iGPI and PGPI: national-scale cooperative R&D rollout of IAM planning methods and tools

S.T. Coelho*, H. Alegre*, J. P. Leitão*, M.A.Cardoso*, M.S. Silva*, P. Ramalho*, R. Ribeiro*, D. Covas, D. Vitorino***, M.C. Almeida*, J.Feliciano****, R.Almeida******

* LNEC - National Civil Eng. Lab. Av. Brasil, 101, 1700-066 Lisbon, Portugal (stcoelho@lnec.pt)
** IST, Technical University of Lisbon, Avenida Rovisco Pais, 1049-001 Lisbon, Portugal
*** Addition. Rua Borges Carneiro, 34 R/c, 1200-619 Lisbon, Portugal
**** AGS, S.A., SintraCascais Escritórios, Linhó, 2714-555 Sintra, Portugal

Abstract: The National Initiative for Infrastructure Asset Management (iGPI) led by LNEC, IST and Addition, and its twin initiative PGPI, led by AGS, were collaborative projects through which a total of 30 Portuguese water utilities developed IAM systems and plans through a collective training, capacitation and R&D rollout programme (Apr 2012 – Oct 2013). The utilities received specialized training, collective and individual support, and networked with the other utilities in a common process with similar difficulties and challenges, leading to an effective sharing of solutions. The products, including software, training materials, guidelines and templates for developing strategic and tactical IAM plans, are in the public domain. The projects have significantly contributed to the rollout of reference methodologies and standards for IAM planning, demonstrated in a range of utilities of varied size and context, successfully pushing a consensual best practice. The methodology and outcomes are discussed and illustrated with selected cases.

Keywords: infrastructure asset management; planning; R&D rollout; collaborative project.

Introduction

The prevailing low levels of rehabilitation of water infrastructure in much of the world constitute a major threat to the long-term sustainability of urban water services - a time bomb largely invisible to society and to policymakers, transferring an excessive burden to future generations. A paradigm shift in asset management infrastructure (GPI) is therefore urgently needed, given the restrictive context of availability of capital and the increasing demands from climate change and environmental protection.

As in many other countries, the rapid growth of public water service infrastructure in Portugal in the last 3 decades has not been matched by adequate capital maintenance levels of both the previously existing and the newly constructed systems, giving rise to a sizeable deficit in infrastructure asset management (IAM). Significant measures have been undertaken in recent years to reverse the trend and help provide the country's utilities with the means to restore long-term infrastructural sustainability. Recent legislation requires an IAM system for water supply or wastewater management services serving 30 000 people and above. The national water services regulator followed up with technical guides outlining an integrated IAM methodology, published in conjunction with LNEC and the Tech. Uni. Lisbon (Alegre et al., 2013).

Grounded on best practice and updated technical knowledge generated in Europe, USA, Australia, New Zealand, as well as IWA's network of professionals, this methodology approaches IAM as a management process, based on continuous improvement principles and requiring full alignment between the strategic objectives and targets, and the actual priorities and actions implemented, thus embedding the key requirements of the ISO 55000 series standards on AM (Alegre & Coelho, 2012).

Widespread implementation of strategic IAM in urban water services requires a substantial mind-set shift for the water sector in most countries, as well for decision-makers, politicians, the media, and society in general. iGPI, Portugal's 2012–2013 National Initiative for Infrastructure Asset Management (www.iniciativaGPI.org), was launched to help broaden the impact of those methodologies and products and reach out to utilities nationwide in a significant way. It utilized a collaborative format pioneered by LNEC in the last decade, and aimed at assisting a representative sample of utilities of diverse size and context develop their own IAM systems and plans through a joint training and capacitation program (Leitão *et al.*, 2013). PGPI, a twin project simultaneously launched by the AGS group of utilities, expanded the reach of the program and tested an even wider variety of organizational frameworks within the controlled environment of a corporate group.

