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Report sets out reform opportunities for Nigeria's State Water Agencies

Recommendations for reforms to improve performance of Nigeria's State Water Agencies have been set out in a report released by the World Bank.

With the country's largest water suppliers struggling to improve service provision in the face of rapid urbanisation, the report, 'State water agencies in Nigeria: a performance assessment,' by Berta Macheve et al, surveyed 35 of the 37 State Water Agencies. It found that many utilities are able to collect and report performance information, but that such reports need to be analysed at the federal level. 'It is necessary to institutionalize a federal performance benchmarking system,' the report states.

According to the report, the 35 State Water Agencies were able to connect some 1 million new customers between 2011 and 2013, but this figure was dwarfed by the approximately 9 million new urban dwellers during this time, meaning urban water coverage dropped by almost 3 percent, to less than 40%. 'At the current rate, within 10 years water coverage may drop below 30% and only 20% of urban residents will have a direct water connection,' the report states.

Around $6 billion needs to be invested over the next ten years to achieve universal water supply, or some $2.9 billion to connect all current municipal residents, yet 18 of the State Water Agencies have never had an investment project valued at more than $10 million. That there is the potential for users to contribute to this investment is supported by the fact that the national cost of water from alternative water providers is estimated at $650-700 million a year, which is four times more than the combined revenue of all the 35 State Water Agencies surveyed, notes the report.

The report's other recommendations include: closing the current information gap as a first priority; clarifying the corporate status of State Water Agencies, especially achieving true separation from State Governments; improving national and state tariff policy guidelines and regimes; reviewing tariffs for cost recovery and affordability; institutionalising metering of water production and consumption; preparing for the financing of future projects with input from State Governments; and for the possibility of a national water fund to be explored. ●

ADB to support Uzbek city of Djizzak

The Asian Development Bank (ADB) has approved a $81 million loan to support upgrade of the urban sewage and wastewater system in the city of Djizzak, Uzbekistan, in a move it says will help raise living standards, improve the environment and boost public health.

'Djizzak is a key driver of regional economic growth,' said Hao Zhang, Principal Urban Development Specialist with ADB's Central and West Asia Department. 'This project will give at least 85,000 residents and over 350 businesses access to clean water, and reliable sewage collection and wastewater management services.'

Djizzak is capital of the Djizzak Province and is a former Silk Road junction connecting Samarkand with the Fergana Valley in eastern Uzbekistan. According to ADB, the government recently approved a long-term development plan that will accelerate urbanization, expand some industries and relocate others, and attract foreign investment by establishing a special industrial zone.

To cope with an expected dramatic increase in the city's population, the project will carry out a massive rehabilitation of Djizzak's deteriorated wastewater and sewage system, which according to ADB was constructed in the 1970s and has been barely maintained since. This has resulted in serious environ-mental damage and public health threats, such as an alarming rise in acute intestinal infections and viral hepatitis.

Along with a new wastewater treatment plant, the project will construct or rehabilitate over 62 kilometres of trunk sewers and four pumping stations and provide support to operate and maintain the new facilities. By the time the project is completed in 2020, the system will be able collect and treat up to 30,000 cubic metres of raw sewage per day, and the pumping capacity will have been increased to more than 15,000 cubic metres per day from around 9000 cubic metres per day in 2013. ●

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Suez marks name change with strong half-year results

French group Suez released its half year results towards the end of July, reporting an increase in group revenues to the end of June of €404 million, up by 5.9% to €7295 million compared to the same point last year.

The Water Europe division saw revenues rise by €56 million at constant scope and exchange rate, and the International division saw revenues rise by €91 million. A favourable exchange rate impact accounted for much of the increase in the overall increase in revenue.

CEO Louis Chaussade commented after the release of the results that the board had approved the change of the brand name to Suez, 'a short, strong name and full of history'. 'This agreement completes the launch of our single worldwide brand. Since March, the 40 Group's trademarks are federated under a single brand positioned in the sustainable resource management, which is already bearing fruits,' he said.

Chaussade added: 'The "Water Europe" division reported strong performance, driven by higher volumes, prices and new services. The "International" division benefitted from sustained growth in almost all geographical regions and in all is businesses.'

In early September, Suez also announced that it had successfully completed placement of €500 million in bonds to mature in 2025. According to the company, demand for the bond had been six times greater than the offering, allowing the company to obtain its lowest 10-year coupon, at 1.75%. The company also noted that the placement was in line with its policy to refinance and extend its debt. ●

European Parliament votes for further Commission action on Right2Water

The European Parliament voted on 8 September in favour of a resolution urging action by the European Commission to take forward measures called for by the Right2Water citizens' initiative.

The European Commission is the body responsible for drafting EU legislation for possible adoption by the European Parliament and Member States. The European Citizens' Initiative is a means by which EU citizens can call directly on the Commission to draft proposed legislation if a minimum of one million signatures can be gathered in support of an issue.

Right2Water had been the first such initiative to gather the number of signatures needed – in fact attracting almost 1,900,000 signatures. The Commission set out its response to the Right2Water proposals in a 13 page communication issued on March last year. At the time, Right2Water's vice-president Jan Willem Goudriaan comment: 'The reaction of the European Commission lacks any real ambition to respond appropriately to the expectation of 1.9 million people. I regret that there is no proposal for legislation recognising the human right to water.'

The European Parliament's response levels a number of criticisms at the Commission and calls for a range of actions. The European Parliament says the Commission's 'alleged neutrality' regarding water ownership is in contradiction with the privatisations imposed on some Member States by the Commission, European Central Bank and the International Monetary Fund. It says that the Commission 'should remain neutral' and not promote privatisation of water services in any way. To this end, the European Parliament document adds that production, distribution and treatment of water and sanitation services should remain excluded from the Concessions Directive.

Among the many other proposals in the European Parliament's response, it urges the Commission to ensure quantitative assessments of water affordability become mandatory in any revision of the EU Water Framework Directive.

Private water operator federation AquaFed commented: 'The choice of "technical" operator must be made by the public authority that remains in control… While some intended to exclude the choice of the private sector option from the range of solutions, the Parliament recognised the positive contribution of all operators including the private sector. ●

i2O recruits for pressure expansion

Uk-based smart pressure management technology company i2O Water has announced the appointment of Keith Hilson as its new Head of Customer Solutions.

Hilson will work with the company's water utility customers around the world to help them meet their leakage, burst reduction and customer service targets. The company announced that he will oversee development of i2O's new products and service delivery models as well as leading its international sales and marketing teams.

Hilson was previously with metering company Sensus, where he was responsible for the company's pre-sales work. Prior to that he was Head of Leakage at water utility South East Water, where his team made wide use of data and pressure management technologies to reduce leakage and help deliver significant operational and environmental savings. This work included specifying use of the i2O system.

The i2O smart pressure management technology is currently used by 66 water utilities around the world, and the company recently secured £8 million in funding to further develop its solutions. ●

The use of the Infrastructure Value Index to communicate and quantify the need for renovation of urban water systems

Urban water systems continue to accumulate renewal deficits. One of the key bottlenecks for a change in policy, mindset and practice is communication. Communication difficulties exist within utilities and between stakeholders. There is a need to convey that if considerable investments in renovation are not made at the present time, and consistently over the years to come, we are preventing our children and grandchildren from full access to the services that current modern societies take for granted. The TRUST project provides paths forward, and one of them is the focus of this paper – the concept of IVI (Infrastructure Value Index) and a software tool to assist in awareness creation, assessing the long-term impact of renovation policies and assist in stakeholders' negotiations. By Helena Alegre, Diogo Vitorino and Sérgio Coelho.

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Urban water systems continue to accumulate renewal deficits, in spite of the efforts made in recent years in terms of awareness, scientific and technological developments, capacity, and renovation itself.

Ample evidence has been provided by reports published in both developed and developing regions. In the USA, for example, the ASCE 2013 Report Card For America's Infrastructure gave America's drinking water and wastewater public infrastructure a D (poor) in an A-to-F grading scheme. Even countries where the quality of the buried networks is a reference worldwide, such as Germany, face difficulties and pressure from the media. "Germany is collapsing" was the headline of a recent, admittedly provocative article by Bartek Starodaj in German news magazine Der Spiegel that criticized "(…) the sorry state of Germany's infrastructure" (www.policyreview.eu/germany-and-the-usa-are-falling-short-on-infrastructure-investment).

When looking for an explanation, economic constraints provide the easy answer. Policy makers and utility CEOs argue that budgets are limited and that they cannot afford the investments needed to compensate for the existing renovation gaps. However, whenever a budget is limited, choices have to be made. Out-of-sight, taken-for-granted, long-lasting infrastructures, when not failing at pace or with consequences that attracts media attention, are at the bottom of society's priority list, and consequently of central and local governments. Therefore, the issue is to understand and communicate the severe consequences of the current policies, in order to create awareness and change priorities.

Internal and external communication

One of the key bottlenecks for a change in policy, mindset and practice is communication, internally to the organizations and among stakeholders. This has been recognized in recent events on infrastructure asset management (IAM), such as in the closing session of LESAM 2013 (IWA & AWA, Sydney) and in the IAM Forum held during the World Water Congress 2014 (IWA, Lisbon); as well as in publications such as AMQI (2014).

Internal communication challenges increase with organizational complexity. The high degree of technical specialization and the busy schedules of most professionals may contribute to a more difficult and less frequent dialogue among colleagues. Silos are naturally created between management processes and between utility departments. Spiraling miscommunication is naturally created: the less interaction among professionals, the less they know about each other's activities and understand each other's professional language, and the less they interact. A similar problem occurs between decisional levels. Mid-level technical managers often complain about the

At the dawn of the 21st century, much of our drinking water infrastructure is nearing the end of its useful life. There are an estimated 240,000 water main breaks per year in the United States. Assuming every pipe would need to be replaced, the cost over the coming decades could reach more than $1 trillion, according to the American Water Works Association (AWWA). The quality of drinking water in the United States remains universally high, however. Even though pipes and mains are frequently more than 100 years old and in need of replacement, outbreaks of disease attributable to drinking water are rare.

2013 Report Card For America's Infrastructure
ASCE www.infrastructurereportcard.org

Annual capital gap for water infrastructure in the USA (billions of 2010 US dollars)

Year	Spending	Need	Gap
2010	36.4	91.2	54.8
2020	41.5	125.9	84.4
2040	51.7	195.4	143.7

Source: ASCE (2011)

PLAN	Compare & decide. A decision-support environment where planning alternatives or competing projects are measured up, compared and prioritized through objectives-guided metrics	
PI	Performance Indicators. Quantitative assessment of the efficiency or effectiveness of a system is provided, through the calculation of performance indicators. A tool for selection and calculation of kPI based on organized libraries, including industry standards (IWA) and user-developed libraries.	
FIN	Financial project. Assess the net present value (NPV) and the investment return rate (IRR) of any financial project from a long-term/ asset lifecycle perspective.	
NETW	EPANet Network Modeling. An efficient, Java-implemented EPANet simulation engine and natively integrated MSX library for full-range hydraulic and water quality network simulation, with advanced 2D/3D visualization and Google Earth integration.	
FAIL	Failure analysis. Using system component failure records, such as work orders, predict present and future probability of failure of pipes or sewers.	
CIMP	Component Importance. Simulate the failure of each individual pipe in a water supply network to measure its hydraulic impact on nodal consumption.	
UNMet	Unmet demand. Quantify water supply service interruption risk through the expected reduced service, calculated as the volume of unmet demand over a given period.	
PX	Performance Indices. Technical performance metrics based on the values of certain features or state variables of water supply is provided. Simulation-based tool provides detailed technical performance assessment, related to capacity, level-of-service, network effectiveness and efficiency, water quality and energy system behavior.	
IVI	Infrastructure Value Index. Analyze the ageing degree of an infrastructure as a ratio between the current and replacement values of its components, and project short- and long-term investment needs.	

Table 1
Tools offered in the TRUST/AWARE-P software platform

lack of understanding that their top managers – often elected politicians or managerial executives without a background in urban water services – have of the existing problems and of solutions to solve them. On the other hand, top managers are often faced with investment proposals, presented as crucial by their staff, but without a convincing rationale and expressed in terms that non-experts cannot fathom. Accountability and justification perceivable by users, shareholders and other stakeholders is almost always lacking.

Poor external communication is also a major obstacle to good governance. Expert jargons are often used in meetings and reports, which are not perceived by people with different backgrounds. How to convey the need for …

… investing in renovation of existing infrastructures at an adequate pace, when the lack of renovation does not have a short-term impact on the quality of service to users?

