A utility-tailored methodology for integrated asset management of urban water infrastructure

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AMAREP

Introduction

The AWARE-P methodology

Software

Producing IAM plans in practice

Case: tactical planning in a midsize utility

Final remarks

Urban water systems

- High levels of deferred maintenance and rehabilitation and overwhelming investment needs demand wise spending and efficient planning.
- Successful infrastructure asset management (IAM) is essential for long-term, sustainable compliance with performance requirements.
- Effective decision-making requires a comprehensive approach that ensures the desired performance at an acceptable risk level, taking into consideration the costs of building, operating, maintaining and disposing of capital assets over their life cycles.

Networked infrastructures

- Systems, not collections of assets

- Long-term evaluation: as a whole, these infrastructures have an indefinite life

IAM

- …the "*art of balancing performance, cost and risk in the long term*".
  - Brown and Humphrey (2005)
- The approach described here was developed under AWARE-P, an R&D project aimed at producing effective tools for assisting urban water utilities in IAM decision-making.
- www.aware-p.org

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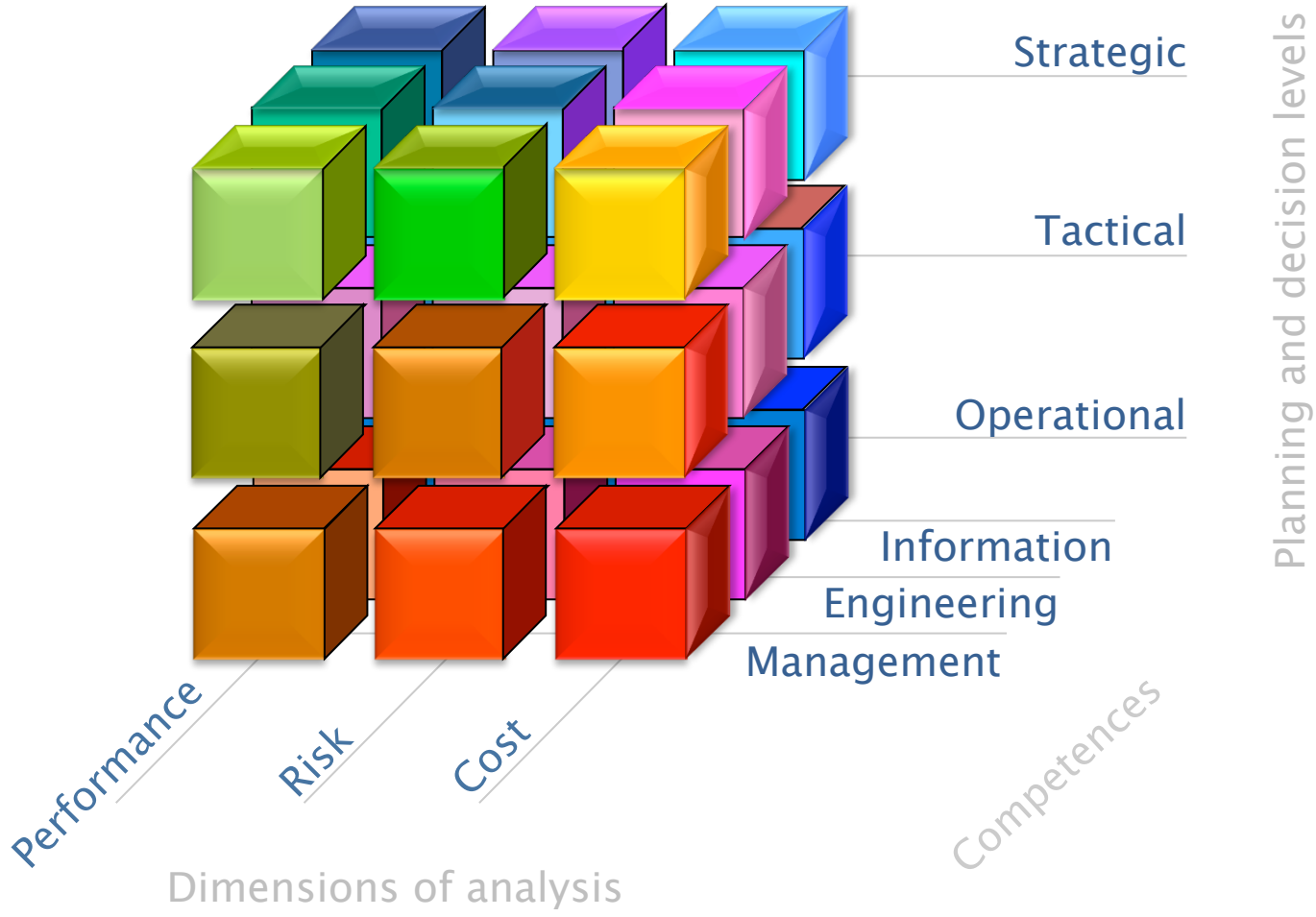
The IAM cube

