

Financing Models in Water Services Enablers of Infrastructure's Asset Management Best Practices

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1. Introduction

One of the major challenges facing urban water services is how to solve the financing gap in order to assure the necessary capital investments in new infrastructure and the rehabilitation and upgrading of existing ones. Governments' budget restrictions in carrying out public investment and the difficulty in mobilizing private investments, are more than enough reasons to understand why water infrastructure financing is a priority in the water agenda and why water utilities must maximize the utilization of existing infrastructures.

Water infrastructure's financing is a priority worldwide. In developed countries, the pressure on Governments' budgets consolidation have deeply constrained public investments in infrastructure. Due to this situation, capital investments in renewal and rehabilitation were postponed and infrastructures' degradation increased, with its consequent costs to society and to future generations (WEF, 2014). In emerging economies and developing countries, construction pace of new infrastructure has not been fast enough to eliminate the existing infrastructure gap (OECD, 2015). Water operators' lack of capacity to properly manage infrastructures and the low levels of cost recovery are key causes for deferred maintenance and rehabilitation, leading to degradation of service standards, risks of collapse and increasing operational costs. As consequence, water utilities in different world regions are currently facing big challenges to ensure long-term sustainability of urban water systems. Comprehensive Infrastructure Asset Management (IAM) approaches are important enablers to overcome these big challenges and should be seen by financiers as relevant vehicles towards water services sustainability.

The thesis evaluates the contribution of the financing institutions for water infrastructure's long term sustainability and proposes a methodology that can be used in infrastructure's financing contracts in order to persuade water utilities to adopt Infrastructure Asset Management (IAM) best practices. It is presented an innovative approach to be considered in infrastructure financing, based on a multi-criteria score system: the Infrastructure Sustainability Scorecard (ISS).

2. Background

The urban water sector is extremely capital intensive with high sunk costs due to the strong infrastructural assets necessary to support urban water services. In such contexts, IAM processes related to infrastructures' longevity and productivity should play an important role for the main stakeholders: water utilities, sector regulators, financing institutions and end users. Several international reports alert for the magnitude of the infrastructure gap and financing gap in urban water services. This diagnostic, confirmed in multiple reports, should lead policy makers and urban water sector stakeholders to implement policies and instruments to maximize the life-time value of existing infrastructures and increase its utility, by investing efficiently in the renewal and expansion of the water systems and thus extending asset life (WEF, 2014).

US Army Corps of Engineers (2013) states that the strongest IAM programs are in the countries in which the central government has made long-term funding for infrastructure asset management a top priority and has promulgated requirements to both their federal and local public institutions. Canada, Australia, New Zealand and the United Kingdom are leaders in these processes. It is not a coincidence that in these countries, central governments produce regularly National Infrastructures' Report Cards with the diagnostic of public infrastructures' present condition and correspondent priorities in public investments. Several of these report cards were studied, especially the approach and rational used to classify national water and wastewater infrastructures condition.

IAM plays a key role in investment decision processes, enabling well-informed decisions and contributing for a continuous balanced relation between performance, costs and risk. IAM programs allow optimal capital spending via risk-based planning and proactive prioritization and a better understanding of existing asset conditions and performance in order to unlock hidden capacity and increase infrastructures productivity.

The Figure 1 provides a clear systematization of the IAM building blocks and the correspondent information support systems.

