlight and correct such issues.

To ensure that all departments communicated better, it was decided that the GIS database would be the only reference, and that no other overall map of the network would be kept in other departments. When new construction is to be undertaken, the new design will be made from the existing available data, extracted from the GIS database and updated following field surveys. The GIS unit was trained to export the data to CAD format, and adapt it as necessary to provide it in a precisely defined format to the Survey and Design department.

It was then realised that when as-built documents were designed, no precise rule had been established for CAD file creation. Each staff member would draw objects according to their own methods, and share them out among the layers with no consistency, making it difficult for the end user to process. To provide a better view when printed out, staff would also divide the map into several areas, rotate it, and modify the scale – once again using no particular method. A new CAD file creation workflow was defined for layer organisation and the use of points of reference that would easily convert any map back to the VN2000 coordinates system. This provided mutual benefits for all departments, even if the acceptance of the modifications of working methods was low at first, as people are reluctant to change. It was finally acknowledged by everyone that a better definition of the file structure would make the process easier for all departments.

Data sharing on an Internet interface

Since it had been decided that the GIS database would be the only reference, it

had to be accessible to everyone in the water company, not only within the head office but also at the water treatment plants, pumping stations, and so on. Nevertheless, responsibility for data creation and updating fell solely to the GIS unit.

An internet interface was installed to share the GIS data among users and enable it to be consulted. Every month, the GIS administrator publishes the GIS database to a web-server hosted within the water company. He is also responsible for managing user rights. Access is via a login and password, and the data available can be filtered depending on the user's position in the water company.

At least two staff were trained in each department. Thanks to this tool, data updating has become everyone's responsibility, and everyone is in charge of providing feedback on inaccuracies within the data in the online database.

Archiving the history of the network

Since 2005, the only existing database had been the WBS, in which all the data on customer contracts were stored. This included data on network interventions for service reasons: water meter openings or closures, water meter calibration or replacements, and so on. Since no adequate or dedicated database existed for incidents, all incident-related activities undertaken on the network were also saved to the WBS database, creating confusion and data loss – the data that was not linked to a specific customer was difficult to identify or process. In December 2011, all the events on the public network (leaks, breaks, burst, and so on) were exported so they could be introduced in the GIS and used for the upcoming asset management mission.

The asset management mission focused on pipeline rehabilitation. Each pipe repair intervention had to be sorted and precisely linked to the corresponding pipeline to enable analysis of the influence of pipe characteristics on pipe breaks. Information about the project date and address, as well as pipe diameter and material was available, but this was insufficient to assure the full input of interventions in the GIS database.

Indeed, the address system quality in Nha Trang is quite poor, and the details of addresses were imprecise – numbers were missing, names of adjoining shops or building might replace the number information, and so on – and pipe rehabilitation had been undertaken without any records, so the diameter and material of pipes often did not correspond to those that were anticipated. The GIS unit spent four months completing this data about seven years of interventions into the GIS, and a substantial amount of data was thus collected.

Asset management

Network ageing is a global problem that increases leakage and seriously impacts network performance. As it is so costly, network rehabilitation is often sparse and postponed, making the issue worse. To enable pipelines to be replaced efficiently and optimise the utility's investments, a good knowledge of the network is a start – and this is one of the main objectives of the GIS. By the end of the second phase of the project, water supply equipment information was available for the overall network (over 750km), and information on diameter, material, laying date and type of soil at a minimum was available for all the pipes.

Our asset management process aims to analyse the network's history in order to model the causes of breaks, predict the network's evolution and identify and prioritise pipes for rehabilitation to reach the water company's objectives. To achieve this aim, a multi-criteria analysis was carried out, aimed at reducing the impacts of breaks on the water supply service for several indicators.

Data preparation and the local context

To make the asset management study more precise, and to better understand the influence of pipe surroundings on the breaks, further information was gathered, mostly on the road build-up and levels of traffic, which were obtained from details of the graph of the roads, and the hydraulic criticality of the pipe – defined as the relative importance of each pipe in the water supply chain.

The latter was input directly by the GIS unit, based on their knowledge of the network. To take into account the local context and KHAWASSCO's priorities for service provision, further numerical data were gathered. This initially focused on local costs: global salary costs and repair times, and repair and rehabilitation costs including material costs, administrative costs, excavation costs, work preparations and technical study costs. In addition, it encompassed parameters that set out KHAWASSCO's service quality priorities: what are the different categories of important customers? Where are they located? How important should service continuity be for each category? How important is avoiding traffic disturbance in terms of public image?, and so on.

For network depreciation time, the Ministry of Construction (MoC) of Vietnam set durations depending on the pipe diameter. These figures, which mostly represent financial amortisation more than the technical lifetime of the pipes, are to be used by all water companies in Vietnam. The official average lifespan of 30 years is very short and does not really correspond to the figures used in western countries, which can be over 60 years, and would imply a high percentage of network rehabilitation shortly after construction. This habit of defining technical parameters based mostly on financial data illustrates a lack of long-term vision in infrastructure management, and was used carefully to ensure reality was depicted properly.

Modelling the network's evolution

The objective of asset management is to study the existing infrastructure and prevent incidents and breaks in the network, to improve performance and reduce leakage. To do so, it is necessary to have an estimate of the network's evolution, and to try to foresee which pipes are the most likely to break. Based on the existing history of the network stored in the GIS database, an analysis of the influence of break factors was carried out.

A preliminary statistical analysis of the pipes' characteristics – diameter, material, laying date and surroundings – the type of soil, traffic level, hydraulic reliability and geographic location – was carried out to better understand the network's past performance. The statistical module in G2C's SIROCO expert system was then used to model the impact of those break factors on the occurrence of breaks. The available data sample – pipe and break records – provided relevant results after model validation. These were then used to calculate a predicted break rate for each pipe in the network, and to obtain a statistical forecast of its state over the coming years.

Multi-criteria analysis for optimal rehabilitation

At this stage of project implementation, all the data had been collated within the GIS so that a rehabilitation strategy could

be defined based on tangible parameters. All this data was published on the web interface of the GIS, which included the dedicated SIROCO asset management modules. The principle is to prioritise pipelines depending on the impact of unexpected breaks for five main indicators:

- Hydraulic reliability: the impact of a break in terms of service continuity and effective water supply to all customers
- The impact on sensitive customers: four categories of sensitive customers were defined, with regard to quality and quantity issues
- The ratio of repair costs to rehabilitation costs: this illustrates the financial opportunity of renewing a pipe instead of repairing it
- Impact on traffic: this is the disturbance implied by interventions in the street
- Linear leakage index: the impacts in terms of water loss and network performance. To compare this criterion across various pipes on the network, it is necessary to be able to distinguish the amount of leakage in different areas. This requires district meter areas to be established. The KHAWASSCO network has not yet been divided into sectors and there are no distribution meters apart from at the treatment plants. This means the linear leakage index is the same for all pipes, and it cannot help differentiate them, so this criterion was not used in this study.

A global score, calculated as a weighted sum of the other criteria, was obtained for each pipe to enable a ranking in terms of rehabilitation priority. To properly describe KHAWASSCO's service objectives and to better mitigate negative network impacts, a number of scenarios were created and compared. The added value of such an expert system is that it calculates the benefits expected from each rehabilitation strategy. The benefits of these scenarios proved to be quite similar apart from their impact on sensitive customers, which guided the choice of the final scenario.

The next step was to define an optimum level of investment. As network rehabilitation is a costly process, it is essential to adjust the amount of rehabilitation against the anticipated benefits. Simulations of impact mitigation for different percentages of network rehabilitation – divided into three portions corresponding to three phases of the rehabilitation works – were undertaken in the online interface of our asset management tool. This enabled us to identify two key facts: the overall short-term optimum amount of rehabilitation is 3% of the total network length. Renewing a larger portion of the network would only bring small additional benefits compared to the extra investment required.

The benefits for the cost ratio, hydraulic reliability and traffic disturbance are covered in rehabilitating the first percent of the network length. The second percent had no significant impact and the third percent had significant impacts only in terms of service reliability for sensitive customers.

After these results were presented to KHAWASSCO and discussed, it was decided to prioritise renewal of pipes in the first percent mixed with those in the third percent, providing they played a significant role in reducing the sensitive customer criteria.