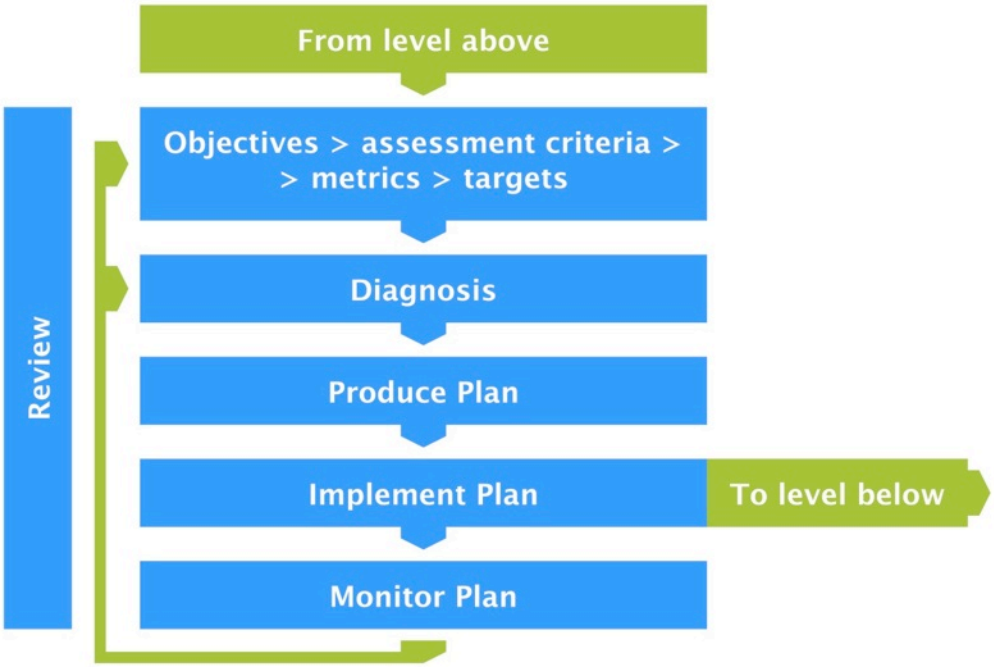

Strategic
Tactical
Operational
Information
Engineering
Management
Planning and decision levels
Performance
Risk
Cost
Competences
Dimensions of analysis