Today, over 25% of the Portuguese population is served by 30 management companies that produced their strategic and tactical IAM plans under the iGPI and PGPI programs. Applied the methodology and guidelines of the AWARE-P project - renowned for ERSAR - the widespread use of open source software, effectively creating alignment and critical mass for much needed change. Outside Portugal, the methodology and software have been implemented by utilities in Spain and the USA, with pilots in Australia and Norway.

Project methodology

The projects followed a cooperative model involving a number of utility partners, with joint teams of research developers and users of the research products, 'working with' instead of 'working for'. In general, this provides scale and national visibility, contributing to creating the aimed awareness and appetite for the theme; it also produces a networking effect and allows for combining strategic research with practical problem solving and industry hands-on capacitation. Mutual validation and recognition from a peer group provides a greater comfort zone for early adopters. Developing nationally representative cases has significant leverage impact, demonstrating applicability and allowing for further learn-by-example training.

The utilities that took part in iGPI and PGPI, ranged in population served from 390,000 to 3,000, with a diversity of service scope (water, wastewater, stormwater) and organizational complexity and nature: municipal, regional and private (**Figure 1**). Maturity in terms of information availability, technical sophistication and management processes implemented was also diverse.

In the case of the public project iGPI, each utility paid approximately € 20k as a participation fee; the total from the participating utilities covered 75% of the lead consortium's (LNEC and R&D partners) costs, who self-financed the remainder. PGPI was run by the privately owned AGS group of utilities exclusively within its concessions, under an internal arrangement, distinct from the above-described terms for iGPI.

The project followed a 4x 4-month phased schedule, with a total duration of 16 months. Each phase began with face-to-face training, and the specification of the work to be developed by each participant. Training is complemented with e-learning via webinars and on-line materials. While the utility teams develop their pilot cases, LNEC analyzes results and provides individual assistance to the utilities.