… rejecting investments with an obvious short-term impact on the population in favor of investing in something that not visible and has no perceivable short-term benefit?

How to transmit that if considerable investments in renovation are not made at present and years to come, we are preventing our children and grand-children to have access to the services that current modern societies take for granted? Media initiatives such as Last Week Tonight with John Oliver: Infrastructure (HBO) (published 2 March 2015) may help, but they need to be accompanied by a change in culture, attitude and forms of communicating by water utilities.

How long is long-term?
Is life cycle approach applicable to a public infrastructure as a whole?
What is better for the service: concentrated investments or continuous renovation over time?
Are we renovating our assets at the right rate?
Are prevailing project financing and PPP contracts adequate for indefinite live infrastructures?

Or, more importantly than all:

How much and when are my renovation needs?

The TRUST project, infrastructure asset management and communication

Much has still to be done with this regard. Some steps were accomplished within the European Research project TRUST (www.trust-i.net). In parallel to technologies and analytical tools, TRUST results include an objective-oriented approach to infrastructure asset management, the TRUST/AWARE-P IAM approach, designed to support a continuous improvement management process (Alegre et al. 2015). It is an outcome-oriented IAM planning for long-term sustainability, embedding key ISO 55000 requirements. Above all, TRUST/AWARE-P is a transparent, defendable planning methodology to support the identification of problems and in the comparison and selection of alternative solutions. This is fundamental for good communication.

The TRUST/AWARE-P software platform offers a growing and customizable number of tools (baseform.org), summarized in 1. Two of these tools were developed within the TRUST project, and are the most instrumental for internal and external communication: PLAN and IVI.

The focus of this paper is IVI (Infrastructure Value Index). The following sections introduce the concept, explain the rational of the tool and exemplify uses as a communication and negotiation support tool.

The concept of IVI

Managing water systems, here designated as IAM, faces the challenge of dealing with assets of very different nature, useful life and cost. Typically, utility managers inherit an infrastructure with assets in diverse conditions and stages of their life cycle. They are expected to manage their value in order to ensure a service of adequate quality, and make sure that what they pass on to their successors is capable of continuing to do so. Due to the indefinite life of an urban water infrastructure as a whole, a classical life cycle approach is not directly applicable – only to the individual assets. Instead, long-term planning is needed, embedding the life cycle of the individual assets without losing sight of sustained and sustainable service provision.

The Infrastructure Value Index (IVI) is the ratio between the current (fair) value of an infrastructure and the replacement cost on modern equivalent asset basis (Alegre, 2008), as stated in (1):

$$\text{Infrastructure Value Index (\%)} = \frac{\text{Infrastructure Current (fair) Value}}{\text{Infrastructure Replacement Cost}} \quad (1)$$

The Infrastructure Current Value would be, in a competitive market activity, its market value. In a monopolistic activity, as in urban water services, alternative valuation

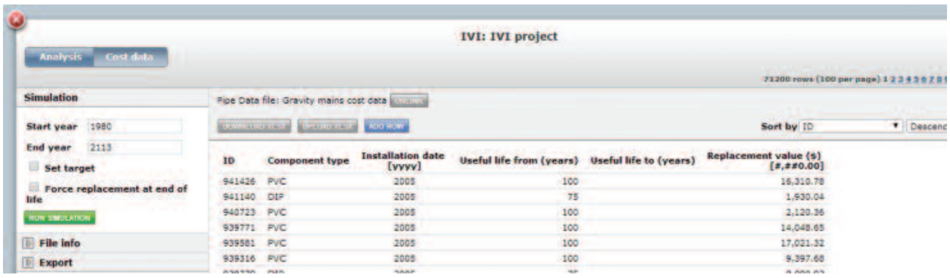

Figure 1
Input data for the IVI tool

approaches must be adopted. One possibility might be the use of the accounting value. However, this option is not recommended for multiple reasons, as discussed in Alegre et al. (2014).

The Infrastructure Replacement Cost is the expected cost of a modern equivalent if the infrastructure were built at the year IVI refers to.

IVI shall refer to a specific date, as it changes over time. It can be assessed in several different ways, derived from two main families, as discussed in Alegre et al. (2014):

- Asset-oriented: Calculation is based on the useful life of each asset, on depreciation curves and on replacement costs for each category of assets;
- Service-oriented: Calculation is based on the performance of functional units of the infrastructure.

Whenever an asset-oriented strategy is applied, IVI may be determined considering the individual contribution of each asset (2):

$$IVI(t) = \frac{\sum_{i=1}^{N} fv_{i,t}}{\sum_{i=1}^{N1} rc_{i,t}} \qquad (2)$$

where: t : reference time; $IVI(t)$: Infrastructure Value Index at time t; N : Total number of assets;
$rc_{i,t}$: replacement cost of asset i at time t ; $fv_{i,t}$: fair value of asset i at time t.

IVI is a standardized measure of social responsibility. The IVI of mature, well-maintained infrastructures is in the order of 50% (45% - 55%). Lower values mean that the current generation is accumulating a debt to the coming generation and putting into risk the service provision. Higher values, pointing towards infrastructure youth, are only apparently good. In reality they mean that in the medium or long-term high levels of investments for renovation will be needed in a concentrated way. Ideally, the renovation needs and the corresponding investment made should be evenly distributed over time. IVI is a long-term planning index and aims at assisting stakeholders understand, communicate and negotiate rehabilitation policies and associated investments.

The TRUST / AWARE-P IVI tool: objectives, root assumptions

IVI Tool objectives

Based on data that can be either detailed (asset by asset) or simplified by cohort, the IVI tool assesses the IVI, the capital needs and the remaining percentage of "living assets" (i.e. assets that did not reach the end of their useful lives) over time. It encourages the users to carry out sensitivity analysis to rehabilitation rates and policies, to planning horizons and to useful lives estimates. It can accommodate both AM of linear assets and of vertical assets, although the utility implementations so far have been mainly for linear assets. Its application to equipment and assets for which useful lives can be defined is straightforward. Assets such as civil works, subject to renovation interventions that prolong their lives indefinitely, is a matter currently being worked out, still marginally implemented in real situations.

The development of the IVI tool had the following objectives:

1. Assess IVI evolution over time;
2. Assess capital needs for renovation over time;
3. Assess the percentage of assets (in terms of replacement values) that did not reach the end of its useful life, as a proxy of the quality of service provided;
4. Be easy to use;
5. Be applicable to cases where detailed information exists on the assets, but also to cases where limited informa tion exists;
6. Accommodate both linear and vertical assets;
7. Accommodate assets of different nature (e.g., water, wastewater, storm water), different replacement values and different useful lives;
8. Be based on and easy to understand rational, even for non-experts;
9. Allow for sensitivity analysis to the main parameters used;
10. Produce easy to understand outputs.

The first version of IVI, developed prior to TRUST, could only respond to objectives 4 and 7. Implementation in real cases showed the need to fully rethink and redesign the tool. The utilities' response to the new version has been very encouraging.

Simplification options resulting from the objectives

There is a major difference between complexity and accuracy. There is a major difference between being simple and being simplistic. The IVI was developed in order to be as simple to use and interpret as possible, without becoming simplistic. Some options made are often object of discussion by scientists and researchers. This section presents the most relevant options made and, when applicable, some frequent questions raised.

Replacement cost: the implementation of the current value of an infrastructure in the IVI tool assumes that the replacement and the current values of the infrastructure may be assessed as the

Figure 2
Screenshots from the TRUST deployment

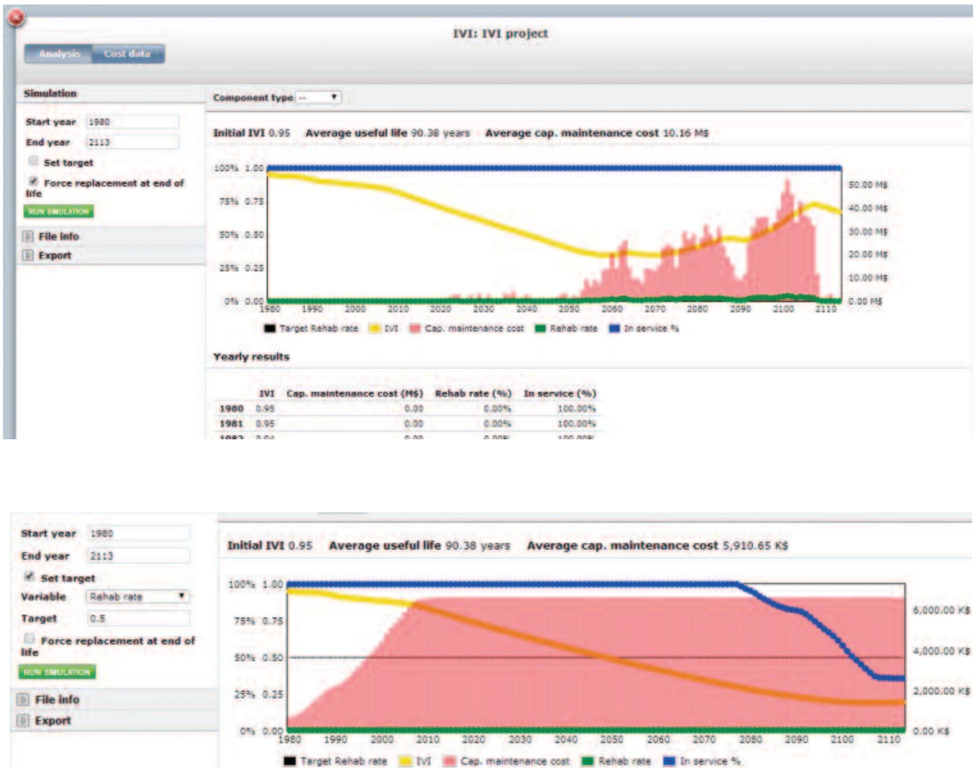

Figure 3
IVI tool output for a large network described in detail

Strategy 1: replacement at the end of assets useful life

Strategy 2: rehabilitation rate = 0.5 % per year

sum of the values of its components. To allow for flexibility, the software has just a column with the replacement cost, without any calculations included. Users are free to assess the replacement cost of an asset or a group of assets as they consider appropriate. Import / export from Excel allow to easily customizing calculations as appropriate. This option results from experience. Different utilities assessing IVI manually used different approaches. Although general guidance is provided (e.g. use costs of modern equivalent; use average replacement and renovation market values instead of historic book values), context may dictate different procedure and the application would became either too complex or too restrictive if the replacement cost calculations were included.

Useful lives: users may specify a single value (e.g. 60 years) or a range (e.g. 50-60 years); if a range is specified, corresponding cohorts are uniformly distributed, processed as a uniform distribution by the software. Given the random nature of failures, it has been often suggested that the IVI tool accepts a statistical distribution instead. This suggestion is not taken on board for one main reason: useful life is a very loose concept. Assets, and particular constructed assets as pipes and civil works, do not "die". There useful life stops when they no longer fit for purpose due to its condition (e.g. leaks, structural resistance), capacity, ease of operation and maintenance, etc. Statistical studies on past history may easily create bias. The use of sophisticated statistical functions often provides a false appearance of higher accuracy, while adding complexity and reduces transparency to the tool. The option is therefore to keep a very simple rationale that easily allows to carry out sensitiveness analysis on the impact of adopting different useful lives. The IVI tool is not designed to support detailed analysis of what, when and how to rehabilitate each asset. It is a long-term planning tool, to be at an aggregated value.

Current value: the implementation of the current value of an infrastructure in the IVI tool assumes simplifications resulting from careful analysis of pros and cons. The current value of an asset (or cohort of assets) is calculated as the replacement value multiplied by the percentage of residual life. Actual condition, if known and different from the average for the cohort, may give place to adjustments in the useful lives specified. A linear depreciation is adopted. Utility users report back that these simplifications are reasonable. Potential features accommodating, for instance, non-linear depreciation rates (e.g. bathtub curve functions) would once more give a false impression of accuracy and would reduce simplicity and ease of communication between technical and non-technical stakeholders.

Parameters to run the simulations: users can easily change some parameters during the analysis and stakeholders discussions at any moment. This includes the period of analysis, the possibility to simulate what happens if replacement at the end of useful life systematically occurs and the possibility of setting a target in terms of IVI, annual replacement rate and annual investment for renewal rate. These features resulted from suggestions from users of the first generation of application and are proving to be rather effective in terms of communication.