The methodology

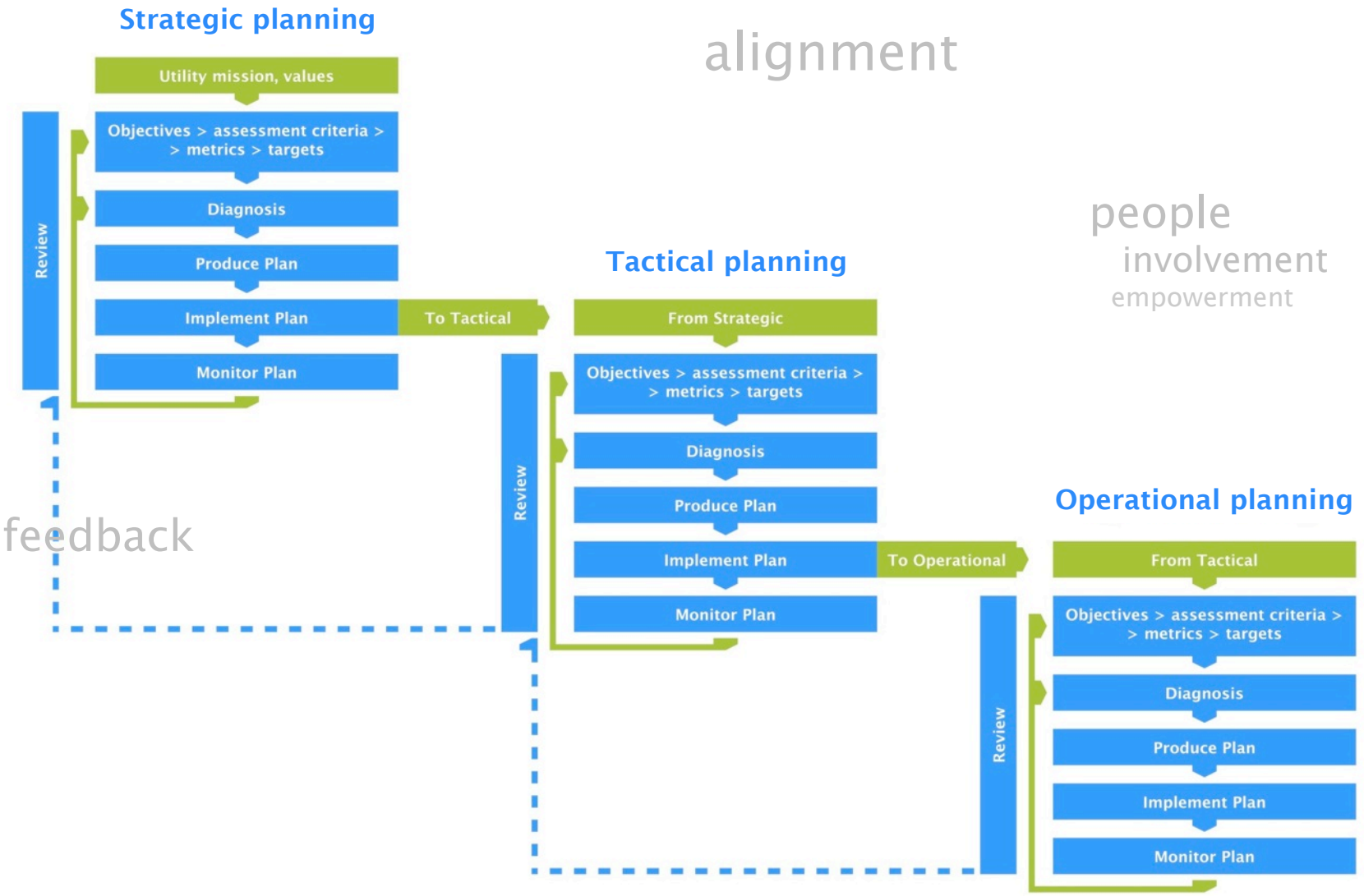
- Standardized assessment and comparison of intervention alternatives from the performance, cost and risk perspectives, over the analysis horizon(s)
- Crucial: define objectives, metrics and targets
- It aims at assisting utilities in answering:
  - *What infrastructures do we own or operate?*
  - *What service do we deliver?*
  - *Where do we want to be in the long term?*
  - *How do we get there?*