Creating a rehabilitation programme

The online interface allowed priorities for rehabilitation to be displayed based on a colour code. In order to obtain coherent and consistent work sets, and to avoid working on isolated pipe sections that would not be relevant, pipe clustering was performed – priority pipes were aggregated based on a precise methodology – the level of priority, adjoining pipes, similar classes of material, diameter and laying year, and the presence of materials identified as dangerous or to be removed.

This resulted in the creation of 14 work sets, ranked by priority. The length and cost of each work set varies depending on the pipe sections involved. The overall rehabilitation plan encompasses 78 pipe sections, coming to 13km, or 1.7% of the total network. Given the average amount of rehabilitation investment over the past years, it was proposed that the VND76 billion ($3.64 million) investment should be spread across six to seven years.

Before the project, KHAWASSCO's asset management strategy was reactive and short-term. At the end of each year they would decide which pipes to renew based on their financial amortisation and visible current state, obtained from the available break rates. The results of the new asset management method and the work sets were presented to the water company and warmly welcomed. This short-term programme was included in KHAWASSCO's rehabilitation plans for 2013, and will be in future.

KHAWASSCO's asset management strategy also aimed at initiating a longer-term vision to improve network efficiency. This was made possible by good, deep knowledge of the network and its surroundings, which was gradually and continuously archived within a single database managed via the GIS system. Thanks to the methods and workflows created during project implementation, population of the database has been assured in a sustainable way. The asset management strategy results can be updated every two to three years, and the water company will thus be supported in a true long-term strategy. ●


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Practical and effective cyber-security risk management for water systems

'Smart water' offers utility operators substantial improvements in service quality and cost reduction. Unfortunately, it also introduces the risk of malicious cyber-tampering. **EARL EILAND** and **ANDREAS HAUSER** discuss how water managers can leverage industrial control system cyber security standard IEC 62443 to mitigate the risk and impact of a cyber attack.

Water and wastewater providers have joined the move toward so-called smart control systems, with the potential to reduce inefficiencies in current water networks driving interest in data driven or smart water management. For example, it is estimated that globally, 38% of potable water is either lost or stolen[1]. Smart water – the integration of water processes into ICT systems – can mitigate this loss through effective leak detection and pressure management systems.

Drinking water quality monitoring solutions also guarantee rigorous control of water quality throughout the network at all times. In both systems, remote monitoring and control increase system reliability and improve maintenance crew effectiveness, driving down costs. Wastewater operators derive similar benefits.

Vulnerability to attack

The ability to respond to events in the field in real-time is an operational boon. With the advent of tablets, smart phones and phablets (a hybrid between the two), operators and engineers are no longer tied to their desks. They can now manage the system from virtually anywhere. Unfortunately, smart water's benefits introduce new risks. The increased real-time capabilities enabled by today's communication and control technologies improve operators' and engineers' effectiveness, but also enable cyber-tampering by others with malicious intent (hackers).

Historically, control system management believed that cyber security was a 'front office' problem, and that operations were of little or no interest to hackers. Even if a hacker had a passing interest, control systems were sufficiently different from the front office, they reasoned, that the hacker would quickly lose interest and move on to more readily compromised targets (security by obscurity).

This sense of immunity, however, has been discredited. In June 2009, the world learned about Stuxnet[2], the first publicly-acknowledged malicious attack against a control system. Even though the target devices (Iran's uranium enrichment centrifuges) were on an industrial control system totally isolated from the internet, the attackers were able to compromise the entire control system. Malicious code was causing the centrifuges to self-destruct while hiding the fact from the operators.

We might be inclined to feel that water utilities are not sufficiently interesting to come under attack, but recent research has shown this perception to be false. Kyle Wilhoit, a threat researcher with Trend Micro, has recently reported on his observations of attacks on a network set up as a water utility in 'small town USA' (honeynet)[3]. Over the five months Wilhoit observed his honeynet, the faux utility was probed 32,000 times and attacked 74 times. Eleven of the attacks he classified as serious. The serious attacks attempted to modify equipment settings, corrupt control messages and steal data.

Wilholt's study showed that the threat is real and that these systems have to be protected from potentially harmful and costly malicious actions by intruders. However, as this type of threat is new to the water sector the corresponding protection requires specialised IT expertise, which is typically not available.

Risk management strategies for water utilities

Protection against cyber attacks is not a simple matter. Whereas water and wastewater technologies change slowly, a list of top cyber attacks today looks vastly different from one even a few months ago. Thousands of new attacks are detected daily, and the attack landscape changes rapidly.

The question is now how security can be managed in such a rapidly-changing environment. Adapting cyber security strategies used in 'office IT' is difficult. In a nutshell, system availability is important in an office environment, but it is critical in an operation technology (OT) environment. Generally, if a key operational service fails, the income stream is interrupted. This is less likely in the front office. As a consequence, IT cyber security solutions do not always maintain system availability, so they may not be useful.

Risk management experts have identified five risk management strategies: acceptance, avoidance, defense, mitigation, and transference. Three are not applicable to water utilities protecting their core services, two are. Acceptance – absorbing the impact of a failure – is impractical for utilities because the consequences are too great. Avoidance – not providing a key service because the consequences are too serious – is likewise unacceptable. Transference – shifting risk to another entity – is also impractical. For example insurance, a conventional means of transferring risk, can compensate for direct financial losses but does not cover indirect or non-financial losses associated with a service failure.

There are two risk management strategies that are useful for utilities. One viable strategy is protection, which entails eliminating vulnerabilities that could cause an unacceptable failure. Operators should strive to ensure their systems are resistant to compromise. Resistance, however, is insufficient because perfect protection does not exist. As illustrated by Stuxnet, sufficiently skilled and deter-

The move towards smart water systems has opened up the possibilities of virtual attacks on utility assets. Credit: pressmaster / Shutterstock.com.

mined attackers will eventually compromise their target system.

When a system is compromised, the risk must be mitigated. There are two mitigation approaches utilities can use: resilience and restorability. Resilient systems exhibit graceful degradation; as the system capabilities decline, critical services are maintained and non-essential services dropped. In the worst case, an attack may actually cause a critical failure, interrupting service. The last line of defense is restorability: the ability to rapidly restore service after a failure.

Water systems must therefore exhibit resistance, resilience and restorability (the 3Rs). While these are system characteristics, failures are not systemic – they are triggered at the component level, so components must also exhibit 3R characteristics. Component design and maintenance is the responsibility of the vendor, so operators must rely upon them to support their product's cyber security quality over its useful life. The legal term 'ready, willing and able' applies to a vendor with this capability. Ready, willing and able vendors will provide and maintain components with a 3R mix appropriate for their customers.

Before deployment, operators have the opportunity to test components, or can require independent component testing and certification. After deployment, operators must rely on their vendors to rapidly release quality patches for newly discovered vulnerabilities. However, the common certification model, product testing and certification, does not meet the need, adding delay and expense to the vendor's release. When it comes to cyber security, delay increases the operator's risk of being compromised, so the conventional means of assuring quality does not fit the cyber security environment.

ISA99/IEC 62443: a standard tailored for water utility cyber security

Recognising the problem, a group of industrial control system experts have created a standard suite: ISA99/IEC 62443 Industrial Automation and Control System Security. This standard addresses the operator's need to have vendors that are ready, willing and able to deliver and maintain appropriately cyber secure components (working from use cases and considering the threat landscape, the stakeholder identifies their end user's cyber security needs and incorporates a mix of 3R capabilities suitable to address that need). It also includes provisions to enable and certify operators that are ready, willing and able to deploy and maintain cyber secure water systems.

The Idaho National Lab published a comparison of three industrial control standards in 2004. Although all of the standards compared recognise the need to use best development practices, the document shows that only IEC 62443 delves into how this can be accomplished[4]. Although the report is somewhat dated, IEC 62443 remains the most mature standard with regard to development process.

IEC 62443's innovation is based on the understanding that a water utility stakeholder's (operator, integrator or manufacturer) being ready, willing and able is not tied to the component or system, but is a process characteristic. IEC 62443 therefore audits stakeholder processes. Because new exploits are constantly being discovered, stakeholder processes must not only be capable of a rapid response but must also incorporate a means for continuous improvement, for adapting their processes to block new exploits in future releases. Continuous improvement ensures that best practices are in use.