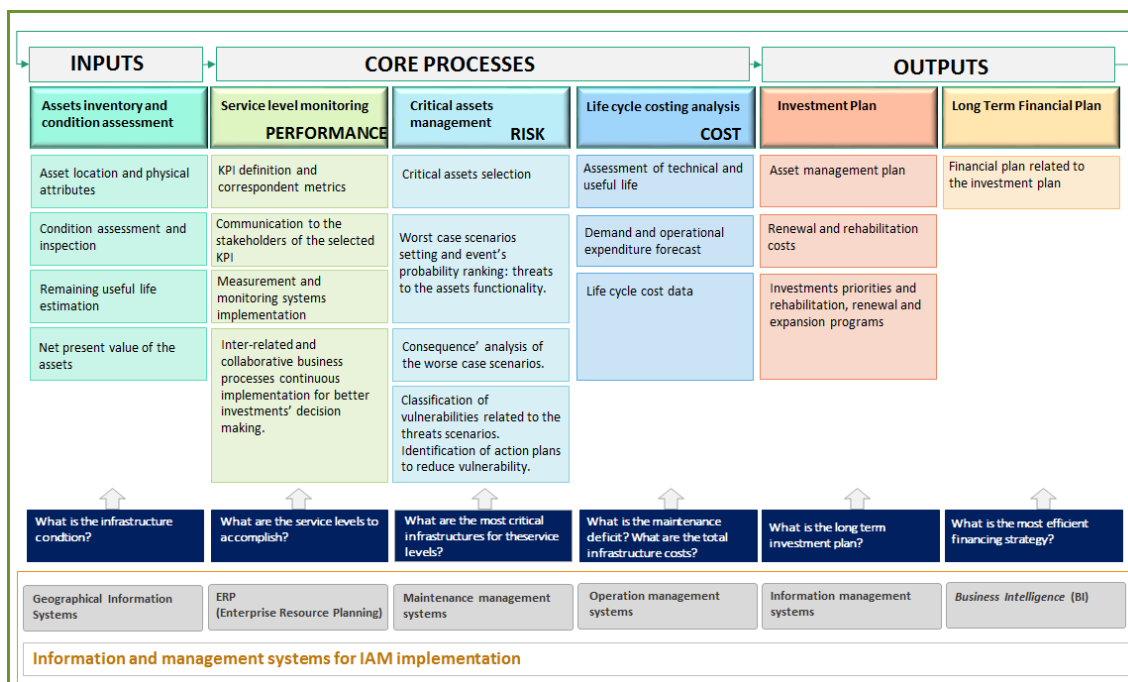


Figure 1 | Water IAM Building Blocks

In order to assure the optimal combination between capital expenditures and operational expenditures (CapEx and OpEx), water utilities planning instruments must be inter-related. In fact, water services sustainability requires a concerted effort to improve long-term planning, which involves, among other aspects, the assessment of: the infrastructure's value over time; the need for reinvestments; and the impact of long-term reinvestment policies (Alegre et al., 2014).

By other hand, it is important to have reliable and updated information to support investments' decisions and to monitor the interactions between infrastructure performance, operational costs and risks of failure. Therefore, a bibliographic research was done to identify the most proper performance indicators related to infrastructure's sustainability and condition. The next table summarizes the selected performance indicators used to monitor infrastructure value, maintenance adequacy and operational & economic efficiency. To have a balanced framework to support IAM decisions, this type of indicators and metrics must combine condition indicators and operational and service performance indicators. Therefore, any complete assessment of the infrastructure's condition should include the following types of key performance indicators (KPI): service interruptions; non-revenue water; mains or sewers structural collapses; rehabilitation rates, etc.

Indicator	Formula	Metrics	Author / Publication
Infrastructure Value Index (IVI)	$\frac{\text{Infrastructure Current Value}}{\text{Infrastructure Replacement Cost}}$	IVI can be seen as a weighted average of the residual life (%) of the infrastructure components. IVI is always referred to a date (year), as a snapshot. Target - between 45% and 55% (on average on long term)	Alegre <i>et al.</i> , 2014
Asset Sustainability Ratio (%)	$\frac{\text{CAPEX on Renewal of Assets}}{\text{Depreciation of Assets}}$	It is expressed as a percentage and it is an approximation of the extent to which the infrastructure assets are being replaced as they reach the end of their useful lives. Target - > 90% per annum (on average on long term)	Queensland Department of Local Government – as referred in Federal Highway Administration (2012)
Asset Renewal Funding Ratio (%)	$\frac{\text{NPV of Capital Invested Over 10 years}}{\text{Needed Investment to Sustain Assets}}$	It is expressed as a percentage and it represents the extent to which the required capital expenditures on renewals per the asset management plans have been incorporated into the 10-year financial model.	Queensland Department of Local Government – as referred in Federal Highway Administration (2012)
Return on Assets	$\frac{\text{Net income}}{\text{Total assets}}$	ROA measures how efficiently a company can manage its assets to produce profits during a period. It is a profitability ratio that measures the net income produced by total assets during a period by comparing net income to the average total assets.	

Table 1 | Performance indicators related to IAM

The answer to one of the key questions of the thesis (what are the benefits of IAM for infrastructures' projects financing institutions and investors) is deeply related to the positive impact of IAM approaches in risk management. Risk assessment plays a key role in the financing decision and financing conditions, which are related with the willingness of risk taking and the risk perception of the financing institutions and also with the water utility situation and context.