Data input

Data input (Figure 1) is a table with as many lines as needed and columns with an (asset or cohort) ID; a description of the component type (that may be used to filter the results per component type; installation date; useful life (one single value or a range); and the replacement costs. Although all data can be loaded directly and manually in the IVI tool, import from / export to MS Excel allows users to prepare or modify the input files quicker and more easily.

Software implementation

The IVI tool is implemented in the TRUST deployment, web-based, available for all TRUST partners. However, it is also available in the AWARE-P Suite Community Edition (baseform.org) that can be used in its web-based form in AWARE-P Trial, or can be downloaded and used locally. Corporate versions are also available under a licensing scheme.

Table 2
Example data for a simplified use of the IVI tool

"Cement town"							
Material (% per decade)	% mains per installation decade					% of network length	Useful live
	before 1975	1985 - 1995	1995 -2005	2005 - 2015	Total		
Asbestos cement		100			100	60	50
Ductile Iron	50	50			100	10	55
PVC			50	50	100	30	80
						100	
Total mains length (approx.)	200	km					
Linear replacement cost	2000	MonUnit / m					
Peri-urban area							
PVC			50	50	100	60	70
HDP		30	70		100	35	50
Cast Iron	100				100	5	50
						100	
Total mains length (approx.)	100	km					
Linear replacement cost	800	MonUnit / m					

Examples with detailed and simplified data

If complete detailed inventories exist, an all of assets input data for IVI can automatically be generated and used. Figure 3 shows an example with 71,200 pipes of a gravity sewer system. It might represent a higher diversity of assets, including for instance water and wastewater, linear and vertical assets, equipment and civil works. Replacement costs were estimated by the utility based on diameters and replacement materials (modern equivalent material). The pink columns represent the annual investment in rehabilitation. The yellow line is IVI, and the blue line the percentage of the system that did not reach the end of the useful life yet.

In an ideal world, Figure 3a (replacement at the end of assets useful life) would show a flat yellow nine at 0.5 and a constant capital maintenance (pink columns). Instead, we have a declining IVI (that will presumably cause deterioration in the quality of service), some decades without investment needs, and afterwards some decades of very intensive investment in capital maintenance. To smooth the curve of investment needs, constant rehabilitation rates might be considered (e.g.: Figure 3b). In this case the alternative devised does not totally respond to the problems occurred and after 2080 it will be needed to increase rehabilitation rated.

If detailed inventories do not exist or the information is not easily available to use, cohorts can be easily used as input date of the IVI tool. The example in Table 2 corresponds to a real case of an African town, where two main areas in town exist: the so called "cement town", corresponding to a more classical urbanized area, and a peri-urban area, of informal housing and slums.

The outputs in Figure 4 show a higher granularity (thicker columns), but in any case rather useful to call the attention for the needs of investments needed in some years, and for rapid decrease in service (many assets beyond its useful life) if these investments are not made. The life discussion generated around these two graphics and other simulations carried out by the stakeholders demonstrated the value of this tool for creating awareness, facilitating communication and assisting in negotiation and consensus-building.

Conclusion

Communicating the needs for investing in renovation of urban water systems at a level that ensures long-term service sustainability is a battle still to be won. Simple-to-use and understandable methods and tools are needed. This paper presents IVI and a software tool, developed under the TRUST project and already broadly used by many utilities, that helps responding to this need. ●

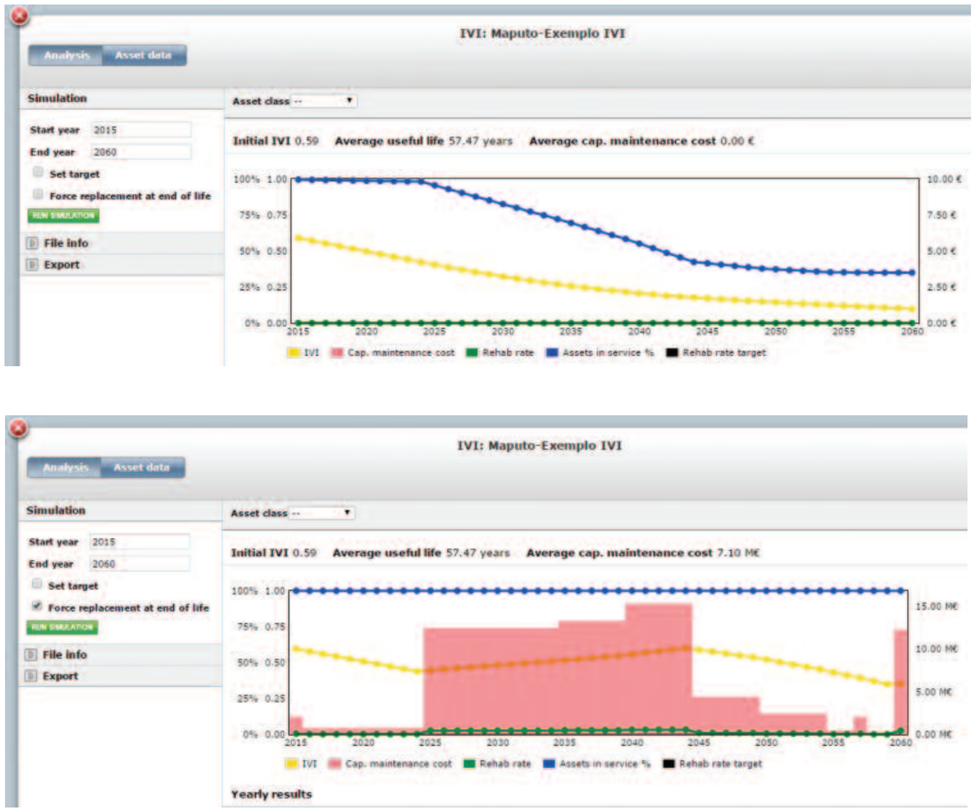

Figure 4
IVI tool output for a large network described in a simplified way

a) Strategy 1: No investment for rehabilitation

b) Strategy 2: replacement at the end of assets useful life

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Energy efficient water supply systems in Albania: moving from energy scans and cost-benefit analysis to the planning, implementation and management of energy efficiency water infrastructure in Albania

Many Albanian water and sewerage utilities have energy costs that make up 30-40 % of their direct operating costs, in several cases even well above 50%. Energy scans and cost-benefit analysis conducted in 14 out of 58 towns have revealed that existing pumping systems often have efficiencies that are well below 50% of a comparable new system. This is due not only to the age of the pumping systems, but also because the systems have been designed and built for purposes different to those they are being used for today. Considering the high proportion of energy costs in the operations along with the low efficiency of existing systems, it is clear that there is a considerable need to improve the use of energy in water and waste water service provision. Efficient use of energy is an important factor to ensure the sustainable use of resources and is also a key ingredient when it comes to the provision of affordable and cost recovery water and sewerage services. Fridtjof Behnsen, Pirro Cenko, Kastriot Shehu and Piro Ndreu outline economically-viable investments and practices to achieve this aim.

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Skenderberg Square, Tirana, Albania (Credit: Fridtjof Behnsen)

Despite the fact that Albania is blessed with abundant water resources, the sector is facing significant challenges in terms of providing safe, affordable and sustainable drinking water and sewerage services. The current challenges are perhaps best explained by looking at some key facts that highlight sector performance (Water Regulatory Authority, 2013 Sector Performance Report):

- On average the municipal utilities only supply water for about 12 hrs/day and in 2013 only nine out of 58 utilities were able to provide regular services of more than 20hrs daily (the target is for all utilities to provide more than 20hrs daily service by 2017)
- Average Non-Revenue-Water (NRW) for all utilities stands at 68.1% (the target is for less than 40% NRW by 2017)
- In 2013, only 18/58 utilities were able to meet their direct operational costs (target: all utilities need to meet their operational cost by 2017)

Energy efficiency

In their efforts to cover all operational costs many utilities struggle with the often old, poorly maintained and amortised pumping systems, (that is, the system comprising pumps, motors, suction and transmission mains and reservoirs). As a result many utilities

Figure 1 Overview of Albanian towns covered by GIZ energy scans

have energy costs that account for 30-40% of the direct operating costs, and for some utilities this goes beyond 50% as in the case of Durres at 56%. The situation with the dilapidated condition of many pumping systems was confirmed in 14 of the 58 towns through energy (system) scans in 2014. The results are documented in cost-benefit-analysis, and by mid-2015 scans of a further six utilities will also be completed (see Figure 1).

With many utilities currently unable

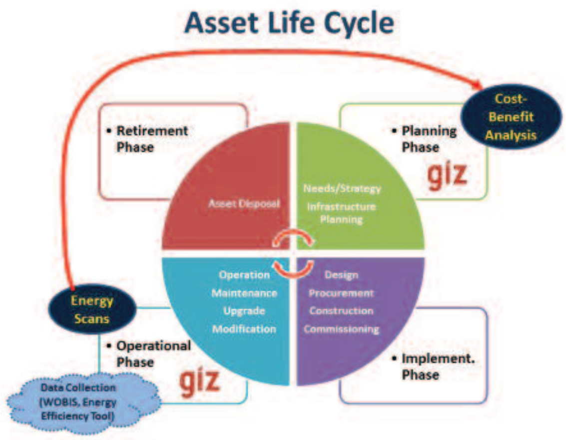


Figure 2
Energy Scans in relation to the Asset Life Cycle

to meet their operational costs, significant electricity arrears are regularly accrued. As a result the government of Albania has repeatedly provided energy subsidies over the years to clear arrears with the electricity distribution company on behalf of the utilities, i.e. about €20 million ($22.6 million) in 2014 and a further €45 million ($50.8 million) in 2015. These subsidies, however, were merely payments of arrears and did not carry any conditions for utilities to make necessary investments and/or necessary changes at the operational level to counteract a future build-up of new electricity arrears.

The energy scans and cost-benefit analysis completed to date come to the conclusion that most of the existing pumping systems that have been visited only attain efficiencies generally below 50% of a comparable new system, resulting in high energy inputs for the water produced.

Knowing that the reported operational data from utilities is generally inaccurate (for instance only about 25% of the water production is measured by bulk meters, and the rest is estimated), the overall use of electrical energy in the water sector probably ranges between 12-15% of the billed energy consumption (excluding water heating). There are hundreds of smaller communal schemes not included in this figure.

Also, and as a direct result of the intermittent water supply and resulting

In 2013 utilities reported to have used 173 Million kWh to pump 160 million m³ of water. This results in a unit energy input of about **1.1 kWh/ m³** and represents **5%** of the overall billed energy consumption in Albania.

low network pressure, very many private households and businesses in Albania have in-house water pumping systems and storage facilities to cope with the erratic supply situation. This means that a very significant proportion of the Albanian energy demand is due to water and sewerage service provision, services that are characterised by many inefficiencies that have significant potential for improvement.

Energy optimisation

In addition to the low energy efficiency of existing pumping systems, the utilities also face a significant challenge in terms of energy optimisation in their networks. Many of the systems operating today are rather old, with largely amortised assets. In addition, these systems were originally designed for different purposes when they were constructed. This leads to a situation where some key assets like reservoirs are not located in the ideal place, or are not matched to the volumes of water that need to be provided.

As a result, reservoirs are quite often sited at high levels that don't allow for the efficient use of energy for pumping. These reservoirs would better be at lower elevations that are better suited to providing adequate supply pressure in the networks. Transmission mains are too small, resulting in high flow velocities that lead to higher friction losses and the need for bigger pumps.

These are major contributing factors to the very high NRW figures in Albania, which currently stands at a sector average, according to sector benchmarking data, of about 68%. A large part of these losses is due to technical losses incurred through leaks and bursts in the transmission and distribution networks. In the case of pumped supplies, this means a lot of energy is being used to produce water that is lost before it is consumed and therefore does not generate any revenue for the utilities.