Thus, an IEC 62443 certified water utility stakeholder will have demonstrated that they release security patches in a timely manner (or, if an operator, that they properly manage patches) and also that their processes apply best practices. Best practices are used when stakeholders are certified and since continuous improvement is incorporated into their processes, best practices will continue to be used. Additionally, the stakeholder's corresponding products must have satisfied use-case-based cyber security requirements when certified, so the stakeholder's continued use of best practices will ensure that the current release does as well.

Unlike product-based certifications, IEC 62443 is economically viable. Instead of needing to have every product build certified, an IEC 62443-certified stakeholder has their processes and product changes reviewed annually to ensure they are indeed providing rapid response and applying continuous improvement, and rarely needs to have their product extensively tested or process extensively audited and re-certified, though major product or process changes may require a more extensive assessment.

Economic practicality, however, is not sufficient: water utility stakeholders must benefit as well. IEC 62443 certification means fewer cyber incidents, and a stakeholder experiencing fewer incidents does receive benefits, including:

- Fewer interruptions to the stakeholder's income stream. This directly impacts water utility operators, who may experience a service failure. Vendors may be indirectly affected if they or their product gains a poor reputation
- Reduced security information and event management (SIEM) expenses. Vendors must rapidly provide their customers with security solutions (patches and work-arounds). This can

be a major support expense that drastically reduces a product's profitability.
- Insurers perceive less risk, so they will offer more favourable terms to IEC 62443-certified stakeholders.

Proof of concept

IEC 62443 is a new standard, so there is no convincing body of industrial control system evidence to support the claimed benefits. However, there is supporting evidence from other markets. One historical example, from about 150 years ago, is steam power. This was a new and largely unknown technology, and operators began experiencing issues with steam boilers exploding. Insurers at the time started challenging business owners about their boiler operations, asking whether best practices were being used. Threatened with claims being denied, European business owners formed inspection and standardisation companies to perform plant inspections and certify compliance with standards. As a consequence, certified operators experienced a 95% drop in boiler incidents.

However, there are substantial differences between steam power and today's industrial control system technologies. Steam power is limited by physical laws, and changes come slowly. In cyber security, cyber attacks are only limited by the attacker's creativity, and the threat landscape from even a few years ago bears little resemblance to that of today. Another strong indication that the IEC62443 concept will work is from the domain of software development.

In the early days of the internet, cyber attacks were a minor problem. However, with the internet's increasing importance, such attacks have become a serious problem. As a consequence, Microsoft found it was incurring substantial expenses releasing security patches for its product portfolio. In response, it created the Trustworthy Computing Security Development Lifecycle[5]. The results were encouraging: Microsoft reported that after implementing its new process, the number of security patches released for three of its major product lines dropped by about two-thirds.

In the age of steam power, testing and certification dramatically reduced operator risk. Microsoft demonstrated that an appropriately structured software development lifecycle could reduce software vulnerabilities. IEC 62443 integrated Microsoft's Trustworthy Computing Security Development Lifecycle by incorporating its concepts into the standard, tailored to the industrial control system environment. In so doing, IEC 62443 provides to water and wastewater utility stakeholders the benefits of a standard written around a concept demonstrated to successfully reduce the risk of cyber attack.

Reaping the benefits

For water utility managers, there are two ways to benefit from IEC 62443 certification. The easiest way is to state that IEC 62443 certified vendors will be given preference when creating RFPs – since the standard is still new, requiring IEC 62443 certification might be too limiting. To the extent that system vendors are certified, the risk of receiving substandard support (not based on best practices) is minimised.

More value comes from being certified as an operator. Not only are the benefits mentioned previously gained, certified operators achieve additional risk mitigation. For instance, if a system failure is caused by a cyber attack, the operator's reputation may be considerably affected. However, if the system is IEC 62443 certified, it is on record that the operator's processes incorporate appropriate response times, incorporate continuous improvement, embed 3R-based strategies and that the operator has implemented an appropriate control architecture.

A certified operator is employing best practices. An IEC 62443 certifier attests that the certificate holder is executing due cyber security diligence, so being certified diffuses the impact of criticism of poor operation. IEC 62443 reduces indirect risk, an impact that, as pointed out earlier, cannot be addressed with insurance. ●

TÜV SÜD: your partner for robust cyber security

TÜV SÜD has a certification programme for water system operators, system integrators and component manufacturers. The service portfolio includes training, analysis, testing and certification, so through TÜV SÜD and our partners, water utility operators and their vendors can strengthen their cyber security. This will yield tangible improvements to operation and bottom line.


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Central monitoring of water supply and sewerage networks: an EYDAP case study

GEORGE SACHINIS, the Head of the Operations Centre at the Athens Water Supply and Sewerage Company (EYDAP), explains the operational framework necessary to create centralised monitoring of network operations in a large water utility.

EYDAP is the largest company in the water and wastewater market in Greece, and one of the largest in Europe. Its 9500km water network and 5000m of household connections provide top water quality and continuous pressure of between 3 and 7 atm (at ground level) to 4.3 million consumers or 2,030,000 water meter connections at 700,000 buildings, accounting for 40% of the Greek population.

The company's 6000km-long sewerage network serves 3.5 million customers or 400,000 connections. Maximising the capacity of the existing infrastructure is the cornerstone of EYDAP's network management. The company invests in responding quickly and efficiently to service and operational incidents as well as pressure management.

EYDAP manages to offer high quality services despite having a very economical pipe replacement programme. The utility offers top water quality at a NRW of 23%, with actual water losses estimated to be about 12%. The annual burst rate is 0.4 per kilometre of network (about eight bursts per day), and the most frequent burst-repair duration is 2.5hrs.

At the core of EYDAP's daily operations is the continuous and careful monitoring of the 3500 unique customer enquiries and complaints per month, the 900 water telemetry stations and the 70 telemetry stations for the wastewater network, as well as field crew activity. Monitoring occurs both centrally through the operations centre and at sector level through local operators. This article presents an overview of the operations centre as a case study for central monitoring of a network.

EYDAP's operations centre

Framework

EYDAP's operations centre began life in December 2011. It is a round-the-clock operation monitoring station staffed by engineers from across the company's departments. It receives telemetry data from all networks (the aqueduct, and the water and wastewater networks) and water treatment plants, as well as call centre data and service crew input. Its mission is to help sector operators to expedite and improve the efficiency of response to service incidents and changes in network operation (see diagram).

EYDAP's control centre

After 3pm in particular, when the sector engineers have left, it is the operations centre that must aid the sector service crews by providing useful insight into incidents. This information has to be derived from quick analysis of various inputs: telemetry, call centre and field crew data, and educated assumptions about the cause of each incident.

For example, information from customer complaints, telemetry data and input from the crews responsible for shutting off the water during a pipe-burst may direct a monitoring engineer to the cause of an incident (such as a malfunctioning pressure reducing valve) quickly enough to help the dispatched service crews in resolving not only the burst, but also its cause.

The service crew is dispatched immediately when a complaint is received (see 'reaction to the incident at t=0' in Figure 1). The most frequent repair duration is between two and three hours. Therefore, in order for the operations centre to really help with the repair by providing information that leads to a possible cause, it has to act fast in analysing and correlating inputs (see the t=+1 section in the diagram).

The operations centre acts quickly to maximise the benefits of EYDAP's vast multi-source real-time operation data. Because of this, it is an important player in the digitisation and upgrading of incident monitoring and tracing processes, cross-departmental reporting and network operation statistics. It has an

R&D office that works closely with EYDAP's IT department in upgrading such processes, usually through incremental changes in the existing systems that are beta-tested through the everyday work of the engineers at the centre.

All real-time correlation, prioritisation and analysis of incidents by the operations centre is stored in a new database designed to contribute to t+2 analysis, such as proactive operational management and crisis control.