Two of the main factors considered in an investment decision are the uncertainty of financial losses and operational and service risks. The lack of information about solutions to minimize these risks can induce low

willingness to finance or increase the price of financing by increasing risk premium to a higher standard than adequate to compensate uncertainty, or even withdrawal.

International credit rating agencies (ICRA) can play an important role in increasing the availability of quality information in the water sector and can contribute for the awareness of the IAM importance both to public and private financing institutions and to the water utility. In the water sector, ICRA are active in private financing for mature markets, but the methodologies applied to classify water utilities and infrastructure projects may inspire innovative approaches to link financing instruments and IAM best practices' enablers. Moody's, Fitch Rating and Standard & Poor's Investor Services apply similar methodologies to classify the risk rating of water utilities. These methodologies are based on rating grids which take into account a wide scope of key-factors, namely the stability and predictability of regulatory environment, the asset ownership model, the cost recovery policies, the revenue risk and the scale and complexity of Capital Program and asset condition risk. Moody's assessment on the factor "Scale and complexity of Capital Program and asset conditions risk" also takes into account the underlying asset condition and the related risk of potential asset failure. A functioning asset-base is paramount for the water utility to comply with fixed service levels and regulatory duties, but also to ensure the stability of future cash-flow generation. Moody's (2015) highlights that deferred maintenance and under-investment may lead to the need for rapidly increasing capex in future years and therefore, it will impact the stability of future cash-flow. In conclusion, the benefits of IAM processes are taken into consideration by ICRA in the water utilities rating classification methodologies. This is a recognition that IAM enablers should be integrated in infrastructures financing instruments.

The benefits of IAM best practices, in the perspective of investors or financiers, are summarized as follows:

- Sound investment planning: optimal capital spending via risk-based planning, proactive prioritization of needs and increased *Value for Money* outcomes.
- Risk management: Improved control of the critical infrastructures and risk reduction for failures or collapses with impact in the water utility reputation and image.
- Capacity to pay debts: Optimized life cycle cost and higher return on assets.
- Service: consistent and continuous responses to the clients' needs and correspondent positive impact in the operator reputation.
- Long term sustainability: Reduced risk of non-payment.

These are the main drivers for the development of innovative water infrastructures financing solutions to unlock IAM benefits by inducing water utilities to adopt IAM best practices.

The relevance given by financing institutions to IAM also depends on their nature, on the project type and on the financing model. Water sector financiers are mainly multilateral development banks (MDB), institutional investors (investment funds, pension funds, insurance companies) and commercial banks (for instance, DEXIA, Bank of Tokyo-Mitsubishi, HSBC, etc.). MDB main goals are related to social and economic development and are mainly focused on the water infrastructures' social externalities. Institutional investors are particularly interested in the long term financing with controlled risk and stable cash-flow generation, which should be found in water infrastructure projects. Traditionally, commercial banks are more focused in the short term financing, mainly for financing construction phase.

The thesis presents a systematization of different water infrastructures financing models and for some of them identifies if and how infrastructure sustainability is taken into consideration. As result, it is clear that although there is a growing awareness of the IAM value by financial institutions, there are still few solutions considered in financing instruments encouraging explicitly good practices of IAM.

3. Implementation

An innovative approach to be taken into consideration in infrastructure financing solutions, based on Kaplan and Norton Balanced Scorecard (Kaplan et al., 1996), is developed in the thesis: the Infrastructure Sustainability Scorecard (ISS).

The main objective of this methodology is to provide financing institutions with instruments that enforce water utilities to adopt IAM best practices, and thus contribute to increase infrastructures long term sustainability and to contribute for the stability of cash-flow generation. In this way, financial resources may be used in a more effective way and the communication and dialogue between financing institutions, water utilities and IAM managers will be facilitated.

Infrastructure sustainability is deeply related with the expected longevity of the infrastructure, in a framework of good operational performance, minimum life cycle costs and controlled risks. Thus, ISS is based on an integrated perspective of three main infrastructural dimensions: VALUE, PRODUCTIVITY and PLANNING. Each dimension is assessed by selected KPI to monitor performance and sustainability ranking.