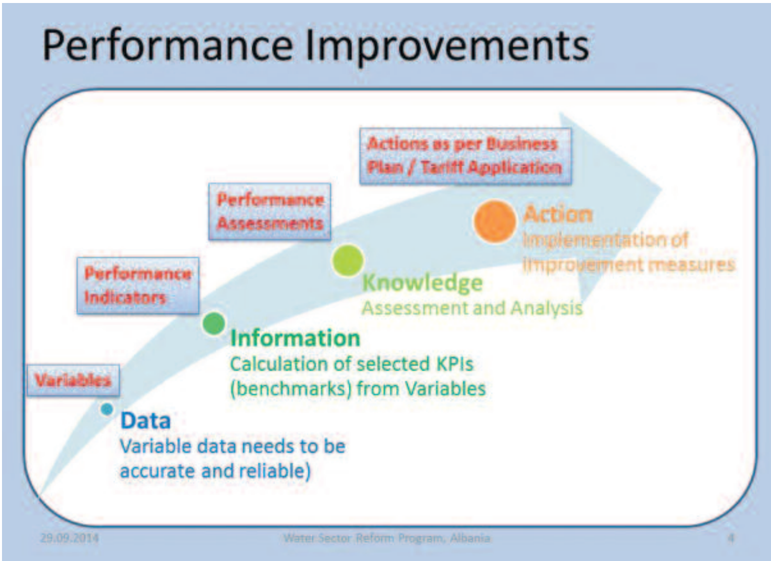
So in addition to new pumping systems with efficient pumps and motors (that is, energy efficient), a reduction in the very high levels of NRW through energy optimisation is required to ensure better use of energy and a significant reduction in the amount of water that needs to be pumped. Many of the supply systems visited do not have operational network zones or any pressure management, maintenance plans or operational plans in place. This further increases the losses.

Future use of energy scans and cost-benefit analysis

To systematically improve the energy efficiency of pumping systems in Albanian water and wastewater utilities, the following 10-step approach was defined from initial data capture, energy scans and cost-benefit-analysis to finally implement measures and monitor the performance of investments. This approach is similar to that found in guidelines such as the EPA Guidelines for Energy Management for example:

In 2013 the 58 municipal utilities reported to have produced 273 million m³ from pumped and gravity fed sources, serving approximately 2.5 million people in the respective service areas. This volume equates to a per capita production of 300 litres/day. This is in contrast to the average per capita consumption of 150 litres/day.

Figure 3
Performance improvement logic



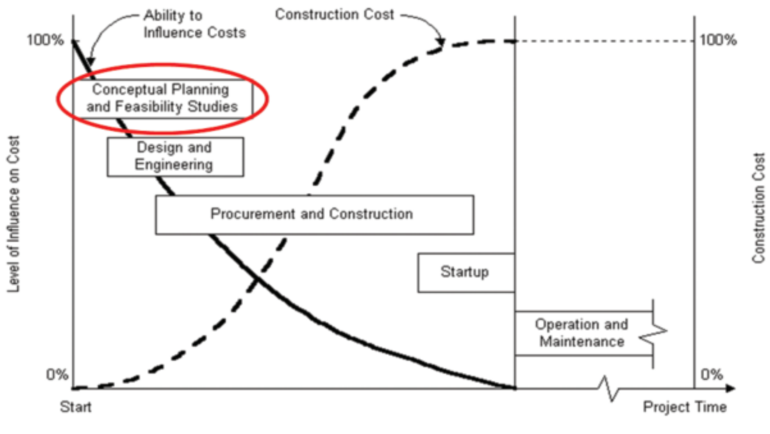


Figure 4
Ability to influence the costs of infrastructure projects along the project development process

- Define main challenges (objectives)
- System information (data capture - system)
- Operational information (data capture - operations)
- Situation assessment (energy scans)
- Technical options (cost benefit analysis)
- Feasibility study
- Secure funding
- Detailed design/tender documents
- Project implementation/ commissioning
- Monitor and communicate outcomes

The work done under the Water Sector Reform programme, a technical assistance programme funded by the German government and implemented by GIZ (Gesellschaft für Internationale Zusammenarbeit), only dealt with steps 1 to 5 of the above approach, that is, energy scans/cost-benefit-analysis. The design and implementation of actual infrastructure measures to mitigate some of the problems was not part of the mandate of the programme. This, however, leaves the question of what can be done with the valuable findings and analysis. How can the Albanian water sector use the findings and recommendations in order to deal with the situation in the sector?

Asset life cycle

With the water sector in Albania responsible for an estimated 12-15% of the billed electricity consumption, and at the same time operating many inefficient pumping systems and water supply networks with multiple operational challenges, isolated improvement measures by some water utilities will not have sufficient impact for the necessary long-term change to provide sustainable and improved service delivery in Albania. There is considerable energy saving potential in the sector that requires energy efficiency as well as energy optimisation measures.

To systematically tackle the challenges it is suggested that utilities focus on the asset life cycle approach depicted in Figure 2. The initial data capture (system and operational data) that led to the energy scans were carried out in the operational phase of the cycle for the existing water supply systems. The results obtained from these operational assessments are documented in the form of cost-benefit analysis, which needs to be considered in the planning phase of the cycle to ensure future infrastructure is energy efficient.

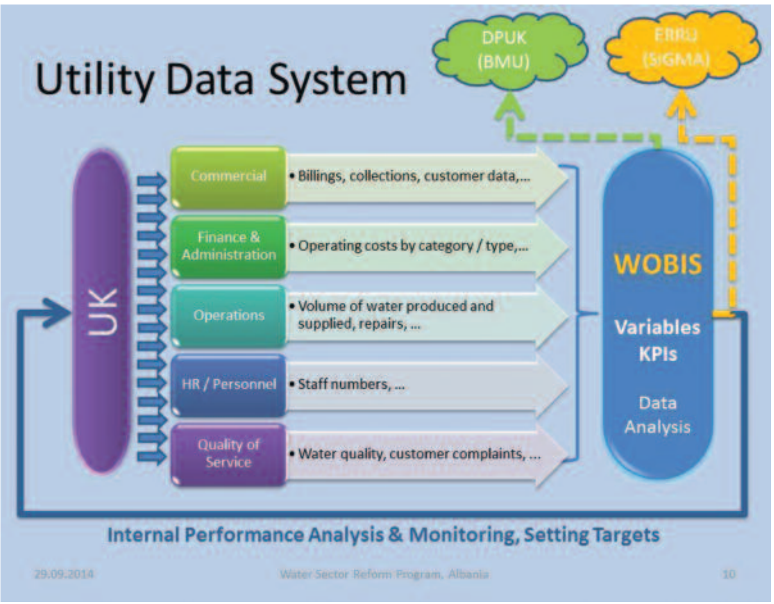


Figure 5
Schematic of the WOBIS System

Life Cycle Costs for pumping systems have shown that 5% of the overall costs are due to the investment cost for the implementation and 10% for the maintenance costs over the life time. However, 85% of the costs that a utility incurs from a pumping system are related to energy costs. Therefore, using more expensive energy efficient motors pays off over the life-cycle and ensures lower operating costs.

Planning phase

For the planning phase the National Strategy of Water Supply and Sewerage (2011-2017) provides clear guidance on the kind of service that shall be rendered by water utilities in Albania by 2017. The main aspects that to be highlighted in this paper are:

- A 24 hour supply with adequate pressure
- A supply with good quality potable water
- Affordable water and sewerage services for the end consumers
- Sustainable services (economically and environmentally), that is, services that attain operational cost recovery and at a later stage total cost recovery

To check whether utilities in Albania are moving towards attaining these sector strategic targets, a system of performance indicators has been in place since 2008. This system has been collecting relevant operational data from utilities over the years and it is used to calculate sector specific Key Performance Indicators (KPIs).

However, so far this data is mainly being collected to calculate the respective KPIs that are reported in the sector. The information from the KPIs is not turned into actual knowledge often enough through assessments, and that knowledge used to define clear actions as depicted in Figure 3.

More effective performance assessments are needed at the operational, regulatory and policy levels. If such assessments are made effectively against the sector strategy targets, for example, they can be used to define management actions to address shortfalls and trigger necessary investments. This could include decision making on subsidy allocations to utilities as well, based on performance.

From the operational/system data capturing that was undertaken for the energy scans it has become clear that in many cases the data at the utility level is either not (readily) available and is

A single leak from a 6mm-hole in a water distribution pipe or transmission main, operated at 5bar pressure, will lose about 40-45 m^3 of water per day. This amount of water could fill an Olympic size swimming pool with a capacity of 2500m^3 in 2 months. With an assumed water production cost of 0.3 **€**/m^3 this single leak will cost a utility almost **€**5000 annually

also often not accurate or reliable. But unless the data variables are correct and accurate, everything else will not represent the actual situation on the ground, which will lead to erroneous assessments.

To achieve this aim, WOBIS (Water Operational Business Information System) was developed to assist the utilities in capturing key operational data variables on a monthly basis and using them to calculate selected KPIs. Thus the utilities are put in a position to monitor progress on a monthly basis such that they can see if operational improvements are being made that lead toward attaining the envisaged KPI targets.

Based on the data collected for the energy efficiency assessments, the cost-benefit analyses that have been prepared generally outline economically-viable measures in the 14 utilities, looking at investments with a simple payback period generally in the range of two to five years.

Implementation phase

For the implementation phase it is vital that the recommendations from the planning phase are based on sound assessments using valid data. It is at the planning stage of any project where the biggest opportunity exists to influence the final costs of new infrastructure as depicted in Figure 4.

If the planning is wrong from the start, this could well lead to inefficient infrastructure with high operating costs. Therefore it is important that for pumping systems, for example, professional pump selection software is used to determine the most suitable pump/motor for the pumping system (for the transmission main). This also means that the impeller diameter of the pump has to be matched to actual operating conditions, and if the demand in the supply area varies a lot, variable speed pump sets should be considered. Finally the use of energy-efficient IE3 motors has to be considered, and appraisals of different technical options need to consider the full life-cycle cost to ensure that operational costs are properly considered.

Since NRW is such a big issue in Albania, a special focus needs to be put on improving the water supply networks. First, the capacities of existing networks have to be checked against realistic demand scenarios. During the energy scans it was found that many transmission mains for example were operating with flow velocities that were far too high. Undersized pipes lead to excessive head losses and require large pumps and motors to transport water to the reservoirs. This uses a lot of energy, and could be remedied by providing additional transmission capacity.

Second, the reservoirs are not always located where they are needed. Many reservoirs were constructed to serve a different purpose to that which they are used for today. This, however, means that a lot of water is lifted to elevations where it is not needed. This consumes a lot of energy that could be saved by constructing reservoirs in suitable locations.

Third, many networks don't have any functional pressure zoning. Not only does this affect the overall operation of the water supply networks, but with reservoirs in high locations the water pressure in the network is excessive in many low-lying areas.

All of the above leads to increased wear and tear on the infrastructure, and increases the NRW. This is why there is a strong need in Albania to design and implement energy optimisation measures. This requires the use of experienced planners and designers, and the need to specify and tender the right equipment and materials, complying with minimum technical standards, which ensure the implementation and use of efficient infrastructure over the asset life cycle. Finally, professional construction supervision and commissioning is needed to ensure that what was designed and specified is constructed and installed to the required standard.

Operational phase

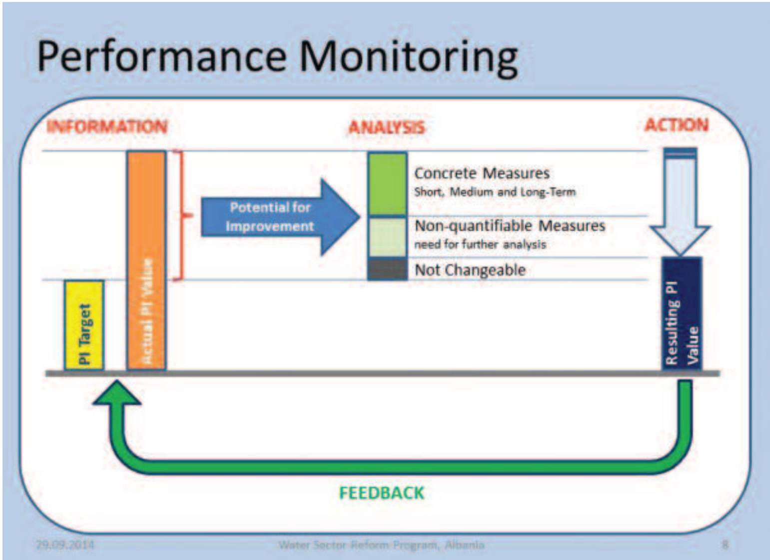
To ensure that good quality services are provided by a utility, it needs to employ qualified staff that will ensure the day-to-day operations are done according to the operating manuals. In many places that were visited, operating manuals were not available and key operational data like water production and pump operating hours were not recorded. Also the utilities generally did not have an up-to-date asset register and networks maps and schematics available that would provide the required information to carry out an assessment like an energy scan at a pumping station.