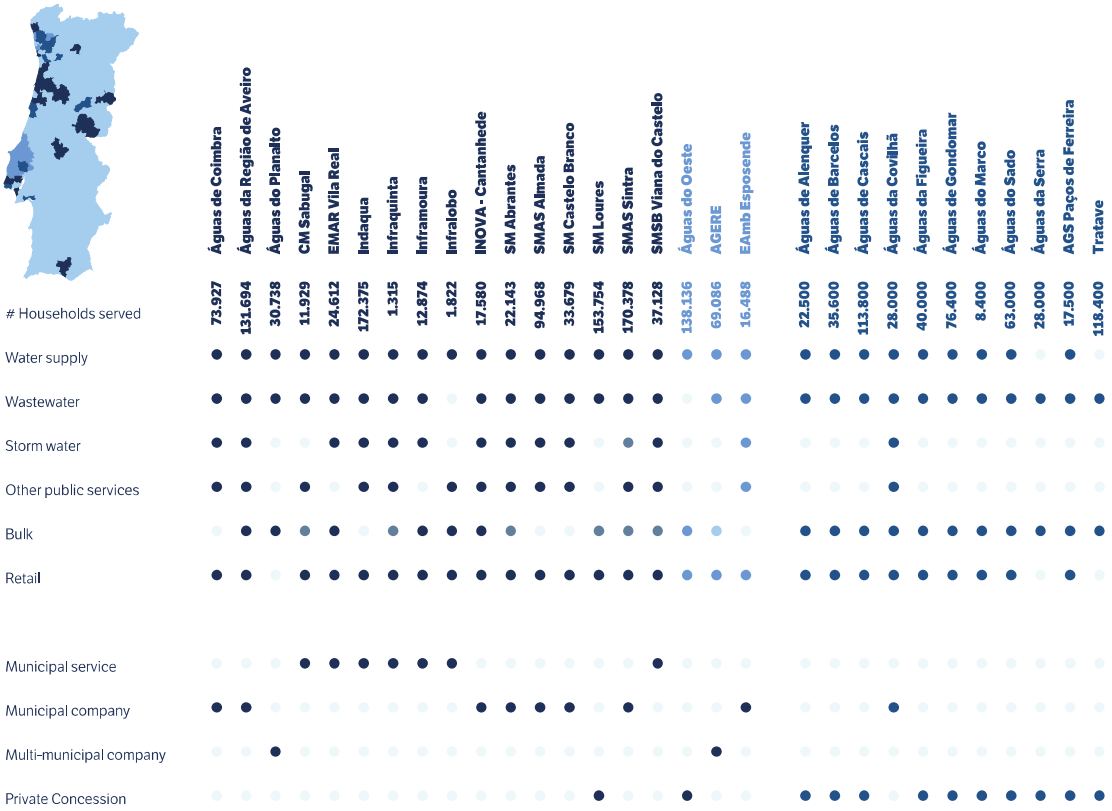

Figure 1. Utilities taking part in the iGPI and PGPI projects

Table 1. The iGPI program: objectives and outcomes

	Objectives	Outcomes
Phase 0 M0	Warm-up; project set-up; beginning of baseline data collection	• Detailed planning of activities; • Definition of teams and project managers for each participant water utility; • Definition of information to be collected.
Phase 1 M1-M4	**Strategic** & **tactical** planning levels: Objectives and diagnosis	• Concise report containing: objectives, assessment criteria, metrics and targets to strategic and tactical planning (macro) levels; • Strategic level diagnosis; • Data survey priorities.
Phase 2 M4-M8	**Strategic** & **tactical** planning levels: Plan development	• Full version of strategic IAM plan; • Prioritization of network sectors at the tactical intervention level.
Phase 3 M8-M12	**Tactical** planning level: Formulation of IAM alternatives for pilots	• First draft of the detailed IAM tactical plan containing: - objectives, criteria, metrics and goals; - diagnosis of priority area(s); - identification of infrastructural and non-infrastructural alternative solutions.
Phase 4 M12-M16	**Tactical** planning level: Evaluation and comparison of alternatives	• Full version of tactical IAM plan, including detail tactical planning for the priority (pilot) area(s); • Procedures for the collection, organization and quality control of data relevant to IAM: e.g. GIS, work orders, condition assessment / inspections, accounting data.

Results

The project's products included guidelines for developing IAM strategic and tactical plans, including MS Word® templates; training materials (presentations slides,

recorded webinars, written materials); significant improvements in the AWARE-P software; a national visibility public event where the participants reported mid-term results (in March 2013; around 200 attendants); papers in industry publications. The main outcomes for the participating utilities are summarized in Table 1.

Figure 2. Some of the strategic IAM plans produced

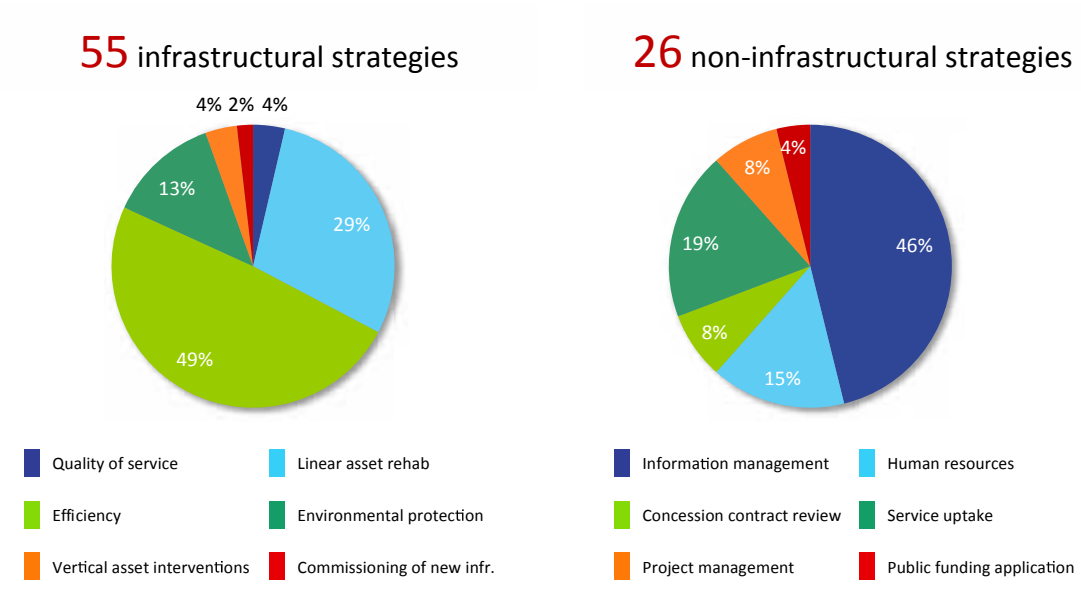

Figure 3. Digest of infrastructural and non-infrastructural strategies included in the IAM plans in the utilities taking part in the PGPI project