To summarise, the diagram shows how the operations centre aims to improve the speed and efficiency of the response to everyday round-the-clock operations and service incidents by qualitative monitoring at t=+1 (shortly after the appearance of an incident) of input from telemetry, crews and customers. By doing this it supports service crews, particularly during the afternoon and night shifts. To achieve this, it so far utilises manual rather than automatic processes, with a pool of 70 engineers from across the company working in rotated 24-hour shifts. Parallel to its main mission, the operations centre also contributes to the following operation management tasks:

- Unifying local monitoring processes
- Upgrading user-friendly digital reporting (such as online real-time main incident reports) and provision of speedy interdepartmental communication
- Real-time mapping of incidents (complaints, telemetry, water shut-offs, bursts and so on)
- Construction of a main incidents database that is 'smart' in that it contains correlated inputs
- Enhanced knowledge sharing across the pool of engineers, and better use of the knowledge of local operators and technicians (by properly recording it)
- Real-time operational statistics

The core process of its everyday operation follows these steps:

- Monitor all input from all sources (customers, telemetry, technical crews, local operators)
- Correlate input based on spatial, time and operational characteristics, and consult historical databases
- Flag incidents based on their severity, recurrence and so on
- Support the contact centre, local operators and decision makers with online reports of main incidents and statistics produced by the monitoring engineers

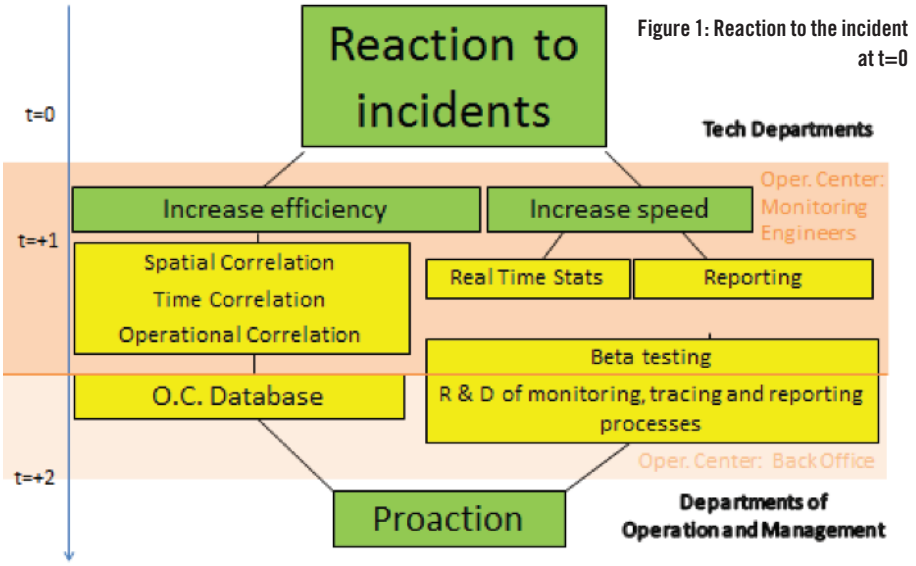

Figure 1: Reaction to the incident at t=0

The basis of the operations centre's processes is shown in Figure 2. The monitoring engineer is the top pillar – the centre relies on the company's engineers to provide quick incident analysis. So far, the development of tools for the centre has been in the areas of user-friendly monitoring, mapping, manual correlation and reporting of operational inputs, leaving sophisticated automatic correlation of inputs for a possible next step. To continuously improve the quality of its monitoring engineers, the centre works with the EYDAP Academy and also maintains an on-line digital library and forum on its monitoring processes.

Input

Apart from its daily phone communication with local operators, the operations centre receives digital real-time filtered input from customers, telemetry and the technical crews in the field. It also has direct access to the complete databases for these sources. The combination of filtered input and historical data is critical in providing educated monitoring and decision support.

EYDAP's contact centre is part of the operations centre. In addition to customer communication, the department is in charge of filtering complaints, digitally providing the centre with a 'main incidents' online report, which is connected to GIS (Geographical Information System) and contains:

- Widespread incidents: simultaneous identical complaints in a specific area
- Frequent incidents: frequent identical complaints by one customer
- Special cases: complaints that are indicators of a critical malfunction in operation, or urgent complaints that have delayed or problematic repair profiles

In addition to filtered outputs, the operations centre has access to the full domain of customer complaints.

The contact centre flags field crew reports connected to customer complaints on problem repairs as 'crew reports with alleged mistakes' for monitoring by the operations centre. For the water supply, all water shut-offs are directly logged and mapped on GIS for use by customer care and the operations centre. Changes in the operation of pumps are alerted through SCADA. Fleet control is undertaken using GPRS technology in sewerage service vehicles and by using SCADA sensors at the facilities. In addition, the operations centre has online access to the full domain of field crew reports correlated to customer complaints.

The operations centre also receives alarms from telemetry. The alarm thresholds are revised according to operational scenarios. The alarms for the water supply network relate to tank water level, pressure, flow, overflow, temperature, pH, chlorine, mode of operation, operating frequency, instrument failure, communication breakdown and power failure.

Aqueduct alarms relate to water level, flow and pressure data at the main canal and at the pump stations. The alarms for the wastewater network all relate to pump station control and overflow monitoring. For the telemetered properties mentioned above, we have to include mode of operation alarms.

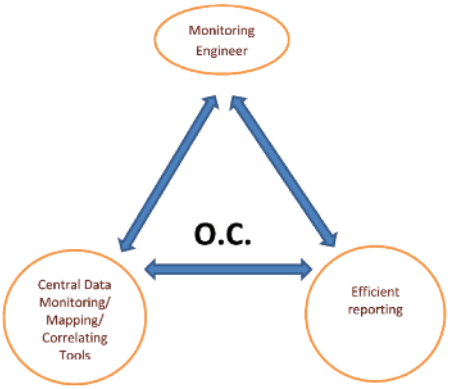

Figure 2: Operations centre's processes

The alarms at the four water treatment plants relate to water and air flow, quality and chemical measurements across the whole plant and monitoring of the plants' equipment and security. The alarms for the three wastewater treatment plants cover similar areas.

Only few of the many meters at the water and wastewater plants are useful for the operations centre, while all of the meters for the aqueduct and the water and wastewater networks are continuously monitored. The operations centre deals with the three or four stages of overflow alarms in the wastewater system (pump overflow, pre-alert of overflow to surface, alert to overflow and overflow) and the high priority alerts (pre-alert and alert) in the aqueduct and water supply.

Correlating input

In daily operation, the role of the engineers at the operations centre is to analyse input and report correlations that instantly improve operation and service, especially in the water supply and wastewater networks (see example in Figure 3).

In water supply, the operational alarms may be correlated with:

- Other alarms
- Call centre input
- Crew reports
- Water shut-offs
- Network condition (broken valves, aged pipes, known design faults and so on)

Call centre input in network operation monitoring

Correlating customer complaint data with telemetry, service crew input and historical data is a process linked to daily operations monitoring as described below.

Filtering of network related complaints

Only 30-40% of the incoming calls to EYDAP's technical service line involve unique incidents relevant to EYDAP's operation and service. Filtering these incidents during each customer communication is made possible by providing the contact centre's front line staff with selected real-time operational information and maps.

For example, real-time mapping of all shut-offs, including progress reports, allows for immediate accurate grouping of water shortage or low pressure complaints that should be linked to the repair. Complaints outside and close to the borders of the water shut-off area are important incidents that require immediate attention as they might reveal otherwise unknown network discontinuities.

Flagging complaints according to their usefulness in operation monitoring

The call centre directly filters out those complaints that are useful for the monitoring of operation, including frequent and widespread complaints or complaints with other special attributes.

Correlation of complaints, telemetry and field reports

The operations centre's monitoring engineers correlate complaints with telemetry and field reports on a round-the-clock basis in order to:

- Quickly detect the source of incidents, expedite repair and minimise further service problems
- Detect inherent network infrastructure and operation problems and make proposals for remediation or optimisation
- Monitor operational changes and pressure management
- Provide up to date information on service incidents to the contact centre
- Detect safety hazards, security breach, theft and vandalism

Recent real-time geo-correlation of complaints with water shut-offs has resulted in rapid improvements both in the quality of customer service and a reduction in needless dispatching of service crews, which is a major problem in a large city like Athens.

Conclusion

Maximising the capacity of the existing infrastructure is the cornerstone of EYDAP's network operation. The company invests in monitoring and pressure management, and is economical in its pipe-replacement programme.