As a result an Excel tool has been developed to capture key pumping system data and help determine the energy efficiency of the pumping systems. In addition, WOBIS (Water Operational Business Information System) has been developed to help the utilities to routinely capture key operational data variables on a monthly basis. Figure 5 outlines the WOBIS system. The operational data to be captured is first and foremost required by each utility to regularly analyse and assess its performance against operational targets, which would be set as part of a utility's business plan or corporate plan. Additionally, the system can also be used to satisfy reporting needs to the Water Regulatory Authority (ERRU) and the Benchmarking Unit (BMU) within the Water and Sewerage Directorate (DPUK) in the Ministry of Transport and Infrastructure.

From the recorded operational data variables, the WOBIS system automatically calculates the respective indicators and can compare these with annual targets for the KPIs, provided these have been set.

These regular performance assessments need to be linked to the definition of specific management and investment actions geared towards

Figure 6 Benchmarking Cycle (adopted from DWA-M 1100E)



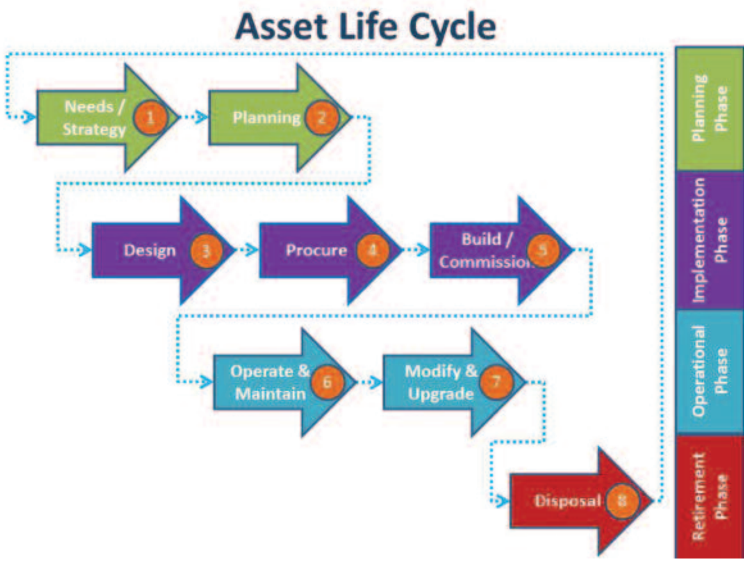


Figure 7
Asset Life Cycle

closing the gap between current performance and envisaged or targeted performance, as outlined in the benchmarking cycle in Figure 6.

Such assessments have also been integrated into the revised tariff application process of the Water Regulatory Authority (ERRU). Since 2014, tariff applications using the new tariff-setting tool need be accompanied by a tariff justification. This can essentially be seen as a summary version of a business plan that requires a utility to highlight the strategies and planned interventions it wants to carry out, in an effort to meet the forecast improvements in the regulatory KPIs. It would be ideal if in future other decisions like allocations of subsidies would also be based on such assessments and plans.

Retirement phase

In the case of planned disposals of assets, it is necessary that steps 1 to 5 of the asset life cycle (see Figure 7) are done before the old assets can be retired. Only at this stage can these old assets be taken out of service and also removed from the asset registers, while the new assets need to be entered. It was noted that many investments in the past have not been recorded properly in asset registers and their status and condition have not been monitored and updated. This would be a huge help for decision making if and when assets need to be replaced.

From the work in the field for the energy scans it was also noted that broken assets (for example pumps or motors) are quite often replaced with whatever is available at the time, to ensure that some kind of service can be provided. These makeshift solutions, however, often remain in place and lead to situations where, for example, oversized pumps and motors are not matched to the system curve and operate very inefficiently. Efforts should be made to properly replace these assets with well-planned and designed solutions as soon as possible to attain cost effective operations.

Conclusion

In the current situation for many utilities in Albania, well planned, designed and implemented energy efficiency and energy optimisation measures could have a significant impact on their ability to cover their operational costs. New pumping systems with highly efficient pumps and motors (that is, energy efficient), along with measures to better control the very high NRW (through energy optimisation) would lead to a more efficient use of energy and a significant reduction in the amount of water that is pumped into the system. Suitable investments have been identified in the cost-benefit analysis and many have been found to be economically viable with a simple payback period of two to five years.

To ensure that the right infrastructure investments are planned and implemented, it is paramount that accurate and reliable operational data is available and also used for regular performance assessments. This requires qualified, well-trained staff in the utilities and for the sector to perform these duties better. Being able to use energy more efficiently and pump less water would also have a big impact on the future development of water/wastewater tariffs, and thus the long-term affordability of services for the end consumer.

To achieve this, significant infrastructure investments are required, as many of the water supply systems are old with amortised networks and pumping systems. According to the Master Plan for the Albanian Water Sector, there is an overall infrastructure investments need to the amount of €5.1 billion ($5.8 billion) until 2040 (or €6.8 billion ($7.7 billion) including all related costs). This equates to an annual investment of €180 million ($203.9 million) to ensure that by 2040 all Albanians enjoy a 24 hour water supply service with good potable water, and adequate wastewater services.

Finally, it would be considered very beneficial for the Albanian water sector if the planning, implementation and management of water and wastewater infrastructure were set up following an asset life cycle approach. To determine how well current processes and practices in the sector are aligned with such an approach, a detailed analysis would be required to determine exactly where there are gaps and weaknesses.

Based on such a gap analysis, concrete measures could be formulated to clarify the roles and responsibilities of all actors involved in the planning, design, implementation and operations. An effective communication structure between all actors would need to be developed based on well-designed processes and appropriate steering and coordination structures, supported by an appropriate capacity development programme at sector, institutional and individual level.

Within the ongoing sector reforms and as part of the current administrative territorial reforms in Albania, this would be an ideal time to develop and integrate such an asset lifecycle approach for the water sector as part of these reforms. Through its expertise in capacity and organisational development and its long-term involvement in the Albanian water sector, GIZ (Gesellschaft für Internationale Zusammenarbeit) would be an ideal development partner to assist in the conceptualisation, design and implementation of such a multi-layered and multi-faceted change process. ●

This article is based on a paper presented at the IWA Regional Utility Management Conference, Tirana, Albania, 13-15 May 2015.

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Analysis of three efficiency models for water supply and sewerage companies: the case of Albania

Evis Gjebrea analyses three efficiency models for the water supply and sewerage sector in Albania, which aim to evaluate economies of scale by focusing on the factors that impact the efficiency of water and sewerage companies. The study analyses financial, technical and operational data for the period 2006-2012 for 29 water and sewerage companies that cover 81% of the population of Albania. For the purposes of this study, this research uses an econometric model for efficiency of water supply and sewerage companies previously tested in a study on the relative efficiency of water utility companies in Brazil, which has similarities to companies in Albania.

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At the global level, water is considered a rare resource and there are several factors that cause this phenomenon. These are global warming, population growth, which increases pressure for more water, and demographic change in the population due to the shift from rural to urban areas. The debate on water has become an important issue worldwide, as shown by the inclusion of water issues in Agenda21 of the United Nations (UN) in 1992 and the Millennium Development Goals.

Water, from being a free or social commodity has become a consumption commodity and many global conditions that have occurred and are occurring have led to its scarcity. As a result one of the challenges of the 21st century is the effective and efficient management of water. To that end, water management theory has changed by introducing the concept of sustainable water management, and its relationship with other sectors such as health, environment, agriculture and industry.

Albania is a country rich in water resources, and with the current capacity of the resources it possesses it is able to meet the needs of the whole population. But the challenge remains efficient use of water resources. Concretely, the annual average capacity of all sources used for production of drinking water is 654M.m^3, while the average volume of water produced is 278M.m^3 (Drejtoria e Përgjithshme e Ujësjellës Kanalizimeve, 2010).

This indicates that only 43% of the country's water resources are used. Assuming that the entire population living in the area of jurisdiction was supplied with drinking water, due to losses and misuse – using water for other purposes – production is 31% higher than the demand for drinking water. Meanwhile, the volume of water billed (sold), meets only 54% of the demand at sector level. These statistics

Table 1: List of Water/Sewerage Companies with both services

No.	Name of the Company	Number of population served with water	Number of population with access to sewerage
1	Berat & Kuçovë	103743	87512
2	Burrel	23025	16475
3	Delvinë	6300	2092
4	Durrës	267612	181240
5	Elber (sh.p.k)	116000	112250
6	Ersekë	5900	5900
7	Fier	126250	76042
8	Fushë Arrëz	1986	1700
9	Fushe Kruje	9616	8360
10	Gjirokastër (Q)	33156	14025
11	Kamëz	40768	20104
12	Kavajë	61071	23751
13	Korçë (Q)	87500	77400
14	Krastë	2213	2013
15	Krujë	16837	16000
16	Kukës	40000	25000
17	Lezhë	31378	31706
18	Libohovë	3082	567
19	Librazhd	18812	16100
20	Lushnjë (Q)	47500	40000
21	Mallakastër	17975	10720
22	Mirditë	6074	5261
23	Pogradec	58142	43885
24	Pukë	2892	2112
25	Rrogozhinë	9007	3504
26	Rubik	2322	2207
27	Sarandë	43220	32346
28	Shkodër (Q)	82649	73465
29	Tiranë (Q)	828200	655000
	Total number of population for 29 companies	2093226	1586735
	Total number of population for 58 companies	2573023	1586735
	Weight of sample /Total population number	81%	100%

Source: General Water and Sewerage Directorate

Table 2: Summary Statistics for the Basic OLS Models

For the Volumes Models:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN WATER VOL PROD	203	7.500128	1.658615	4.60517	11.59958
LN SEWER VOL COLL	186	6.167105	1.523327	2.079442	9.917996

For the Population Models:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN POP SERV WATER	203	10.06328	1.466459	7.482214	13.7233
LN POP ACCESS TO SEWER	195	9.698738	1.579222	5.607639	13.57662

For the Connections Model:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN WATER CONN	199	8.15966	1.947109	.6931472	12.02472
LN SEWER CONN	196	8.292021	1.414973	5.62852	11.92949

show the high financial costs of the water and sewerage companies (WSCs) in Albania.

In Albania there are currently 58 water and/or wastewater companies operating, and the performance indicators show an unhealthy financial situation. Overall, companies face more or less the same problems, regardless of their severity, which varies from one region to another. Some of these problems faced by companies in the sector level according to the data by Water Regulatory Authority (Water Regulatory Authority, 2012) are as follows:

- A relatively low level of water supply: there is 80% coverage in general, of which 90% is in urban areas and 60% in rural areas
- Coverage of sewerage services is at a level of 50% in total, of which 70% is in urban areas and 17% in rural areas.
- The degree of losses (the water that is produced and introduced into the system, but that does not generate any income) is approximately 67%, while the standard in Western Europe is 20%, and furthermore the standard according to the Water Regulatory Authority (WRA) is 30%. This is due to low levels of meter installation, illegal connections to the network and the network being overused.
- Continuity of water supply is on average 10.8 hours, while the standard in Western Europe is 24 hours a day.

According to the World Bank study undertaken in 2010, it is estimated that 80% of WSCs are small cities with less than 50,000 inhabitants, a fact that shows there is a lack of economies of scale (Padeco, 2009). The poor performance of these companies exerts pressure on the government, which is obliged to provide subsidies. Although these have been reduced, they still remain high at 8% of total operating costs for 2012. The subsidies are provided to cover the financial losses of the WSC, while today's debate is that subsidies should be provided to help the poor.

In Albania, there are no in-depth studies on increasing the efficiency of the WS sector. The only institutions that have conducted several studies in the field are the World Bank and the German Bank for Reconstruction and Development (KfW). Specifically, the World Bank has conducted studies on decentralization, increasing the efficiency of the sector and investment projects, while KfW has conducted studies for investment projects carried out in several cities including Korça, Pogradec, Kavaja, Kukës Rrogozhina, Lushnja, Berat, Kuçovë, Saranda, Gjirokastra, Lezha and Fier. Recently a master plan for the necessary investments in the WSC was prepared by a German consulting company, which analyzed the financing needs of the WS sector until 2040.

Literature review

It is known from the literature that the introduction of competition in the water sector is more difficult than in other sectors such as energy and telecommunications, because the technical characteristics of the water sector differ from those of other sectors, and the total cost of the private network is a substantial part of the total cost of water, leading to a natural monopoly (Mergos, 2005). Specifically, competitors cannot build parallel water supply and sewerage systems in the same city (Urio, 2010).

Quiggin (2011) argues that most cases of public ownership exist for infrastructure services such as energy and water and there are two reasons for this: first, these services require huge investments and what counts is the low cost of public borrowing, and second, such services are a natural monopoly and if they were privatized they would require regulation by the government. In this sense, the choice is between one form of government intervention and another.