Central among the project results were the 30 sets of strategic and tactical IAM plans that the utilities produced, a rich and diverse first batch of cases creating a sizeable precedent for a broader roll-out (Figure 2). The way in which the several participating utilities developed their strategic and tactical plans, and implemented their IAM processes, was shaped by their context, resources, organizational maturity, information availability and the existence of other management systems or instruments. A large variety of cases illustrating the diversity of situations and solutions are available, two of which are illustrated in Table 2.

For the participating utilities, the project has led to effective harmonization of the organization' objectives, among the various management systems in place, with considerable alignment between decision levels and management processes (e.g., harmonizing kPIs cross-levels); the IAM strategic plans developed under iGPI are used as a central management tool in several of the participants; the project and IAM processes have been powerful drivers for improvements in data depth, quality, focus and integration; and many enhanced procedures for data collection, particularly related to work orders and surveying of buried assets, have been implemented.

The project has also had a major impact on the country's water industry, helping to raise awareness to the issue and making available software tools, documentation, planning templates, and a networkable community of IAM practitioners. The project provides the water services regulator with a workable basis to further develop the current regulatory framework and public policies.

The variety of cases covered demonstrates how, in actual practice, systematic and well-devised IAM processes can be tailored and successfully implemented in many different contexts. The collaborative project format has proven to be particularly suited to the task, enabling a quicker and more effective cultural change, technical uptake and process implementation.

Cases

The way in which the several participating utilities developed their strategic and tactical plans, and implemented their IAM processes, was shaped by their context, resources, organizational maturity, information availability and the existence of other management systems or instruments. Below are some cases illustrating the diversity of situations and solutions. Utility size is classed as follows: *Large utility*, above 100,000 households served; *Midsize utility*, above 40,000 and up to 100,000 households served; *Small utility*, above 15,000 and up to 40,000 households served; *Very small utility*, up to 15,000 households (not legally required to have IAM programs). The national average household occupancy is 1.8 persons, although with some significant regional variations.

Table 2. Sample cases from iGPI

CASE 1 Midsize	**Features:** technologically developed utility; well trained staff; good inventory; complete, reliable GIS; good monitoring systems; hydraulic models available for the entire water supply system.
• The availability of a large amount of information, mostly reliable, including all-mains calibrated hydraulic models for the entire water supply system, allowed this utility to use more sophisticated and data-demanding metrics to address aspects such as pressure adequacy and flow velocity adequacy. • Automated procedures have been implemented in order to calculate the selected metrics. • Some metrics at the strategic level result from the aggregation of more detailed metrics adopted at the tactical level. • Despite the technological maturity, the use of work orders information for reliability analysis revealed room for improvement. Non-infrastructural tactics were established to address this problem.	

- With an IAM metrics system in place, the fact that a significant part of the process has been automated shortens the time and manpower needed for detail diagnosis, which allow this utility to work simultaneously with 4 pilot network sectors at the tactical level (2 each for water supply and for wastewater) during the course of the project.

CASE 2 **Very Small**	**Features:** technologically aware utility at an early stage as an organization, having inherited their infrastructure; capable but limited human resources available; good inventory; full coverage, recent GIS; runs other municipal services. Serves a seaside tourist area.