The operations centre helps sector operators to achieve fast and efficient operation and service incident response, especially after 3pm. It centralises, standardises and expedites monitoring and real-time operational data correlating processes, and also maximises the real-time use of customer complaint data, correlating it with telemetry and field crew input to provide sophisticated support for both network operation and the call centre. ●

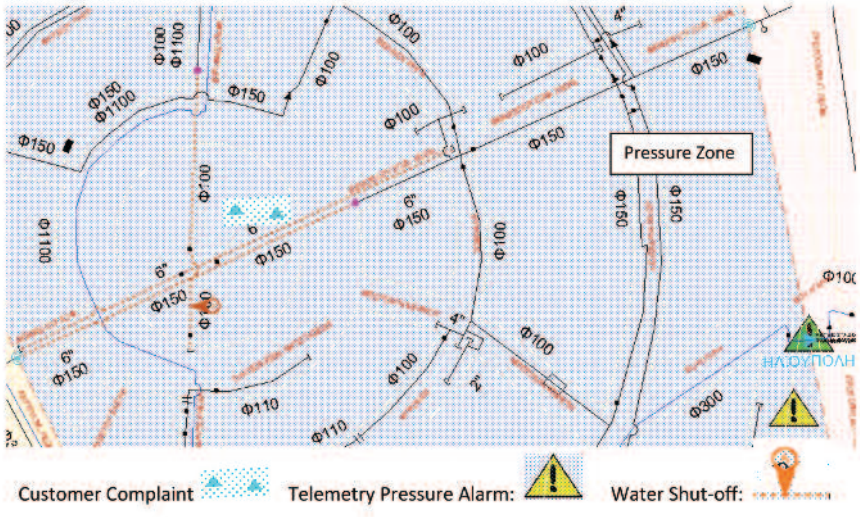

Figure 3: Example of real-time mapping of heterogenous input to be correlated by the operations centre

This paper was presented at the IWA Regional Utility Management Conference: Improving Performance in Emerging Economies, held 13-15 May 2013 in Tirana, Albania.

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Increasing market-based external finance for investment in municipal infrastructure

Required investment in the water sector in South Eastern Europe may be double the amount of financing currently available. **GIEL VERBEECK** argues that policymakers and operators have a duty to explore complementary sources of financing, including market-based repayable external financing.

Most countries in South Eastern Europe (SEE) consider increased access to potable water, sanitation and solid waste services to be government priorities. The Organisation for Economic Co-operation and Development (OECD) (2012, p59) estimates that the investments required to meet the Millennium Development Goals (MDGs) in Eastern Europe and Caucasus Central Asia (EECCA) total €7 billion ($9.5 billion) annually; roughly half the amount of financing that is available for the sector each year. The investments needed for SEE to upgrade the water sector to EU standards are therefore going to be in the order of billions of Euros each year, well beyond what can be accumulated from the '3Ts': tariffs, transfers and taxes.

In a broader context the challenge is not only financial but also operational and institutional, encompassing how to acquire the necessary capital, how to carry out capital expenditure in a competent and cost-efficient way, and how to develop institutions, regulations and mechanisms that ensure sustainability.

The water utilities do not have sufficient cash flow to finance the required investment in network and treatment capacity themselves. Often, they lack not only the cash flow, but also the expertise to manage complex investment projects. Experience with non-budgetary sources of finance is limited. National ministries may have the expertise or the skills to procure the works, but lack the funds for the required investment.

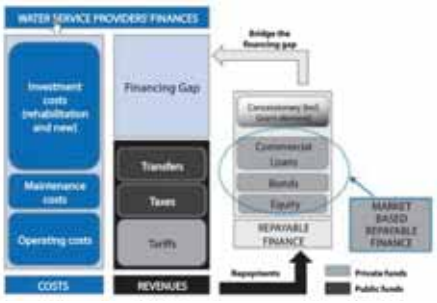

Figure 1: Illustration of various forms of financing from OECD (2009)

International financial institutions and donors have both expertise and funds, but the investment needs exceed their budgets and scope (OECD, 2009). It is not in their mission to work as a normal bank. Major donors such as the EU are ill-equipped to act as financiers. A donor is neither an owner, nor a bank, it is a budgetary organisation with different interests than financial institutions. As a result, the financial viability of chosen projects is sometimes questionable. Money is spent in accordance with bureaucratic rules, rather than on the basis of the rules of the market. If these bureaucratic rules fail to ensure financial viability, problems arise.

Private sector participation (PSP) is often mentioned as a means of attracting finance, but unlike many countries in Asia (such as India, The Philippines and China) the appetite of private operators to invest in municipal infrastructure in SEE has been limited. It has declined in the past ten years due to negative experiences and an aversion to risk associated with the financial and economic crisis. As a consequence the water sector suffers from chronic underfunding, sustaining poverty, poor health and gender inequality.

In theory, the water sector should be amongst the safest sectors to invest in, based on being a natural monopoly, with recession-proof demand and regulated prices. Investment in the water sector has amongst the highest social and financial cost benefit ratios (OECD, 2011). How can this injustice be resolved? What self-reinforcing mechanisms can be developed to change the course of events? Part of the solution may be increased use of market-based external finance.

Market-based repayable external finance: the facts

What is market-based repayable finance (MBREF)? Utilities, like other companies, finance operations and investments through a combination of debt and equity. Equity can be generated internally through retained earnings (profit) or externally by issuing new shares through a public or private offering. Debt, in the form of loans and bonds, is by definition issued externally.

External finance can be permanent or repayable, that is, either or not in need of repayment, including a compensation for the use of capital in the form of interest or a dividend. External finance can be public or market-based. Market-based external finance is a subset of repayable finance, in which finance is provided via the market through private actors (OECD, 2010).

Forms of MBREF

MBREF can come in the forms of debt or equity. The dominant form of MBREF is debt, through bank loans in particular. OECD (2010) identifies the main forms, which are described below.

Commercial banks

Commercial banks regularly finance the working capital needs of utilities. However, they would usually not enter into longer-term financing for a number of reasons: they may be unfamiliar with the water sector, uncertain about the tariff regime, or have doubts about management and a perception that the sector is too corrupt to become involved in.

In some cases commercial banks will not lend to the sector because they feel they cannot compete with the concessionary (soft) loan terms

Table 1: Progress of national governments in measures facilitating MBREF

Country	Regionalization carried out	Autonomy provided	FCR and harmonized tariffs	Economic instruments	Benchmarking data available	Ranking
BiH	X	X	X	X	X	4
Kosovo	✓	✓	✓	X	✓	2
Romania	✓	✓	✓	✓	✓	1
Serbia	X	X	X	X	✓	3

of the IFIs, let alone donors. However, in reality, the supply of such finance is small and accessible only to the larger or better-connected utilities.

Bond finance

In the USA the water sector has a low risk profile and municipal infrastructure is typically financed through bonds, which can be listed and traded on capital markets. Bond financing is virtually nonexistent in SEE transitional countries.

Project finance

A project finance scheme consists of a number of equity investors (sponsors) together with a syndicate of banks that typically finance the entity on a non-recourse basis. This means that the loans are paid exclusively from the project's cash flow. Project finance entities are behind a wide range of public private partnerships (PPPs) from straightforward instances of Build Operate and Transfer (BOT) contracts all the way through to concessions. As mentioned above, however, the appetite for the risks associated with the latter type of contract has decreased over the last ten years.

Listed and privately-held equity

Lloyd Owen (2006) identifies 94 listed water companies, mainly from the USA, EU and China, and 32 that are privately held. This form of financing is unlikely to play an important role in the near future in SEE. The reasons for this lies in the combination of popular skepticism towards privatization of the water supply and an unconducive regulatory framework (level playing field).

Can MBREF make a difference?

The limited financial and technical capacities of Official Development Assistance, IFIs and national governments mean that the supply of and access to MBREF must be enhanced. This would be beneficial and not just in terms of financing required capital expenditure.

Market-based finance may avert investment in some 'white elephants'. Prestigious projects that do not lead to services for which people are willing to pay for may find it much harder to gain funding through MBREF. Network extensions and quick and cost-efficient improvements in service may receive higher priority. Market forces can provide welcome 'competition' to the experts currently responsible for assessing financial viability.

PSP in financing is not as controversial as direct PSP through management, lease contracts and outsourcing. As long as it results in a net flow of funds into the sector, few would object. Nevertheless, Hall and Lobina (2010) claim that MBREF is undesirable and that the MDGs must be realised through tax collections alone. One may question whether anyone without access to clean drinking water would take the same position. Where private sector participation has failed due to political controversy, private sector money in the form of MBREF may succeed.

The incentives that MBREF gives to stakeholders are attractive compared to the traditional channels of infrastructure finance such as governments, IFIs and ODA. So why then do market forces stay on the sideline in SEE? Why is the water sector denied the benefits that market forces provide to other sectors: consumer surplus, innovation, lower prices, increased volumes and quality of service?