Infrastructure VALUE refers to the present infrastructure condition, measured by the remaining useful life. Useful life and renewal rate are key factors in the assessment of infrastructure value. Therefore, the ISS integrates the longevity perspective and the renewal rate. **Infrastructure PRODUCTIVITY** refers to the functional performance, which is also consequence of the infrastructure condition. It is related with operational efficiency and with contractual service levels. It complements the long-term vision reflected in the infrastructure VALUE, by combining performance with the remaining useful life. **Infrastructure PLANNING** refers to the complementarity between IAM planning, investments planning and long-term financial planning. Also includes a projection of the IVI for a 10-year period, assuming in the next 10 years the same level of historical renewal rates.

The criteria and assumptions considered in the ISS methodology are described in the next paragraphs:

- **Weight of each infrastructural dimension:** The criteria for the selected weight was to have a balanced distribution between the three dimensions: Value, Productivity and Planning: 30% - 30% - 40%.
- **ISS infrastructure concept:** in the ISS approach, infrastructure should be considered in its systemic concept, either all infrastructural systems managed by the water utility, or one of the systems, or even a water distribution network, depending on the objective and on the financing model.
- **ISS time frame:** the time frame to be considered is the long term and must be related with the financing contract maturity or with the concession contract duration, depending on the operator's nature and the type of the financing.
- **ISS flexibility and adaptability:** this is a critical point for the design of the ISS methodology and perhaps the more complex one. The ISS setting for a specific infrastructure project depends on multiple aspects and its

design should take into consideration all possible situations. For instance, the type of project (green field or brown field) determines different targets and rankings for some ISS indicators.

- **Water utility type and context:** ISS should have a broad scope of application. It can be applied in developing countries or developed regions, in public or private utilities. This ambition increases the complexity in the ISS design, namely because different environments and Utilities maturity also impacts on the information availability and reliability to support the ISS indicators measurement.
- **Incentives:** a core aspect in the ISS methodology is related with the incentives setting and its links with KPI targets. Taking into account that the ISS is centered upon the financing institution perspective, the incentives must be linked with financing conditions, utility eligibility, disbursement conditions and financing costs (spreads and interest rates).
- **ISS rating scale:** The ISS scale was inspired in the National Infrastructures Report cards analyzed in chapter 2.3. The maximum score is 5, which corresponds to a high standard of infrastructure sustainability. By opposition, 1 corresponds to high risk of infrastructure unsustainability correspondent to management practices that will lead to a rapid infrastructures' degradation, low service levels and increased risks of collapse.

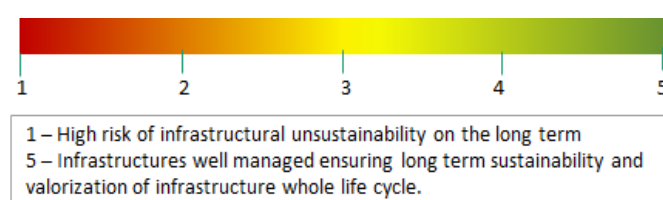


Figure 2 | Infrastructure Sustainability Scorecard rating scale

The implementation of the ISS approach to a real case should involve four main steps:

- **Step 1:** Diagnosis of the operator maturity in IAM practices in order to set the baseline for each KPI.
- **Step 2:** Operator contractual obligations and responsibilities, including ISS targets and initiatives check list to be implemented in 2, 5 and 10 years time order to achieve the fixed targets.
- **Step 3:** Survey and assessment of the resources needed to implement and monitor ISS compliance in the short, medium and long term. The financial contract should include a component for IAM capacity building and IAM management systems implementation.
- **Step 4:** ISS final design to be adaptable to the real case. The real case framework can lead to different targets and different paces to implement IAM initiatives.

The detailed structure of the standard Infrastructure Sustainability Scorecard is presented in Table 2.

In order to support the water utility to gradually implement IAM, ISS methodology is complemented by a check-list of IAM initiatives that can help to define a 10-years road-map for the implementation of IAM best practices, depending on the level of IAM maturity in the WU (Table 3).