- Seasonality causes overcapacity of the systems for a good part of the year; the utility is particularly interested in exploring flexible solutions in their IAM plans.
- Dependency on tourism increases the utility's exposure to the economic crisis, which required the consideration of diverse revenue-generation scenarios in developing and analyzing IAM capital maintenance plans.
- Successfully assessed and used the Infrastructural Value Index (Alegre & Coelho, 2012) as a prime metric for long-term scenario and intervention evaluation.
- After successful development of a strategic IAM plan for the water services, the utility decided to apply the same approach to the other services it runs (roads and public gardens).
- Due to the relatively small territory, a single stage was adopted in the tactical planning and the entire systems were the object of detailed analysis in the framework of the project.

CASE 3 **Small**	**Features:** technologically developed utility; capable human resources available; good inventory; mature BSC management system; quality of management certifications; full coverage, reliable GIS for the whole area; good monitoring systems.

- The existence of certified management systems was felt to be an advantage in terms of maturity, but also a challenge, given that the existing systems did not address the long term effect of managerial decisions.
- Top management agreed to review the BSC and introduce some small but critical changes. Due to the management's committed efforts and the small size of the utility, by the project's midterm a considerable harmonization of all existing management systems had been successfully implemented, with an adequate consideration to long-term sustainability, previously not present.
- The IAM planning approach is being applied to the other services this utility is responsible for.
- The detailed analysis of the water supply pilot area was thought to justify a hydraulic model. LNEC assisted the utility in generating a basic model file from the GIS and loading nodal demands in a simplified but effective way for planning purposes. This allowed for a sound diagnosis and assisted the development and comparison of intervention alternatives. The process and results achieved showcased the solution for the other utilities in a similar situation.

CASE 4 **Large**	**Features**: the utility is the result of the recent merger of several municipal water and wastewater services; very diverse contexts, challenges, and data availability and quality among the municipalities; certified BSC management system; GIS reflects the municipalities' disparity in data availability, depth and quality.

- The program was seen by the utility as a golden opportunity to help establish sound organizational processes.
- One of the challenges for this utility was to prioritize the municipalities with higher rehabilitation needs, in a sound, transparent and accountable way, in a context of local political sensitiveness where consensus-driven negotiation is crucial. The results from iGPI helped respond to this challenge, particularly through a sound IAM metrics system.
- The existing BSC implementation did not address the long-term effect of the managerial decisions. Although changes are more difficult to implement given the size and complexity of the organization, several new metrics have been included and a transition process has been devised towards a fully satisfactory BSC implementation.
- iGPI also gave rise to multiple new data collection procedures, particularly related to GIS, work orders, and harmonization among information systems.

CASE 5 **Very Small**	**Features: an** inland region municipality with the lowest population density in the project, with one main town and several dozen small rural villages scattered across a large expanse, several hours away from the country's main metropolitan areas. Small but capable and very motivated team. Strong mayor support to the project . In-house GIS implementation, based on open-source software.

- This utility is challenged by their limited human resources, who must share their time among multi-service responsibilities, and by the high time and cost of any operational or maintenance intervention outside of the main town. The utility took part in the project because they have long recognized a vital need for streamlining and maximizing efficiency, due to the resource limitations, as well as supporting their priorities on a sound basis. They also perceived that the collaborative format of the project would

provide them with access to experiences, assistance and networking which would be unattainable in other circumstances.

- The project allowed this utility to establish clear priorities in terms of intervention needs and start addressing the most problematic cases, related to aged networks and very high non-revenue water. Infrastructural and non-infrastructural tactics have been established and a short-term action plan is being under way.

CONCLUSIONS

Although with a long way to go, the authors believe that Portugal is progressing rapidly and with steady steps in terms of IAM of urban water services. Having recognized the need for change in this field, LNEC and its parters initiated the process by developing a well-structured IAM approach, supported by technical guides, training courses and leading-edge open-source software (aware-p.org, 2008-2012).

Learning from leading know-how and practice (e.g. Australia, New Zealand, EU research and IWA's network of professionals), LNEC partnered with other R&D organizations, software developers and utilities in the AWARE-P project to jointly develop a ground-breaking IAM planning methodology, supported by technical guides and a professional-grade, innovative software, plus e-learning and demo cases. A rollout & capacitation stage implemented through twin national-level initiatives, led by LNEC and by AWARE-P utility partner AGS, allowed the methods and software to be validated and refined while supporting the effective, on-field development and implementation of IAM methodologies by over 30 utilities.