One way to address this issue is to merge several water companies and create big regions, which is known as regionalization. This process has occurred both in developed and in developing countries. According to Kingdom (2005) there are few publications on regionalization. The European Union (EU) and the World Bank are promoting this scheme in developing countries. The main reasons for regionalization are to achieve economies of scale by serving a large number of people, and the ability to access private sector financing or funds from international institutions that are encouraged to finance based on the benefits from economies of scale.

The most important factor in regionalization is achieving economies of scale. This is especially important for small cities which, being small in size, have difficulties in achieving economies of scale. According to a report prepared for Western city projects (McFarlane, 2003), the reasons for sharing access to water resources are financial, geographic inter-dependence, public health concerns, regulatory changes, and public expectations.

According to SMC Martin, Inc (1983), regionalization favors economies of scale, as the total costs will decrease with the increase in population served. Also the savings arising from the aggregation of financial, human resources and technology contribute to achieving the economies of scale.

Since 1998, the most important studies that have looked at the economies of scale in the water sector are those by Kim and Clark (1998) in the US, Garcia and Thomas (2001) in France, and so on. These econometric studies failed to show that economies of scale are more powerful for small companies in providing services to the WS sector, and that economies of scale are more stable when company size is determined by the volume of water produced. But these studies also show that the most powerful economies of scale exist when the number of connections or the population served is used as an indicator for the size of the company (Tynan and Kingdom, 2005). The overall result is that in all cases analyzed in various studies, the regionalization process has as its main factor increased efficiency as indicated by the economies of scale theory.

With the introduction of the concept of integrated water management, merging companies becomes a necessity in order to maximize economic and social welfare in an equivalent way without compromising the sustainability of ecosystems. For example in England and Wales, economic growth and the emergence of pollution problems forced the central government to reorganize management of water resources by bringing together more than 200 water companies and 1400 sewerage companies to form only 10 regional companies. These companies had the objective of managing water and also sewerage services in an integrated manner (Kingdom, 2005).

According to McFarlane (2003), financial benefit is provided by geographic interdependence, meaning that some areas may have problems in gaining access to water resources, and thus merging water companies also offers access for areas that are unable to access water.

Table 3: Basic OLS Models for 2006-2012

Dependent Variable: (ln) Operating Cost

Variable	MODEL		
	Volumes	Population	Connections
Constant	3.850199*** (4.82) value t (0.000) value p	-0.1922845 (-0.30) value t (0.764) value p	2.971766*** (3.83) value t (0.000) value p
Wage	0.231528 (1.61 value t (0.110) value p	0.4476861*** (4.01) value t (0.000) value p	0.0913152 (0.65) value t (0.517) value p
Water Volume Produced	0.6544855*** (12.05) value t (0.000) value p		
Sewer Volume Collected	0.107497* (1.84) value t (0.067) value p		
Population served with water		0.6366187*** (8.94) value t (0.000) value p	
Population with access to sewer		0.2021717*** (3.02) value t (0.003) value p	
Water Connections			0.0770307*** (2.67) value t (0.008) value p
Sewer Connections			0.8050484*** (20.56) value t (0.000) value p
Observations	186	195	192
R^2	0.8364	0.8918	0.8498

Methodology

The basic units of analysis in this study are WSCs operating in Albania that offer both types of services, namely access to water supply and sewerage systems for the period 2006 to 2012. First, the analysis started for all water and/or sewerage companies, 54 in total, for that period. Currently in Albania there are 58 water and/or sewerage companies operating, but out of these four did not exist during the period of analysis.

From the data analysis, it was found that not all companies offered both water and sewerage services. In this context, the analysis was reduced from 54 to 29 companies that constitute the selected sample. The sample of 29 companies is representative because it covers 80% of the population served. The data used are publicly available on the web page of the General Directorate of Water and Sewerage.

Research questions raised in this study were:

- What are the factors that affect the company's operating costs?
- Which of the factors is the most important in the operating costs?
- What are the criteria used for ranking WS companies by their efficiency?

The quantitative hypotheses are as follows:

- The reduction of technical losses reduces the volume of water produced and the annual operating costs
- The effect of scale in relation to the population served by the water/sewerage company should be important in reducing relative operating costs
- Increasing the number of meters installed leads to a significant increase in operating costs
- The current methods for ranking the companies by efficiency should be changed, taking into account ranking according to operating conditions

This paper is based on econometric techniques that use parameters or variables. In general, a non-parametric data envelopment analysis model can provide answers to some important questions. However, this study relies on the parameter model to evaluate the most important parameters and to test the relative importance of variables (Cubbie & Tzanidakis, 1998; Berg & Lin, 2005). When it comes the question of measuring efficiency with an econometric model, analysts have two options: cost functions and production functions. Neither is perfect, due to limited data. The preference for one or the other depends on the particular circumstances as analyzed by Sabbione (2006).

One of the most important circumstances is the environment in which the company operates. When we talk about maximizing profit, a production function can be a natural choice for a company, which can choose its production level. However, if the company has an 'obligation to serve', it will need to produce as much as is required by customers. In this regard, the production function may not be adequate. In the case of Albania a cost function may be applicable because the WSCs are of different size, and the service areas are also different.

Such companies have an obligation to serve the population, and in this regard it is more appropriate for a company to produce as much as is required by its customers. Since 42% of the companies serve fewer than 50,000 inhabitants, this indicates that there is a lack of economy of scale, and profit maximization on the basis of production would not be appropriate.

Table 4: Summary Statistics for the Basic OLS Models with the Environmental Variable Z

For the Volumes Models:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN WATER VOL PROD	203	7.500128	1.658615	4.60517	11.59958
LN SEWER VOL COLL	186	6.167105	1.523327	2.079442	9.917996
LN VOL WAT MEASURED	186	5.612998	1.955937	-1.07881	10.57029

For the Population Models:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN POP SERV WATER	20	10.06328	1.466459	7.482214	13.7233
LN POP ACCESS TO SEWER	195	9.698738	1.579222	5.607639	13.57662
LN VOL WAT MEASURED	186	5.612998	1.955937	-1.07881	10.57029

For the Connections Model:

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
LN OPER COST	203	10.78009	1.354354	8.317204	14.45287
LN WAGE	203	5.844669	0.3050549	5.072671	6.808056
LN WATER CONN	199	8.15966	1.947109	.6931472	12.02472
LN SEWER CONN	196	8.292021	1.414973	5.62852	11.92949
LN VOL WAT MEASURED	186	5.612998	1.955937	-1.07881	10.57029

We assume that a WSC can maximize its profits by minimizing the cost of producing some exogenously given output level, subject to the available technology (that is, the production function). The solution to this optimization (cost minimization) problem is a cost function (Sabbione, 2006):

Equation (1):
C= f(Y,W, Z)

Where Y is the output vector, W is the vector of input prices, and Z is the vector of environmental characteristics. It is assumed that this cost function C (.) can be deconstructed as the product of two functions g (.) and h (.). The function g (.) will have the input prices W and outputs Y as arguments, while the function h (.) will incorporate the exogenous variable Z that will affect the technology of the company. The cost function is then:

Equation (2):
C= g(Y,W) h (Z)

Characteristics of the cost function
Having introduced the mathematical side of the cost function, this section analyses the regression model used and the results of the test of the significance of the model. The model used is a multiple linear regression, which includes several variables that affect the efficiency of a WS company. Theoretically, the model has the following formula (Ramanathan, 2002):

Equation (3):
$Y_t = \beta_1 + \beta_2 X_{t\,2} + \ldots\ldots \beta_k X_{tk} + \mu_t$

Where:
t is the number of surveys which varies from 1 to t; Yt is the dependent variable; β_1 is the constant; $\beta_2 \ldots\ldots \beta_k$ are the coefficients to be determined; $X_{t\,2} \ldots\ X_{tk}$ are the independent variables; and μ_t is the error term.

In this paper, the dependent variable is the annual operating cost of the company, excluding amortization. In Albania, the majority of companies have financial losses, and subsidies from the central government are allocated to cover the annual operating costs.

The challenge for all WSCs, as described in the National Sectorial Strategy 2011-2017 for water and sewerage, is for the company to initially cover its operating costs and then as a final objective to cover its total costs, which would be an indication that the company is moving to financial autonomy. Specifically, the Strategy stipulates that by the year 2017, coverage of direct operating costs with revenues and payables must reach 100%. This is a strong argument for companies to understand which variables most affect the variability of the dependent variable.

The first set of results consists of three different specifications of the cost function depending on the output variables chosen: a Volumes model, a Population model and a Connections model. These versions are called basic Ordinary Least Square (OLS) models, which exclude the external variable Z. Although there is limited information, specifications show that a high percentage of variability in operating costs of companies is explained only with selected independent variables that are variables of the production and price inputs W.

Each model has an output variable associated with the water service, and an output variable associated with the sewerage service. Independent variables are grouped into three categories (Sabbione, 2006):

The Volumes model except wage includes as variables:

- The volume of water produced in thousands of m^3 (000 m^3)
- The volume of sewerage collected in thousands of m^3 (000 m^3)
- The volume of water measured in thousands of m^3 (000 m^3)

The Population model except wage includes the variables:

- The population served by water that is the number of people served with water services
- The population number with access to sewerage services

The Connection model except wage includes the variables:

- The number of water connections
- The number of sewerage connections

The theoretical hypotheses are as follows:

- Hypothesis H_0: the annual operating cost is not influenced by the independent variables of the three models, and in this case there is no linear relationship
- The alternative hypothesis $H_1 \neq H_0$: annual operating costs are significantly influenced by the independent variables of the three models, or at least one of the variables linearly affects the dependent variable, which in this case is the annual operating cost

Results of the three models

From the results of the Basic OLS models, some preliminary and expected conclusions can be extracted. First, we see that the coefficient of the variable WAGE is always positive, but not always important. WAGE is important when choosing production by having the population served as an output. In all three regressions, the models confirm the hypothesis that the firm's operating costs will increase if the price of labor goes up, but confirmation of the hypothesis becomes more specific when we choose to produce on the basis of the population served, because all indicators are positive and significant.

Specifically, the mathematical relationship between variables for the three models is given below:

Equation (4):Volumes model
Operating cost = 3.8 + 0.23 × wage + 0.65 × volume of water produced + 0.11 × volume of sewerage collected + 0.54

The result is that the variables of the Volumes model have a positive linear relationship with the operating costs. What is evident in this equation is that an increase of one percent of the volume of water produced will increase operational costs by 0.65% and an increase of one percent of the volume of sewerage collected will increase the operational costs by 0.11%.

Equation (5): Population model
Operating Cost = -0.19 + 0.45 × wage + 0.64 × population served with water + 0.20 × population with access to sewerage services + 0.44

The result is that the variables of the population model have a positive linear relationship with the operating costs except for the constant. What is evident in this equation is that an increase of one percent in the population served with water will increase operational costs by 0.64% and an increase of one percent in the number of people with access to sewerage services will increase operational costs by 0.20%.

Equation (6): Connections model
Operating Cost = 2.9 + 0.09 × Wage + 0.07 × Water Connections + 0.8 × Sewerage Connections + 0.52

The result is that the variables of the connections model have a positive linear relationship with the operating costs. What is evident in this equation is that an increase of one percent in the water connections through meters will increase operational costs by 0.07%, and an increase of one percent in the sewerage connections will increase the operational costs by 0.8%.

In all three models, the coefficient of determination R^2 is high, which shows that 83% of operating cost variability is explained by the variables of the volumes model, 89% of the variables of the population model and 85% by the variables of the connections model. As a general result, all three models have high R^2 to explain the variability of annual operating costs, and none of them is excluded, but of the three models, the model that explains best the variability of operating costs is the Population model, with a coefficient of determination of 89%.