The reason is that markets do not automatically generate what is required for markets to function well. Intervention is required and justified in order to improve both supply of and access to MBREF.

Enhancing the supply of MBREF

Understanding why suppliers of MBREF do not take the water sector sufficiently into account is key to removing obstacles and formulating the required financial innovation. Since MBREF may be supplied by a diverse group of actors it is possible to develop a long list of required actions, which includes increasing investors' familiarity with the water sector. As insiders dominate the water industry, potential financiers need to be actively invited to conferences, company visits, study tours and other events. If the lack of understanding between engineers and financial experts can be overcome, the perception of risk will improve.

Risk transformation is a key function of financial markets. But the existence of some forms of risk, such as political and exchange rate risk, may prevent market participants from becoming involved. ODA, IFIs and even the private sector can sell Partial Risk Guarantees (PRGs), which mean that remaining risks such as sector and company risk can be successfully transformed in a diversified bank portfolio to a manageable form and amount.

Instead of lending directly to water utilities and municipalities, the IFIs could leverage the amount of financing going to the sector by providing credit lines to commercial banks. These banks would thus become increasingly familiar with the sector, and willing to put in more of their own capital.

Due to the capital intensity of the sector, the required maturities of debt are longer than usual for commercial banks. Domestic pension funds could be encouraged to step in, as long maturities are an advantage to them. Domestic pension funds do not suffer the exchange rate risk either.

Small water and sanitation providers incur relatively high transaction costs for external financiers. One way to overcome this is the creation of grouped financial vehicles such as through a revolving fund, a bond bank or pooled financing for a larger bond issue.

Credit ratings, monitoring and transparency are also key. Obtaining a credit rating is too costly for the vast majority of SEE service providers. ODA and IFIs may support new and cheaper alternatives that put performance information and credit track records into the public domain.

Micro finance is another option. Consumers may borrow funds to finance

connection fees from a micro credit institution. Small water utilities may still be welcome as clients themselves. OECD (2010) discusses a wide variety of financial products, as well as the required innovations.

Enhancing access to MBREF

The bigger challenge lies in enhancing access to MBREF. In most SEE countries there is much that national and local governments can do.

National level

Local utility managers often sigh before over-ambitious consultants, aiming to implement terms of references for financial and operational performance improvement programmes (FOPIPs) that are full of grand goals for cost recovery, regionalisation and performance monitoring. They are right. In the absence of a coherent national policy, local stakeholders can make little progress. The following issues require a national policy, and cannot be developed from the bottom up.

Commitment to time-bound, output-based targets such as connectivity ratios

Within the framework of EU accession, Romania committed itself to time schedules for the percentage of its population enjoying a water and sewage connection. The commitment was therefore firmly in the public domain. Such targets pave the way for systematically clearing the obstacles to investment in the water sector. For providers of external finance this provides security. The country is putting its reputation at stake. Without access to MBREF such commitments cannot be made, so governments are forced to actively clear obstacles. The two biggest obstacles are:

Suboptimal economies of scale and scope, which require regionalization
Suppressed tariffs, which require measures to force them to reach dynamic full cost recovery as described further below.

Regionalisation

Small municipal utilities lack the expertise to oversee larger investment projects. In SEE countries, the focus of capital expenditure is now moving from urban water supply in the larger cities towards the periphery, where capacity is not available. Regionalisation enables pooling of human resources with the required skills, which include those needed for capital expenditure oversight (management, engineering and planning), as well as customer services and IT.

Typically these small municipal utilities, which serve populations of up to 50,000 people, are combined utilities providing, in addition to water, solid waste services, street cleaning, green market and other services. Although ring-fencing the costs and benefits of each of these services is possible in theory, in practice cross-subsidies are bound to happen and will continue. Amalgamation into regional entities and unbundling of non-water services is necessary to eliminate cross subsidies (a condition for full cost recovery); improve corporate governance; prepare for and oversee the required investment; and develop project management, financial modelling and long-term planning skills. All of these improvements are needed to access MBREF.

Dynamic full cost recovery

Full cost recovery (FCR) by the utility is a principle that serves several purposes, which include ensuring sustainability of service, allocation of scarce resources, and meeting the polluter pays principle. Affordability, and more often political acceptability, place constraints on charging full cost recovery tariffs. Typically, tariffs will need to at least double to account for the costs of replacement and discounted future investment needs.

Affordability constraints can be addressed by increasing tariffs gradually above FCR in order to fully recover operational and capital costs over an extended period of up to 25 years. However, if tariffs are left to local government the decision horizon does not extend that far. Usually local governments can only decide tariffs on a year-by-year basis. National policy is needed to enforce dynamic FCR, for instance through an independent regulator.

Dynamic FCR is essential for MBREF because current and future customers pay the cost of service provision. Market-based external finance can only bridge but not close the gap, as illustrated in Figure 1. Without a guarantee that over time these operational and capital costs will be paid for by end users, no commercial investor would step in.

Economic instruments facilitating reinvestment

Governments can do more to attract MBREF by ensuring that components of the tariff meant to cover capital costs are actually invested rather than used to cover cash operating costs. Depreciation is a widely-accepted part of the tariff formula, but often the utility spends the associated revenues on salaries, rather than on capital replacement. Therefore, a mechanism is needed to prevent that from happening. National authorities must set policies to enforce creation of the chosen instrument, whether this is a depreciation fund, escrow accounts (in the custody of a third party) or an alternative that results in reinvestment or provisioning for it.

Water infrastructure in SEE requires significant investment

Municipalities and utilities can voluntarily agree on the basis of civil law agreements and create such instruments, but in practice there is insufficient trust, willingness and capacity to proceed. National authorities need to provide leadership and legislation.

The Romanian Maintenance, Replacement and Development (MRD) Reserve Fund is a successful example. The water company contributes in cash into this fund the equivalent of its depreciation expenses and retained earnings. The local authorities contribute the dividends received from the utility.

The fund has its own legal entity, and is subject to regulation and reporting obligations. Its statutes stipulate that it can be used only for capital expenditure and larger maintenance projects for the water infrastructure in the service area. Money in the fund that is not used in a particular year simply stays in the fund. The funds made available for capital expenditure are not nearly sufficient to cover the required investments, but will be enough to convince lenders to step in, as the local stakeholders have invested their own money. The principle is exactly the same

as a bank demanding that a borrower put in his own, albeit insufficient, savings into a project, before committing to a loan.

Benchmarking

Although no panacea, increased national benchmarking activities provide guidance and confidence for those monitoring the performance of a utility. Often policy-makers and utility managers protest that benchmarking is a futile exercise. There are indeed challenges in comparing utility performance, but with a concerted effort these can be overcome and have been overcome in many other sectors and technologies. The internet has been very helpful, and has mobilised 'the crowd' to monitor performance of numerous service providers. Performance monitoring and benchmarking is getting easier, not harder.

From a lender's perspective it is obvious which country is more attractive to start a water sector lending programme: the one with a national water services benchmarking programme. Not only are the performance data themselves are important, what also counts is the signal that the national government takes an interest in the sector's performance.

Looking at a cross section of SEE countries, based on the author's own experience, governments vary in their progress in facilitating MBREF, as illustrated in Table 1.

Local actions to improve access to MBREF

Local government

Municipalities can be demanding of their water utility managers. It is quite normal for a director to be called into a sudden meeting with the mayor without any prior notice, but in other cases municipalities are too lax. Monthly reports, business plans and other documents from the water utility are accepted without substantial scrutiny and without expecting quality, consistency and substance.

Local governments need to act more like owners, either of utility shares or utility assets – that is, as a lessor or concessioner. Responsible owners expect accountability and autonomy from the managers they put in the job.

Autonomy and accountability for water utility management needs to be increased and formalised to improve performance (Braadbaart et al, 2007). This will also increase the sector's attractiveness to external financiers. Baietti et al (2006) also hint at the importance of autonomy and accountability for performance. Through generational change, utility managers' perception of the utility as a local government agent that is solely responsible for O&M activities will move towards viewing it as an autonomous, social enterprise with a long-term mission to fulfill.