Today, over 25% of Portugal's population are served by utilities that have produced their corporate strategic and tactical IAM plans based on the AWARE-P methodology and templates — endorsed by the national water services regulator ERSAR — with widespread use of the open-source software, effectively creating alignment and critical mass for much-needed change. This has been supplemented by 2 utilities in Spain and one in the USA, with a pilot starting in Australia in 2013; while the AWARE-P software has over 1000 registered users in 5 continents. IWA's LESAM 2013 singled out Portugal's disruptive IAM program in its conclusions, while WERF and USEPA (USA) are promoting uptake of the innovative methodology and further development of the software in the USA, and the World Bank's Danube Water Program has expressed an interest in the rollout formula utilized in the project. Given the diversity and representativeness of Portugal's water market, this project provides a valuable blueprint for similar development elsewhere.

ACKNOWLEDGEMENTS

The authors wish to thank the outstanding efforts and contributions from all the utilities, organizations and individuals that took part in iGPI and PGPI.

REFERENCES

Alegre, H., Coelho, S.T. (2012). *Infrastructure Asset Management of Urban Water Systems.* Chapter 3 of "Water Supply System Analysis", ed. Avi Ostfeld (ISBN 978-953-51-0889-4). Open access at: www.intechopen.com/books/water-supply-system-analysis-selected-topics

Alegre, H., Coelho, S.T., Covas D., Almeida, M.C., Cardoso, M.A. (2013). *A utility-tailored methodology for integrated asset management of urban water infrastructure*. Water Science & Technology: Water Supply, (in press) ©IWA Publishing 2013.

Alegre, H., Covas, D. (2010). *Infrastructure Asset Management of Water Services. An aproach based on rehabilitation*. Technical Guide 16. ERSAR, LNEC, IST, Lisboa, 472 pp. (in Portuguese) ISBN: 978-989-8360-04-5.

Almeida, M. C., Cardoso, M. A. (2010). *Infrastructure Asset management of Wastewater and Stormwater Services. An approach based on rehabilitation (in Portuguese).* Technical Guide n.17. ERSAR, LNEC, IST, Lisboa (ISBN: 978-989-8360-05-2) (in Portuguese).

Coelho, S.T., Vitorino, D., Alegre, H. (2013). *AWARE-P: a system-based software for urban water IAM planning*. IWA LESAM 2013, 10-12 Sep, Sydney, Australia.

Decree-Law no 194/2009. «D.R. 1.ª Série». 161 (20-08-2009) 5418-5435 (in Portuguese).

ERSAR and LNEC (2010). Quality of service assessment system for water and waste services – 2nd Generation of quality of service indicators. Technical Guides Series – ERSAR, LNEC, Portugal (in Portuguese).

Feliciano, J.; Almeida, R.; Alegre, H.; Covas, D. (2013a). Asset Management in small and medium *utilities – AGS' Experience.* LESAM 2013, IWA / AWA, 9-12 Sept., Sydney, Australia.

Feliciano, J.; Almeida, R.; Santos, A.; Ganhão, A.; Covas, D.; Alegre, H. (2013b). *Energy efficiency in water distribution systems – A path to an ideal network*. LESAM 2013, IWA / AWA, 9-12 Sept., Sydney, Australia.

ISO (2012a). ISO/CD 55000.2 *Asset management — Overview, principles and terminology*.

ISO (2012b). ISO/CD 55001.2 *Asset management — Management systems — Requirements*.

ISO (2012c). ISO/CD 55002.2 *Asset management Guidelines for the application of ISO 55001*.

ISO 24510: 2007. *Activities relating to drinking water and wastewater services - Guidelines for the assessment and for the improvement of the service to users.*

ISO 24511: 2007. *Activities relating to drinking water and wastewater services - Guidelines for the management of wastewater utilities and for the assessment of drinking water services.*

ISO 24512: 2007. *Service activities relating to drinking water and wastewater - Guidelines for the management of drinking water utilities and for the assessment of drinking water services.*