Components		DIMENSION A Infrastructure VALUE		DIMENSION B Infrastructure PRODUCTIVITY						DIMENSION C Infrastructure PLANNING	
				Service perspective				Economic perspective			
Weight 1		30%		20%(*)				10%		40%	
Weight 2		20%	10%	5% (*) Water Supply	5% (*) Wastewater	5% (*) Water Supply	5% (*) Wastewater	5%	5%	30%	10%
FRAMEWORK		Infrastructure present value	Renewal rate	Physical losses	Number of colapses in sewers	Water interruptions	Flooding occurences	Rentability	Revenue	IVI ₁₀	Planning instruments
KPI DESIGNATION		Infrastructure Value Index	Infrastructure Renewal Rate	Physical losses index	Number of structural colapses occurrences	Water interruptions	Number of flooding occurrences in public streets or properties	Infrastructure rentability	Infrastructure economic margin	Infrastructure Value Index (Long Term)	Long term planning
ACRONIM		IVI (%)	IRR (%)	PLI (%)	SC (n./100 km.ano))	WI (n°/(1000 connections.year)	FO (n°/(100 km.ano)	IR (%)	IEM (%)	IVI ₁₀ (%)	IAM Plan + Long term financial plan
VARIABLE A		Present fair value	Annual economic depreciation	Volume of distributed water	Number of structural colapses occur per 100 km of sewer lenght	Number of monthly water interruptions	Number of flooding occurrences in public streets or properties originated by the sewers per 100 km of sewer length	Operational result	Revenue	Fair value in 10 years time, considering the present renewal rate in the next 10 years	IAM Plan
VARIABLE B		Replacement Value	Renewal capital expenditure	Volume of abstracted water	n.a.	n.a.	n.a.	Infrastructure present value	Economic depreciation rate	Replacement Value in 10 years time	Long term financial plan
FORMULA		A/B	B /A	operational measure	operational measure	operational measure	operational measure	A/B	B/A	A/B	n.a
What is measured:		Remaining useful life	Economic depreciation rate	Efficiency	Efectiveness	Resilience	Resilience	Return on assets	Relation between depreciation and the revenue	Simulation of remaining useful life in 10 yeras time	Integration of long term planning instruments
Rating Scale	GOOD = 5	45% <= IVI <= 55%	IRR => 90%	PLI <= 15%	0	0 <= WI <= 1	0 <= OI <= 1	4% <= IR <= 8%	IEM > 1,5	45% <= IVI <= 55%	With both plans
	ADEQUATE = 3	IVI > 55% 35% < IVI < 45%	40% > IRR > 90%	15 % < PLI < 25%	Between 0 and 1	1 > WI > 3	1 > OI > 3	0% => IR > 4%	1,2 > IEM => 1,5	IVI > 55% 35% < IVI < 45%	No IAM Plan
	POOR = 1	IVI <= 35%	IRR <= 40%	PLI => 25%	> 1	WI => 3	OI => 3	IR <=0%	IEM < 1,2	IVI <= 35%	Without both

(*) - When the ISS is applied only to water supply or wastewater systems, the weight for Productivity should be considered 10% for each KPI

Table 2 | Infrastructure Sustainability Scorecard

Anos após a conclusão da obra financiada	Check-list of initiatives to be implemented by the WU (the selection of the check list initiatives must take into consideration the WU maturity)							
	A. ORGANIZATION		B. INFRASTRUCTURES		C. PLANNING		D. MONITORING	
	Iniciativa A.1	Iniciativa A.2	Iniciativa B.1	Iniciativa B.2	Iniciativa C.1	Iniciativa C.2	Iniciativa D.1	Iniciativa D.2
2 anos (curto prazo)	Asset management function considered in the organizational chart		Inventory and asset valorization	IAM processes implementation	IAM Plan			
5 anos (médio prazo)	Asset management function at strategic level (Chief Asset Officer) and tatic level	IAM accountable area creation	Infrastructures condition assessment	Information and Management Systems implementation	IAM Plan update	Strategic Financial Plan integrated with IAM Plan	KPI monitoring	KPI external audits
10 anos (longo prazo)		IAM accountable area consolidation	Infrastructures condition assessment	Information and Management Systems integration	IAM Plan update	Strategic Financial Plan update	KPI monitoring	KPI external audits

Table 3 | IAM related initiatives to be implemented during the financing period

The ISS approach was applied to a real case: Fatima wastewater system, managed by a portuguese regional public operator, Águas do Centro Litoral. Table 4 summarizes the ISS results for Fatima Wastewater System.