That process may be accelerated. Autonomy can be increased in a controlled way, together with enhanced accountability for results and the quality of monitoring. If necessary local governments can fall back on old-fashioned command and control structures, but if autonomy is not developed it also hinders access to MBREF. Financial institutions do not take over management unless they are forced to – they know better than local government that they are ill equipped to run a water utility. Therefore, there is only scope for MBREF if utility managers truly act as leaders. No document better reflects the autonomy of management than the annual or multi-annual business plan.

Business planning

One of the functions of a business plan is to show the focus and viability of the utility, which are key conditions for any commercial investor. Unfortunately, the utility focus is not necessarily external (e.g. on customers, increased access to service, and operational and financial performance). Too often the focus is on internal issues (such as satisfying legal reporting requirements, staffing and power struggles). Sometimes there is no focus at all, as is the case when actual decision-making takes place in the municipality.

The business plan also sheds light on the financial viability of the utility. If the utility is responsible and accountable for its operations, it will prepare a cash flow projection to ensure that its operations are viable. On the other hand, if the utility functions as an arm of local government and is only responsible in name for its financial viability, pro forma financial statements understandably do not matter. If they are generated at all, it is literally pro forma. The business plan will reflect the autonomy, focus and viability of the utility, either directly through its substance or indirectly, through its absence of it.

Business planning has another function: it helps companies to get the focus right, creating ownership of internal targets and communicating them externally. It is therefore important that local governments demand business plans that constantly improve and can eventually be offered to attract MBREF.

Annual financial statements

In every country utilities are legally required to deliver annual financial statements, and this rule is enforced in all SEE countries. Increasingly these statements are supposed to be in accordance with the International Financial Reporting Standards. Audits of these statements are also a requirement, but most utilities treat this as a formality. Smaller, cheaper auditors are preferred, which do not make too many difficulties for the management.

To be eligible for MBREF, utilities need to adopt a different approach. An audit by a reputable firm may easily cost €20,000 ($26,600) rather than only a few thousand Euros. But as well as helping the utility to improve its performance and reporting, it also improves access to external finance. Compared to the annual costs associated with water losses or of overstaffing, a good audit comes at a fair price.

Bankable projects

Utility managers usually know what investment projects are needed; sometimes they carry these plans for years. But a manager's vision may not be a bankable project. The utility manager that wants to ensure a plan is carried out should imagine themselves in the position of the banker, just like a salesperson imagines himself in the position of the client. Cash flow and output forecasts, elevator pitches (a very short summary that theoretically should last the length of an elevator ride in the case of a chance meeting), feasibility studies, project summaries and business plans are his tools. A determined marketing effort is needed – this is different to the traditional public finance budget allocation process, which again has its own rules.

Conclusion

The scale of water sector investment required means policymakers and operators must explore complementary sources of financing, including market based repayable external finance. This paper identifies measures that enhance the quality of supply and access to MBREF.

MBREF can come in a wide variety of forms. For SEE countries, micro financing and water investment credit lines for

commercial banks clearly appear suitable. Policymakers will need to familiarise themselves with and learn from experiences in other regions such as East Asia.

The benefits of measures that increase access to MBREF go well beyond enhanced investment in the water sector, and include improved performance and service delivery. Action is required from utilities and municipalities, and national governments have an important role to play. Where local stakeholders cannot be expected to move forward, national policy and regulation is needed.

For SEE countries there is scope for a decisive move from direct lending for projects towards backing credit lines for municipal infrastructure finance to financial institutions. ●

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The value of lost drinking water

Water utilities are starting to discover that they are sitting on a goldmine: more than a third of the drinkable water in urban areas leaks out of the distribution system, never reaching customers, and therefore is not being billed. **ASAF UNIE** reports on how as utilities embark on water loss reduction projects, an integrative approach adopted by some may be the best lead to follow.

When the average resident in one of the world's rapidly-growing cities turns on the tap for a glass of water, another, hidden tap is opened somewhere underground, leaking precious drinking water into the earth. In most urban environments, according to World Bank estimates, more than 30% of the water pumped through the distribution system is lost due to leakage, old infrastructure, illegal connections, the wrong water pressure, bad metering (or none at all) and a variety of other problems. This situation is neither financially sustainable, nor does it bode well for future generations' water supply and the environment.

Altogether, some 5000M.m^3 of potable water is lost each year through urban systems; enough to fill two million Olympic-sized swimming pools annually. Experts explain that the main problem with water losses is twofold: first, drinking water, which is becoming a rare resource in many areas due to population growth

Manila engineers repairing pipe line leaks

Manila Project Leader Roland Liemberger teaches a group of engineers some techniques out in the field

and climate change, is being wasted; second, cash-strapped utilities that need the income for maintenance and development are losing money around the clock. Globally, the value of lost drinking water, which experts call non-revenue water (NRW), is estimated to be around $18 billion annually.

One might assume all that cash would be sufficient incentive to encourage utilities to reduce NRW, but worldwide experience shows that the process is slow and more difficult than had been thought. Only a few governments or private utilities have so far tackled the problem seriously, though the number is steadily rising. In most countries, utilities belong to the public sector, and day-to-day problems often cloud the need for major infrastructure projects. Moreover, the utilities that do embark on expansive projects on their own often fail because they lack the know-how and experience to do them right.

Realising the problem, experts say, is the first step towards a solution. 'Until utility owners are sufficiently aware that they are "sitting on a goldmine", they will continually fail to incentivise or oblige their CEOs to take action,' says Roland Liemberger, who co-authored an influential World Bank report on the issue, titled 'The challenge of reducing NRW in developing countries'.

Mr Liemberger lives in Manila, one of the few mega-cities in the developing world in which the water utility, in this case a private concessionaire, has realised the financial potential of a NRW reduction project. Like many Asian cities, the capital of the Philippines has experienced a rapid rate of urbanisation and development over the last few decades. The western part of the city is one of the most densely populated places in Asia, with nine million inhabitants and still growing. Sustainable water practices are incredibly important not only to support the increasing demand for clean water but also for the water utility's survival.

'In 2007, before Maynilad [the western Manila water provider] implemented the project, a third of the population was still unserved and supplied only by private water tankers or from boreholes; Maynilad's NRW level was very high, at 67%,' recalls Mr Liemberger. In the five years since the project began, NRW has been nearly cut in half, saving more than 600MLD, providing two million additional people with access to running water and quadrupling the company's value, to around $2 billion.

'No utility has ever achieved such a massive water loss reduction in only a few years', says Mr Liemberger, who helped Maynilad to design and implement the project on behalf of Miya, a global water efficiency company that partnered with Maynilad for the ongoing NRW project.

But where Manila succeeded, other cities fail.

The complexity of reducing the NRW

'There is no right or wrong formula,' says Arjun Thapan, chairman of Waterlinks and former special advisor on infrastructure and water to the Asian Development Bank (ADB) president. 'A solution that fits one metropolis does not fit the other, and the right mix needs to be determined by experts.'

Mr Liemberger agrees: 'Much of the failure until now is due to underestimating the technical difficulties and complexity of NRW management. NRW is a complex and integrated problem and needs a complex and integrated solution.'

Another key problem is organisational. Both experts believe that one of the necessary steps is to establish a single body – whether public or private – and to entrust it with overall responsibility for solving the problem. 'You have to view water as a business,' analyses Mr Thapan. 'It doesn't matter whether it is managed privately or publicly, so long as the assets are owned publicly. The water issue needs to be corporatised if it's wished to be resolved.'

'Only if you make one party truly accountable for solving the problem you can be sure that you will get your "bang for the buck",' says Liemberger. 'Too often too many cooks spoil the broth, and at the end nobody is accountable and no results are achieved. This leads to frustration and utilities give up and don't make any more effort.'

In fact, some experts already see NRW reduction projects starting with high expectations, but ending up abandoned because of an incorrect approach. 'Despite abundant efforts by governments, international finance institutions, donors, water operators and research institutions towards NRW reduction, it is striking that in many cases the performance improvements in NRW tend to reverse with time,' says Jan Janssens, a former programme leader for the World Bank's Water and Rural Development programme.

The problem is not confined to the

developing world. In the US, where an estimated 23M.m^3 of fresh water are lost annually, most of the infrastructure is over 100 years old. Replacing all the pipes, as a crude way to eliminate water loss, would require a staggering investment of more than $400 billion. In the current economic situation, such investment is unrealistic and daunting, so the question of how to reduce water loss using a variety of methods becomes a global consideration.