Table 5: Basic OLS Models for 2006-2012 only for the Environmental Variable Z

Dependent Variable: (ln) Operating Cost

Variable	MODEL		
	Volumes	Population	Connections
Constant	4. 27644*** (5.31) value t (0.000) value p	- 0.0614173 (-0.08) value t (0.935) value p	3.162032*** (3.87) value t (0.000) value p
WAGE	0.1656319 (1.17) value t (0.245) value p	0.3893714*** (3.18) value t (0.002) value p	0.0796103 (0.55) value t (0.584) value p
Water Volume Produced	0.53318*** (9.22) value t (0.000) value p		
Sewer Volume Collected	0.1128604* (1.87) value t (0.063) value p		
Population served with water		0.5749276*** (7.02) value t (0.000) value p	
Population with access to sewer		0.2840244*** (3.62) value t (0.000) value p	
Water Connections			0.0475238 (1.41) value p (0.160) value p
Sewer Connections			0.7664642*** (15.51) value t (0.000) value p
Water Volume Measured	0.1500166*** (5.11) value t (0.000) value p	0.002597 (0.09) value t (0.930) value p	0.0768459 ** (2.23) value t (0.027) value p
Observations	175	178	179
R^2	0.8507	0.8822	0.8413

The next step is to test the environmental variable Z to isolate its effect on the operating cost and evaluate it in detail. The additional variable Z was included only if it added significant explanation to the operating cost by having a stable, meaningful and statistically significant coefficient. The result is that the variables of all the three models have a positive linear relationship with the operating costs. In all three models the coefficient of determination R^2 is high, which shows that 85% of the operating cost variability is explained by the variables of the volumes model, 88% of the variables of the population model and 84% by the variables of the connections model. As a general result all three models have a high R^2 to explain the variability of the annual operating cost, and none of them is excluded, but of the three models, the model that explains best the variability of operating costs is the Population model, with a coefficient of determination of 88%. As a final conclusion, adding the environmental variable in our testing does not create a significant change.

As mentioned in this article, the level of water losses in the water and sewerage sector is high. According to the WRA, sector performance report for 2012, it is reported that the level of losses in the sector is 67%. Similarly, in the WS sector strategy for 2011-2017 the objective is that by year 2017 losses be reduced to 40%, a change of 27%.

On the basis of the results reached through the regression formula, the final conclusions are as follows:

- A reduction of technical losses from 67% to 40% will reduce the volume of water produced by 45%, and operating costs will decrease by 29%. (Hypothesis 1 is verified)
- Serving a greater population of 1% to 5%, the operating cost increases by less than the increase in population (from 0.57% to 2.8%). (Hypothesis 2 is verified)
- Increasing the number of meters installed (from 10% to 20%) the operating costs increase much less (0.7< C < 1.4 %). (Hypothesis 3 is rejected)

Rankings of the water and sewerage companies

To estimate the efficiency level of the WSCs, three stochastic cost frontier models were run. Basic OLS regressions were valid to identify the significant variables that most explain

Table 6: Final Ranking for year 2012 for W/S Utilities according to stochastic cost frontier models

Volumes Model	Population Model	Connections Model
Tiranë	Tiranë	Tiranë
Durrës	Durrës	Durrës
Berat & Kuçovë	Berat & Kuçovë	Berat & Kuçovë
Elber	Elber	Elber
Shkodër	Shkodër	Shkodër
Fier	Fier	Fier
Gjirokastër	Gjirokastër	Gjirokastër
Korçë	Korçë	Korçë
Sarandë	Sarandë	Sarandë
Lushnje	Lushnjë	Lushnjë
Kavajë	Kavajë	Kavajë
Lezhë	Lezhë	Lezhë
Pogradec	Pogradec	Pogradec
Burrel	Burrel	Burrel
Kamëz	Kamëz	Kamëz
Krujë	Krujë	Krujë
Kukës	Kukës	Kukës
Mirditë	Mirditë	Mirditë
Librazhd	Librazhd	Librazhd
Mallakastër	Mallakastër	Mallakastër
Ersekë	Ersekë	Ersekë
Fushë Krujë	Fushë Krujë	Fushë Krujë
Pukë	Pukë	Pukë
Fushë Arrëz	Fushë Arrëz	Fushë Arrëz
Delvinë	Delvinë	Delvinë
Rrogozhinë	Rrogozhinë	Rrogozhinë
Libohovë	Libohovë	Libohovë
Krastë	Krastë	Krastë
Rubik	Rubik	Rubik

the variability of annual operating costs, but the construction of an efficiency ranking needed to account for both inefficiency and randomness in the error term. The error term explains the random factors arising from natural disasters or other conditions that are outside the company's control and do not depend on it, such as geographic position - being located in an area that serves a limited number of people or that is a long distance from access to the river basin.

What is evident from the ranking results is that the five best WSCs for efficiency during 2012 are the same companies across the three models. These utilities are: Tirana, Durrës, Berat & Kuçovë, Fier and Elber Ltd. Some of the factors that could have contributed to the efficiency are good management, qualified staff, accumulated expertise and so on. The five WSCs with the worst efficiency are the same companies across the three models. These are: Delvinë, Rrogozhinë, Libohovë, Krastë and Rubik. The constant term in the stochastic model in this case takes into account other factors besides those above. Factors that affect inefficiency could be bad management, unqualified staff, lack of expertise, and so on.

The stochastic test results are in line with the theory of efficiency on the economy of scale and the conclusions of empirical studies carried out by recognized authors, who conclude that the greater the increase in the population served, the lower the cost per unit. This finding is relevant in the case of Albania, that an increase in the number of population served leads to an increase in population density, which impacts the achievement of economies of scale.

Comparison of the Performance Ranking of WSCs with ranking by the WRA

In Albania, performance monitoring of the WS sector started in 2006 based on a benchmark set by the benchmarking Monitoring Unit and later by the WRA. It is important to compare the ranking of the companies based on the results of this scientific study and the ranking produced by the WRA.

Specifically, the WRA groups the companies in three categories using as criteria the number of connections to the water system. According to the WRA, the grouping as per connections contrary to the size of the service area helps to differentiate between large and small companies. For each group, the benchmark is calculated for the main sector indicators and the performance of each company is then calculated by comparing with the benchmark of each indicator.

Ranking of the best companies according to both evaluations is as follows:

Scientific Paper	WRA
1. Tirana	1. Tirana
2. Durrës	2. Korçë
3. Elber	3. Elber
4. Berat & Kuçovë	4. Vlorë
5. Shkodër	5. Shkodër

Ranking of the worst companies according to both evaluations is as follows:

Scientific Paper	WRA
1. Delvinë	1. Pukë Fshat
2. Rrogozhinë	2. Orikum
3. Libohovë	3. Gjirokastër Fshat
4. Krastë	4. Libohovë
5. Rubik	5. Has

The test results confirm Hypothesis 4, that the current methods for ranking companies according to efficiency should be changed to take into account the ranking as per operating conditions. This was shown by the constant term that explains other factors not captured by the volumes model, population model and connections model.

As is evident, both rankings are different. There are several reasons for the differences in the rankings found in this comparison. Both types of rankings use different methodologies. Also, the ranking of the scientific paper considers both types of services, and as a result companies that offer only water service are not included, which is an added value of the scientific paper, while the WRA ranks all companies regardless of the services they provide.

In addition, the ranking criteria used by the WRA to group companies according to their size are on the basis of water connections, while the criteria used by the scientific paper are according to three models: the Volumes model, the Population model and the Connections model. What is found is that the ranking used by the WRA does not take into consideration the part of the population that is supplied with water, but is not equipped with meters. It is a fact that part of the population served with water may not be equipped with meters, but still companies receive their payables using a fixed method for price calculation. In this context, this is revenue for the company and affects its financial performance. This can be a point of strength in the ranking used in the scientific paper.

Conclusions

Albania is a country rich in water resources, and with the current capacity of the resources it possesses it is able to meet the needs of the whole population. But water management is not efficient because only 43% of water resources are used, the production is 31% higher than the demand for drinking water, and the volume of water billed (sold) only meets 54% of the demand at the sector level. The degree of losses is approximately 67%, while the standard in Western Europe is at 20%, and furthermore the standard according to the WRA is 30%. This is due to the installation of meters being at low levels, illegal connections to the network and the fact that the network is overused.

One way of addressing the inefficiency of the sector is to merge several water companies and create big regions, known as regionalization. This process has occurred both in developed and in developing countries. According to Kingdom, the main reason for regionalization is to achieve economies of scale by serving a larger population, and the ability to access private sector financing or funds from international institutions. According to SMC Martin, Inc regionalization favors economies of scale, as the total costs will decrease with the increase in population served. Also, the savings arising from the aggregation of financial, human resources and technology contribute to the achievement of the economies of scale.

In all three models, the coefficient of determination R^2 is high, which shows that 83% of the operating cost variability is explained by the variables of the Volumes model, 89% by the variables of the Population model and 85% by the variables of the Connections model. As a general result, all three models have a high R^2 to explain the variability of the annual operating cost, and none of them is excluded, but of the three models, the model that explains best the variability of operating costs is the Population model, with a coefficient of determination of 89%.

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The testing used for efficiency through the econometric model is a scientific contribution recommended for consideration by the WRA. Efficiency is just one aspect associated with economies of scale. In addition to this factor there are other factors such as institutional, political, administrative and legal that the companies must consider. It is recommended that in order for the companies to achieve economies of scale, regionalization and the creation of bigger regions could be an option. In this context, in the framework of the new territorial and administrative reform that is happening right now in Albania, policy makers should define a regionalization model that takes into consideration not only the economic factor but also other factors as mentioned here.

Clearly, much work remains. For the purposes of rewarding good performance and penalizing weak performance, scholars and practitioners need to develop benchmarking procedures that can pass legal challenges. Econometricians must contribute to the debate on increasing the efficiency of the WS sector in Albania. In order to address the efficiency issue, academicians must collaborate more closely with the WRA and other policy makers to decide on a standardized ranking assessment.

In the context of the new territorial and administrative reform, the government should promote the offering of water and sewerage services by the same operator. This could help the company to reduce costs and increase savings, thus improving efficiency. ●

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Milestones and results for the Budapest Waterworks water safety system

The Budapest Waterworks (BWW) was among the first to establish a water quality system, both in Hungary and in Europe. As a first step, a system was established for the Csepel island water treatment works, Budapest, as this has complex drinking water treating technology due to the water's iron and manganese content, which necessitates the active intervention of the operator to maintain water quality. Géza Csörnyei and Genovéva Frank look at the eight-year-long development process for the BWW potable water safety system, the structural changes, water quality events and water quality event management experiences. In addition, the authors look at modification of the structure of the drinking water safety manual due to mergers and legal changes, and water quality results achieved through more polished, efficient operation.

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The control centre (credit BWW)

Budapest Water Works (BWW), which celebrated the 147th anniversary of its establishment this year, is one of the significant water utility suppliers of the Central-Eastern-European region given the size of the population served and the outstanding level of technology.

During its over 140-year lifetime, BWW has developed along with the capital city. The first temporary water treatment works was established in 1868, followed by the construction of two water treatment works in Buda in 1882. Then the Káposztásmegyer water treatment works was put into service in 1904, which was the most up-to-date such facility in Europe at that time.

The company has made immense progress in the past 100-plus years. The early plants that used to be operated by steam engines have been replaced by modern, automated facilities that meet the most exacting hygiene requirements. In almost a century and a half, newer and newer water towers, pumping stations, and pipe networks have been built, and wells put into operation. The company's pipeline network has reached more than 5,000 km in length throughout the city. The company's water treatment, network operation and water quality testing activities are enabled by cutting edge technologies. Today, the potable water production and supply systems are completely automated.

Looking at its core activities, the company deals with potable water treatment, potable water production, network operation and potable water supply – today it supplies more than two million people with healthy piped potable water – as well as with wastewater treatment and related services, which are supported by the application of world-class technologies.

BWW's international activities

The professional queries we receive from countries all around the world indicate a demand for cooperation among our partners. Negotiations have been started recently with several European and Asian cities in the fields of consultancy, technology development and main contracting, and contracts have been signed. Among them, the reconstruction and capacity increase of two water treatment plants supplying potable water to the capital city of Sri Lanka is worth mentioning. The National Water Supply and Drainage Board of Colombo awarded this contract to our company. Apart from that, the Hungarian government has concluded a comprehensive water sector framework agreement with Vietnam, within which, as per the plans, BWW will build two water treatment plants. Furthermore, memoranda of understanding in the field of cooperation have been concluded between our organisation and the utility providers of Baku in Azerbaijan, Ohrid in Macedonia, Tirana in Albania, Istanbul in Turkey, and Urunqi in China.

It is of special value that in the period since the change of regime, BWW has already walked a path of market, technological, operational and economic development that is still ahead of these cities. Regional co-operation, by strengthening alternative revenues not directly gained from potable water sales, by increasing the value of the company, by gaining experience related to the core activities, and by extending know-how, serve to achieve our owners' goals.