IAM at each planning level

- A PDCA loop



Through decisional levels…



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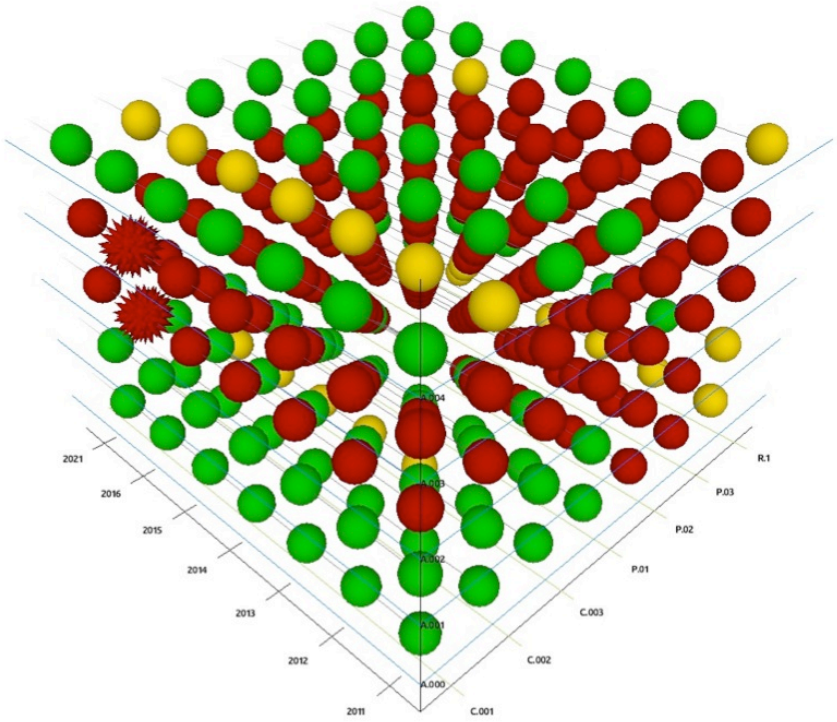
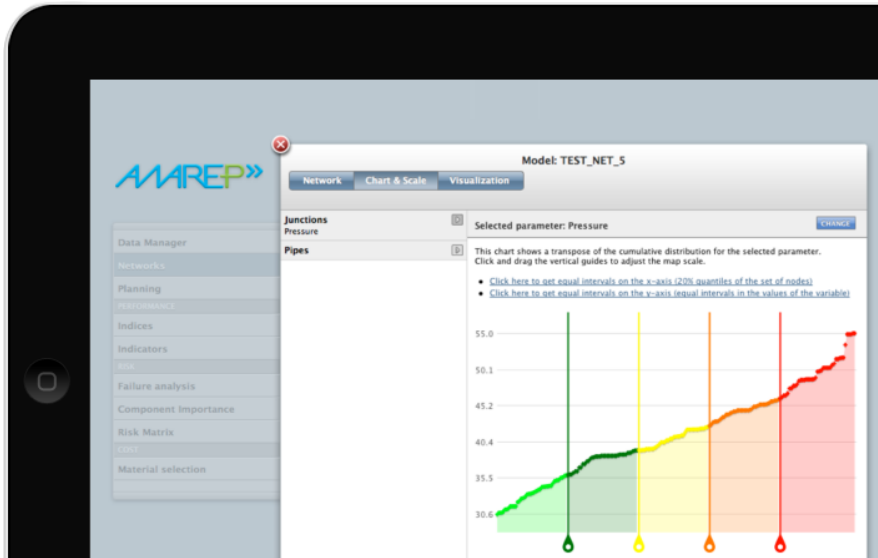
The AWARE-P software

- An organized assessment environment where planning solutions or competing projects are measured up and compared.
- A portfolio of performance, risk and cost metrics and analysis tools for diagnosis and sensitivity gain.
- www.baseform.org



The AWARE-P software

- Integrates all the necessary data
- Oriented to system response
- Capable of system-level metrics and component-level metrics (within the system)
- Web-based, client-server (cloud/ corporate/ local)
- Modular, made to grow
- Multi-user
- Multi-platform (PC, Mac, iPad, Linux)



Current toolset

- NETWORK – model-enabled network environment
- PLAN – the central planning framework
- PI – Performance Indicators
- PX – Performance Indices
- FAIL – Poisson and LEYP, pipe failure prediction
- CIMP – component importance.
- UNMET – reduced service estimation.
- IVI – Infrastructure Value Index
- FIN – Financial project planning

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Project utilities (2010-2012)

STRENGTHS	WEAKNESSES
- Good information systems on the water supply infrastructures - Sufficient information to assess the water supply systems condition and performance - Strong competence of human resources - Relation between information systems and work orders	- Insufficient information systems on wastewater infrastructures - Financial restrictions - Inadequate tariffs - Poor structural infrastructure condition - Poor functional infrastructure performance - Insufficient historical records - Inadequate quality of data
OPPORTUNITIES	**THREATS**
- Equipment and technologies available to support IAM - Portuguese regulation by ERSAR * - Portuguese legislation related with IAM - Incentives for sustainable use of energy	- Portuguese legislation and regulation by ERSAR* (increase in costs) - Political uncertainties - Economic crisis and financial restrictions - Demographic development uncertainties - Illegal cross connections in wastewater systems

* ERSAR: the water and waste services regulator in Portugal

Common key strategies

- Water supply-specific:
  - *Control water losses*
  - *Promote proactive rehabilitation practices*
- Wastewater/ stormwater-specific:
  - *Reduce untreated wastewater discharges*
  - *Reduce cross connections and WW infiltration/ inflow*
- Common to both:
  - *Improve infrastructure information systems*
  - *Increase system reliability*
- AWARE-P: 4 utilities
- iGPI IAM initiative: 19 utilities (iniciativaGPI.org)