Holistic is better

Utilities around the world are learning that a successful long-term NRW reduction programme is hard to implement. Even though problems are commonplace, solving them may require a variety of different measures, usually including some mix of water-pipe replacement, active leak detection, water pressure management, new metering devices and methodology, accompanied by public education programmes. But the exact recipe changes from one city to the next.

The right approach, as Manila and other recent examples show, may lie in choosing an integrative solution that balances the technical, financial and organisational parameters according to need in consultation with international advisors and expertise. 'Ultimately, what is required is the development of an array of technical, institutional, economic and managerial capacities,' declared the UN Water Decade programme on capacity development in 2011. More and more governments and utilities have adopted this approach recently instead of single large-scale projects such as overall pipe-replacement or building new water-treatment plants, which have proved to be highly inefficient.

One project that illustrates this holistic view began recently in the Bahamas. Because of high NRW levels, the Caribbean state loses around 20 million litres of water each day. The losses alone cost the utility almost $16 million a year. With the support of the government and the Inter-American Development Bank (IDB), the Bahamas Water & Sewerage Corporation began a ten-year comprehensive NRW reduction programme.

'Several solutions were tried over the years using internal and external resources,' said Glen Laville, the general manager of the corporation. 'Nothing made our network more efficient, because every action had its benefits and consequences. We finally determined that only an integrated, comprehensive approach that encompasses all aspects of network efficiency could solve the problems.'

Along with technical complexities, another key challenge is to understand the public dynamics of water issues. 'NRW reduction projects are usually not so attractive for local governments,' says Mr Thapan. 'They are smaller in nature and more difficult to undertake, because it means going into the network and fixing leaks. Some politicians will always prefer building a brand new treatment plant instead.' Yet it is inefficient if almost 50% of the water produced goes down the drain.

Financially, NRW reduction programmes lead to the highest return on investment in terms of both water and money. Castalia Consultants, a group that deals with infrastructure projects, recently compared the return on investment from NRW projects to water treatment plants. Their conclusion was that a litre of fresh water coming from a new treatment plant, 'is 2.5 times more expensive than a litre of fresh water coming from water-loss reduction programmes.' This is yet another example of why improving existing systems and conserving resources is the sustainable solution.

A recent NRW project undertaken by the São Paulo's water utility (SABESP) proved the financial potential of well-managed NRW reduction programmes. Aimed at dealing with NRW figures of more than 60% in the suburb town of Itapevi, the project covered the initial investment in only 17 months, increasing the water supply to the entire population and cutting NRW by more than half.

SABESP understood the financial potential of comprehensive NRW reform. Its current level of NRW is 26% and the utility has undertaken an ambitious ten-year programme to reduce NRW even further to 13%. 'We have learned through a number of successful NRW projects that this is the most sustainable and cost-effective way to optimise the existing network. The financial aspect has already proven itself,' said Gesner Oliveira, a former president of SABESP and currently a board member of Miya Brazil.

Mary Ann Dickinson, chair of the IWA Efficient Urban Water Management Specialist Group, says these kinds of projects have proven their value all over the globe. 'Utilities often fail when they cut corners on data collection and rely on their own inaccurate estimates, and when they don't budget the financial resources to get the job done in managing their leakage. It is all cost-effective management: the positive return on the investment can be easily documented.'

Ms Dickinson also believes NRW management projects send the right message to the public, especially in urban areas that suffer from water scarcity. 'Any water utility short on water supply must demonstrate to their consumers that they are, themselves, practising what they are preaching,' she says. 'While the average customer has little understanding of the mechanics of water loss management, they certainly understand the inequity of being asked to sacrifice their own water use when water is seen leaking from the network.'

The 'new oil'

As water is becoming a scarcer, more valuable resource, some analysts are calling it the 'new oil'. But the water issue is even more pressing than oil because, unlike oil, there are no other alternatives. Because of this, saving potable water is expected to move higher and higher up governments' agendas worldwide. Utilities will be under pressure to stop losing half of their produced water, repair hidden underground leakage and ensure a level of efficiency that is the norm for other resources.

Experience is expected to play a key role. 'Manila worked because NRW reduction became the flagship activity of the local utility,' says Mr Liemberger. 'It worked because of adopting a holistic view on NRW management and because the department dealing with it, which was established in the beginning of 2008, started with only five staff but grew to around 450 local engineers. It worked because there was sufficient funding, and last but not least because there was willingness to partner and learn from international companies and experts.'

This paper was presented at the IWA Regional Utility Management Conference: Improving Performance in Emerging Economies, held 13-15 May 2013 in Tirana, Albania.

About the author:
Asaf Unie is an environmental journalist invited by Miya to conduct an in-depth independent analysis of the water efficiency industry.

Veolia introduces WWT plant optimisation software and remote monitoring for contamination events

Engineers at Veolia Water Solutions & Technologies have developed a software package, OCEAN, which will help change current approaches to municipal wastewater treatment, says Veolia. The software will enable sewage treatment plants to generate energy, recover resources, and recycle water thus reducing reliance on fresh water supplies. According to Veolia, OCEAN can contribute to this by, for example, identifying energy-saving solutions and changing wastewater treatment from a net importer of resources into a net exporter.

OCEAN can calculate energy balances, sludge production and carbon dioxide emissions so that treatment options can be evaluated quickly and easily. The inputs to the software are the treatment process units, the design loads and the operating parameters. Using benchmark data collected from over 3500 Veolia municipal wastewater treatment plants, OCEAN constructs a plant model, including chemical consumption, sludge production, energy balance and carbon dioxide emissions. OCEAN displays these graphically so potential performance improvements and cost savings can be assessed.

Veolia's environmental monitoring unit has also been utilized at high profile events including Wembley Stadium during the London 2012 Olympic Games to identify in real time the introduction of contaminants in water networks. It is based on smart sensors which continuously collect data and transmit it to a secure central server through a modular communication system, via radio or GSM. 24/7 supervision is provided by Veolia experts who monitor and analyze streaming data. In case of an alert, experts identify the source and determine the accidental or intentional contamination of water. If abnormal changes in water quality remain unexplained, an alert is sent immediately to the authorities responsible for the event. This monitoring solution can be implemented on a temporary basis, in the case of major events, or permanently, wherever safety and operational safety of drinking water is essential, says the company. ●

www.veoliawaterst.co.uk

Siemens offers protection for redundant networks

Siemens' Industry Automation Division has developed a new security module, Scalance S627-2M, which is designed to protect automation networks from unauthorized access by means of a firewall. In this way, redundant network structures can be securely connected for the first time according to MRP (Media Redundancy Protocol) or HRP (High Speed Redundancy).

Scalance S627-2M is also equipped with three fixed electrical ports, including one secure and one DMZ (Demilitarized Zone) part as well as two slots for media modules, which can be optionally connected. As an option, the user can add up to two electrical or optical ports per

media module and thus integrate the security module directly in optical networks. Fault-tolerant connections can be realized by means of two Scalance S627-2M used in parallel. As soon as one security module fails, the second device is automatically activated from standby mode and takes over data traffic. ●

www.industry.siemens.com

Yokogawa to supply monitoring system for large-scale water distribution pipeline

Yokogawa Electric International has received an order from Sinopec International Petroleum Service Corporation (SIPSC) to supply the monitoring system for a large water distribution pipeline that the Saline Water Conversion Corporation (SWCC) is building in Saudi Arabia between the cities of Yanbu and Medina.

When completed, the new water distribution pipeline will stretch 610km from a seawater desalination plant in Yanbu to the city of Medina and its surrounding districts, and will be capable of supplying 709,000m^3 of potable water per day.

This order includes the FAST/TOOLS SCADA software and the STARDOM network-based control system for monitoring the pipeline, the PRM integrated device management software package for instrumentation monitoring and online diagnosis, pipeline leakage detection systems, and a telecommunications system. ●

www.yokogawa.com

DIARY

Efficient Water Workshop, Seminar and Exhibition
5-6 February 2013, Birmingham, UK
Web: www.watercourseevents.com

WASH 2014 - Water, Sanitation and Hygiene for Everyone, Everywhere
24-28 March 2014, Brisbane, Australia
Web: www.wash2014.com.au

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

Water IDEAS - Intelligent Distribution for Efficient and Affordable Supplies
22-24 October 2014, Bologna, Italy

Events in blue are organised or supported by the International Water Association