Fatima Wastewater Infrastructures System									
		Infrastructure Value Index	Infrastructure Renewal Rate	Number of structural colapses	Number of flooding occurrences in public	Infrastructure rentability	Infrastructure economic margin	Infrastructure Value Index (Long Term)	Long term planning
		2015	2011-2015	2014 (RASARP)	2014 (RASARP)	2015	2015	2025	2015
VARIABLE A - 2015		9 899 907	1 562 903	0,6	3,5	42 924	418 215	6 390 870	não
VARIABLE B		15 517 135	71 426			9 899 907	330 364	18 008 269	não
KPI results		64%	5%	0,6	3,5	0,4%	1,27	35%	não
Rating Scale	GOOD = 5	45% <= IVI <= 55%	IRR >= 90%	0	0 <= OI <= 1	4% <= IR <= 8%	IEM > 1,5	45% <= IVI <= 55%	With both plans
	ADEQUATE = 3	IVI > 55% 35% < IVI < 45%	40% > IRR > 90%	Between 0 and 1	1 > OI > 3	0% => IR > 4%	1,2 > IEM => 1,5	IVI > 55% 35% < IVI < 45%	Com PGPI
	POOR = 1	IVI <= 35%	IRR <= 40%	> 1	OI => 3	IR <=0%	IEM < 1,2	IVI <= 35%	Without both
SCORE (base line)		3	1	3	1	3	3	3	1
		0,6	0,1	0,3	0,1	0,15	0,15	0,9	0,1

2.4

2,4

Table 4 | Fátima Wastewater System. ISS results.

This exercise was important to test ISS methodology and identify aspects that should be further detailed:

- The relations between KPI results and the ISS rating scale must be further detailed, based in the WU available information.
- Different depreciation criterias have great impact in the KPI results and in the infrascrtutue value. National accounting regulamentation related to asset depreciation should be in line with economic and physical depreciation rules.
- The ISS sub-domain related to the infrastructure economic-financial productivity must be further analysed.

Although the ISS methodology should be further detailed and tested, it may be a step to directly involve financiers into the challenge of unlocking the benefits of IAM best practices. Indeed, it is urgent to set the scene for a more effective dialogue between the financing world and the IAM managers.

4. Results and conclusions

In the next decades huge amounts of capital investments will be needed to develop urban water infrastructure assets, globally. In most regions, water systems are aging, there is a large backlog for the replacement and rehabilitation and many assets are coming close, or even going beyond, the end of their useful lives and need to be urgently replaced. In others, recent water infrastructures are out of service due to inadequate management practices. This picture confirms the urgent need to address these problems through innovative approaches and to increase infrastructures sustainability and productivity.

Even if it is already clear for financing institutions that IAM can contribute to increase investments effectiveness, there are still few instruments in financing models that enable water utilities to adopt IAM best practices. The necessary change of attitude of financiers and investors towards IAM requires a transformation of behaviors, not only from WU managers and regulators, but also from multilateral lenders, towards a shared understanding of common solutions to effectively achieve sustainable infrastructures' investments. For this new culture, it is necessary to promote dialogue and innovative forms of communication between financiers and IAM experts regarding infrastructures projects. IAM can definitely contribute to improve sustainable financing in the urban water sector.

One of the thesis conclusions is the need to increase incentives in financial instruments to leverage infrastructural investments' sustainability and to minimize the risks of inefficient use of capital investments. In developing countries it is rather frequent to have recently constructed systems out of use due to ineffective IAM. Other important constrain is the scarce information available to investors and financiers about water infrastructure projects and their limited understanding about the sector (OCDE, 2010).

Thus, it is urgent to develop innovative tools linking IAM and infrastructures financing that can boost two complementary objectives: greater attractiveness of water infrastructure projects for private financiers and improvement of infrastructures sustainability and productivity.

In this sense, the innovative solution conceived in the thesis, the Infrastructural Sustainability Scorecard, has the dual objective of giving incentives in order for water utilities to maximize the infrastructure's life cycle value, through well-informed investment decisions, good-sound renewal practices and integrated long-term planning, and provide, in a regular basis, information on the performance and condition of financed infrastructure to the lenders. Thus the ISS may contribute to a comprehensive framework for infrastructure sustainability and an effective and efficient use of financial resources in infrastructure projects.

There is still a long way to go, but innovative solutions, as the ISS methodology, can also play a role to solve the financing gap in the water sector.

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