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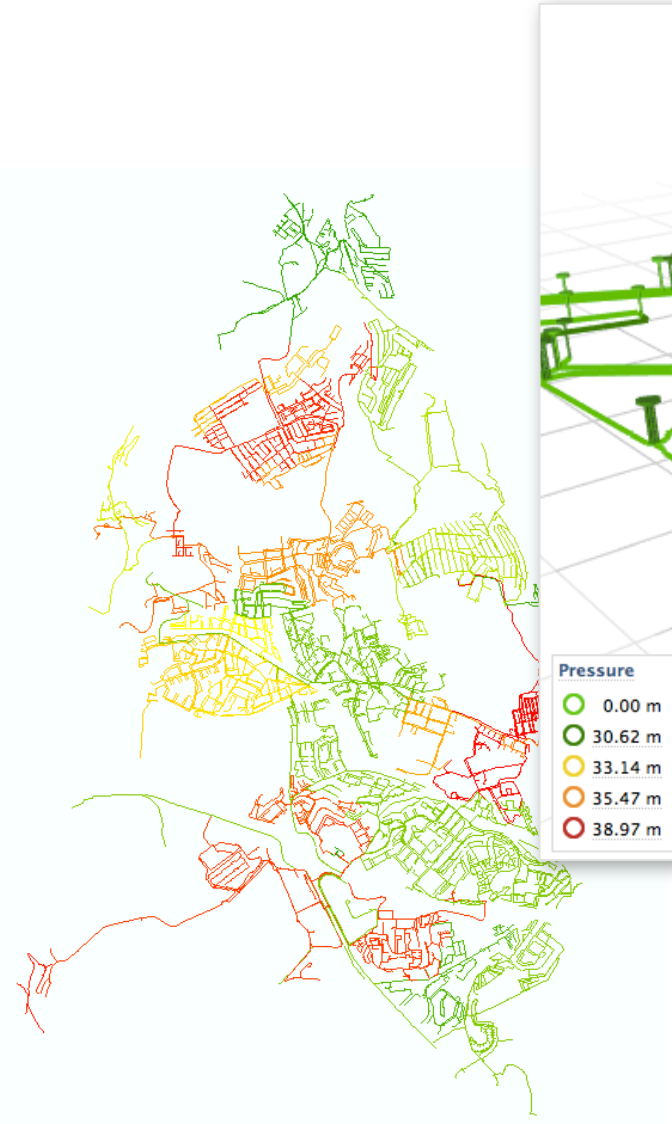
Case