BWW water safety systems

Water safety plan legal background

Water utility companies were first obliged to prepare water safety plans according to the requirements of the 65/2009. (III. 31.) Government Decree, on the basis of WHO guidelines. Requirements for the content of these plans were not fixed then in any Hungarian legislation. Later, these requirements were determined in the 201/2001. (X. 25.) Government Decree regarding quality requirements for drinking water and the water sampling process.

Authorities

The water safety plan has first to be sent to the National Center for Public Health for professional acceptance, then, having this expert opinion, to the National Public Health and Medical Officer Service for authorisation.

Steps for preparing the water safety plan

BWW was among the first in Hungary and Europe to start building a water safety management system. Hungarian legislation did not yet deal with the preparation of water safety plans, but BWW was already planning the implementation of a water safety management system. During the implementation, BWW used the ISO 22000:2005 standard on food safety management systems and requirements for any organization in the food chain, as being more comprehensive.

- The water safety management system was certified:
- firstly for southern water production in 2007
- then for northern water production in 2007
- then for the entire water production and network operation in 2009

Later, BWW implemented an integrated management system by amalgamating four management systems:

- quality according to ISO 9001:2008
- environmental according to ISO 14001:2004
- water safety according to ISO

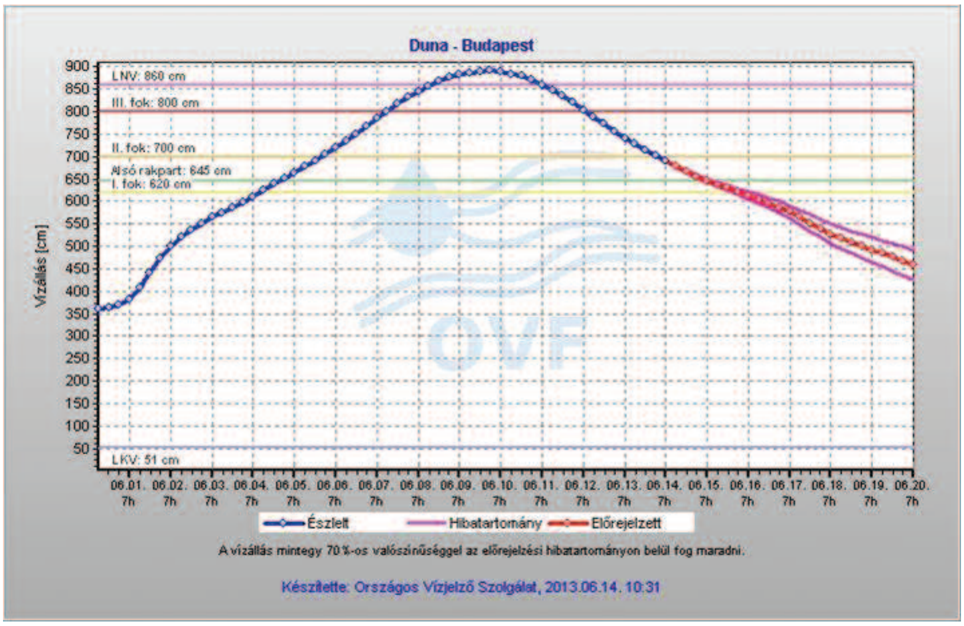

Figure 1: Water level of river Danube

Wells under water during flooding (credit BWW)

22000:2005
- occupational health and safety according to BH OHSAS 18001:2007

The BWW water safety plan achieved professional acceptance from the National Center for Public Health on 23 June 2011, then permission from the National Public health and Medical Officer Service on 7 November 2011. BWW has until 7 November 2015 to initiate public health surveillance of the plan.

Main elements of the water safety plan
The BWW water safety plan contains a description of the water supply system, hazard analysis and risk evaluation, determination and evaluation of measurements for checking risks, establishment of a checking monitoring system, and establishment of a drinking water risk management system.

The relationship between the water safety plan and the quality management system

Advantages and disadvantages
Council directive 98/83/EC directive 3 November 1998 on the quality of water intended for human consumption gives recommendations for member states to implement an appropriate quality management system for checking whether drinking water intended for human consumption complies with the requirements of this Directive.

The ISO 22000 standard determines uniform requirements for HACCP plan and makes HACCP certifiable, and describes an internationally accepted quality management system.

The HACCP plan and water safety plan contain specifics on risk evaluation, operational monitoring, hazard analysis, protection of water resources, which are essential, but neither of them can be certified per se. However, the food safety management system according to ISO 22000:2005 can be.

The food safety management system according to ISO 22000:2005 can basically serve as a good basis for a drinking water safety plan, but cannot contain sufficiently detailed hazard analysis and risk evaluation for the whole water supply system.

Application of the food safety management system (ISO 22000:2005) provides an enormous advantage and continuous development for the water safety plans and HACCP, with its all advantages at BWW: it includes an annual examination, is infrastructure and resource-centered, and offers document management and international certification.

Specialties of risk assessment
Due to the condition of BWW's water resources even the raw water can be mentioned as a hazard in some cases. During the operation of bank filtration wells, potential industrial or municipal contamination, temporary flooding and drought periods have to be considered. Internal regulations have been created for the fast management of sudden operational statuses such as event management at water production facilities, a flood manual, and actions for drought periods. A collection of decision matrices related to water quality complaints was created to manage complaints about water quality and background pollution.

Laboratory testing (credit BWW)

Decision matrices
Steps for managing complaints were taken in 2005 according to:
- BWW's technological process steps Water quality parameters determined by the 201/2001. (X. 25.) Government Decree regarding quality requirements for drinking water and the water sampling process
- Technological water quality results determined by the water safety team

Various corrective actions are necessary to manage non-compliant results from wells and well pump houses, collection points, reservoirs and consumer points.

Implementation of and experiences with the integrated management system

Pseudomonas compliance in Surány
Pseudomonas was found during scheduled sampling of the water in the ROCLA pipe at Surány in 2010. The conclusion was that the sampling tap has to be located as close as possible to the sampling location, with no affecting factors in between (such as a pump, or online measuring instrument).

Red sludge disaster
The red sludge disaster happened on 4 October 2010 at Kolontár-Devecser-Somlóvásárhely. The corner of the 10th section of Ajka Alumina plant's tailing pond burst, and the entire flora and fauna of Torna creek were destroyed by red sludge. The pollution passed through the rivers Marcal, Rába, and Mosoni-Danube and reached the river Danube. BWW's laboratory started a sampling programme for the river Danube and wells, monitoring pH, conductivity, heavy metals, earth metals and performing toxicological tests on the waters of the river Danube. The Water Production Department completed these tests by measuring the pH every four hours.

On the basis of measurements lasting for one and a half months, it can be declared that the red sludge disaster had no effect on the drinking water supplied by BWW.

Supervision of reservoir vents (see tables)
Venting of water storage reservoirs is necessary due to fluctuating water levels. Reservoir vents create a water quality risk as drinking water can come into contact with the environ-

UV treatment installed in Budapest's oldest pumping station. (credit BWW)

ment if the vents are incorrectly protected. To prevent contamination, a closing fiberglass filter layer has been installed at the end of the vents since 2010. The filters are replaced every year. They are contaminated by iron (Fe), manganese (Mn), antimony (Sb), aluminium (Al), zinc (Zn), lead (Pb), Phenanthrene, fluoranthene, pyrene, chrysene, benz(b)fluoranthene, pollen, plant parts and insect wing scales. CFD simulation was performed to examine the flow of dust.

Flooding

Regarding earlier high water levels, flooding in 2013 brought challenges from an operational point of view.

Hypo dosers

Many chlorinators have been reconstructed and have operated as hypo dosers since 2014. Among other methods tested, use of a separated flowing stream of 'driving water' for dilution with the modification of the PLC program was successful. The minimum dosage limit was eliminated and flow-rate proportional dosage has been implemented. The precipitation of hypo crystals has been accelerated due to the use of the driving water stream. Checking and maintenance of the dosing lance is performed every week, and an acid wash every three weeks.

Table 2: PAH content of fiberglass filter

Phenanthrene	22,47	µg/l
Fluoranthene	29	µg/l
Pyrene	16,5	µg/l
Chrysene	15,72	µg/l
Benz(b)fluoranthene	17,91	µg/l

Actions to improve water quality

Accredited laboratory and rapid test laboratory

The laboratory was established in 1960. For the accreditation, the entire sampling system was reformed; use of cars for sampling and manual measurements were implemented. The process of sampling was accredited in 2004. Later, to make the administration of the sampling process easier, a PDA mobile workstation and the LIS laboratory information program were implemented. The laboratory instrumentation has been continuously expanding and developing over the past 10 years.

Informative microbiological rapid test measurements, which are used to examine reservoir status following washing, have been operating efficiently for years. The results are available 24 hours earlier than accredited laboratory results, and are in line with them.

Mobile water purification and packaging system

BWW has been dealing with the topic of cleaning and packaging water in case of catastrophes and extraordinary situations. Our equipment can be used to supply smaller settlements, parts of settlements, industrial facilities, institutional consumers and settlement populations with healthy drinking water. Though the equipment is part of our own emergency water supply, it has been used in several emergency

Table 1: Contaminants of fiberglass filter

Parameter	Measured value		Limit value	
Fe (total)	35	µg/l	200	µg/l
Mn (total)	2,5	µg/l	50	µg/l
Sb	1,2	µg/l	5	µg/l
Al	60	µg/l	200	µg/l
Zn	13	µg/l	-	µg/l
Pb	2,7	µg/l	10	µg/l

Horizontal filtering wells (credit BWW)

situations abroad. The equipment can be transported on EUR pallets or in 10 or 20 feet standard containers. The equipment is considered to be a mobile plant, so the HACCP system is implemented and operated for them.

Drinking water dispenser bottle filler
BWW owns a little drinking water dispenser bottle filler plant, which initially served only the hot and cold water supply for our own employees. The plant underwent technological development and reconstruction in 2012. Monitoring of the product and related raw and auxiliary materials is elaborated in the operating HACCP system, in accordance with the Codex Alimentarius and other legal requirements.

Online measuring instruments
The installation of online measuring instruments has become a reasonable option due to the need to monitor water quality results and rapidly recognise operational errors. Measurements results (for Fe, Mn, nitrite, pH, chlorine and turbidity) are available 24 hours a day, are documented and can be retrieved in the SCADA program and are monitored by the dispatcher continuously for possible interventions.

Challenges and future developments

Network cleaning technologies
Beside the implementation of scheduled network flushing, the improvement of water quality in the network is also ensured by various network cleaning technologies such as air scouring, soft sponge cleaning, chain-and-drag and RAK cleaning. Two new pipe cleaning technologies have been tested on an experimental basis: dry ice-WOMA cleaning and jelly cleaning.

Inspection and review of fire hydrants
Fire hydrants have to be examined and flushed every six months according to the 28/2011. (IX. 6.) Department of Home Affairs Decree. An advantage is that stagnant pipe sections and dead ends are regularly flushed, which minimises sediments and secondary contamination in the pipe network.

Installing non-return valves
BWW has been installing non-return valves since 1 July 2005 to prevent water flowing contrary to the proper flow direction. Non-return valves should be installed in domestic potable water pipes just before the valve after the water meter, according to the MSZ 22115:2002 Consumer water connections standard.

Lead in the drinking water network
There are almost 4000 pieces of connection pipe that are known to be made of lead in BWW's network. Regular analysis is performed on lead connections at different points in the supply area to check compliance with the 10 μg/l dissolved lead limit value for water from consumer taps defined by the 201/2001. (X. 25.) Government Decree. The entire connection pipe is replaced when the lead concentration is above the limit. Similarly, lead connections are replaced instead of being repaired during maintenance work.

Asbestos cement pipe network
Some 42% of the material of the pipe network operated by BWW is made of asbestos cement. Asbestos cement means a risk mainly during repair works when it is necessary to cut the pipe. Exposure of workers to asbestos fibres in the air must be kept below 0.1 fibre/ml. So ensuring the use of the required labour protection devices, and the choice of cutting and assembling technology and appropriate waste management are essential. Nevertheless, reconstruction of asbestos cement pipes is due because of their age and to ensure the safety of water supply.

Conclusion

Implementation and continuous development of the drinking water safety management system in the everyday life of BWW is a good tool for improving water safety actions, enabling BWW to cope with the water quality problems that occasionally occur. BWW's risk assessment method and decision matrices, and the water quality improvement actions taken over the past years have made it possible to react efficiently to water quality events and, with the continuous improvement, to provide our consumers with highly-compliant drinking water and give the chance to solve potential challenges in the future. ●

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All the information above is BWW's own methodology and system, and is based on BWW's own data.

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