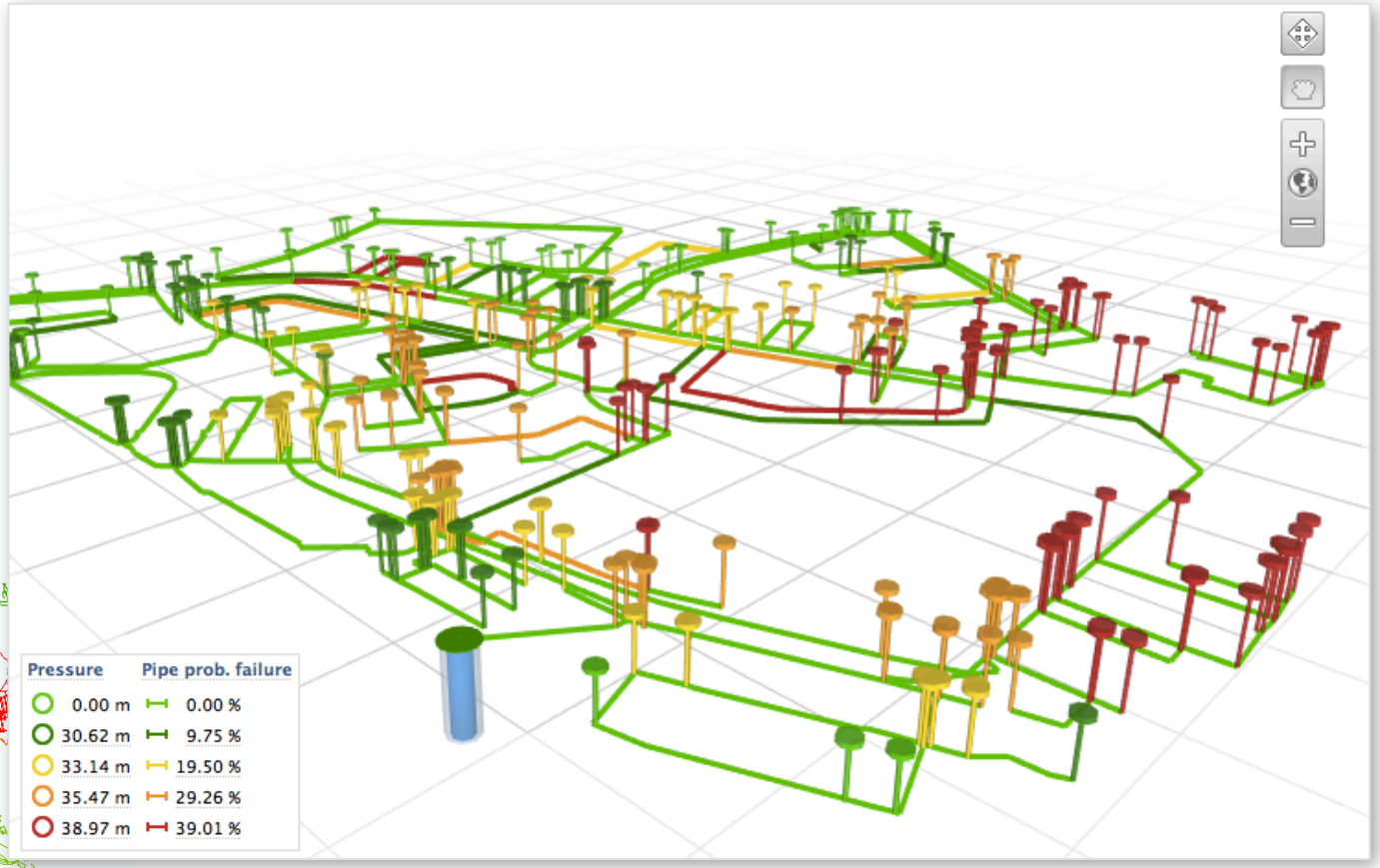
- Tactical plan for a midsize WU

Strategic objectives	Criteria
1. Adequacy of the service provided	1.1 Service accessibility; 1.2. Quality of service provided to customers
2. Sustainability of the service provision	2.1. Economic sustainability; 2.2. Infrastructural sustainability; 2.3. Physical productivity of human resources
3. Environmental sustainability:	3.1. Efficiency of use of environmental resources

- Based on the strategic plan, the following tactical IAM objectives were set:
  - *Increase system reliability in normal and contingency conditions*
  - *Ensure economic sustainability*
  - *Ensure the infrastructural sustainability of the system*
  - *Decrease water losses*

A 5-yr plan for DMA 542





Metrics and reference values

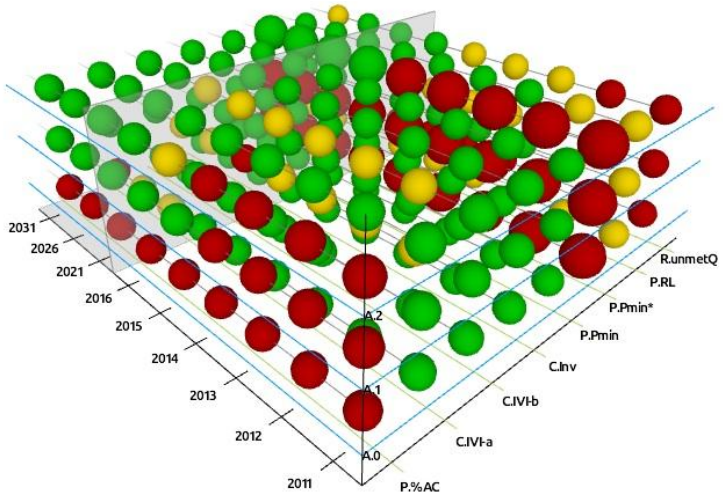
	Good (green)	Fair (yellow)	Poor (red)
Inv (cost units)	[0, 350[	[350, 450[	[450, ∞[
IVI (-)	]0.45, 0.55[	[0.30, 0.45[; [0.55, 0.70[	[0, 0.30]; [0.70, 1]
$\mathbf{P_{min}}$ (-)	[3, 2[	[2, 1[	[1, 0]
$\mathbf{P_{min}}$* (-)	[3, 2[	[2, 1[	[1, 0]
AC (%)	[0, 9[	[9, 15[	[15, 100]
RL (l connection^{-1} day^{-1})	[0, 100[	[100, 150[	[150, ∞[
UnmentQ (m^3/year)	[0, 20[	[20, 30[	[30, 100]

- Diagnosis:
  - System reliability: *insufficient pressure in normal conditions in some locations; high pipe failure rates; low system resilience in contingency operation conditions.*
  - Infrastructural sustainability: *poor condition asbestos cement pipes, with high failure rates.*
  - Water losses: *undesirable leakage levels.*

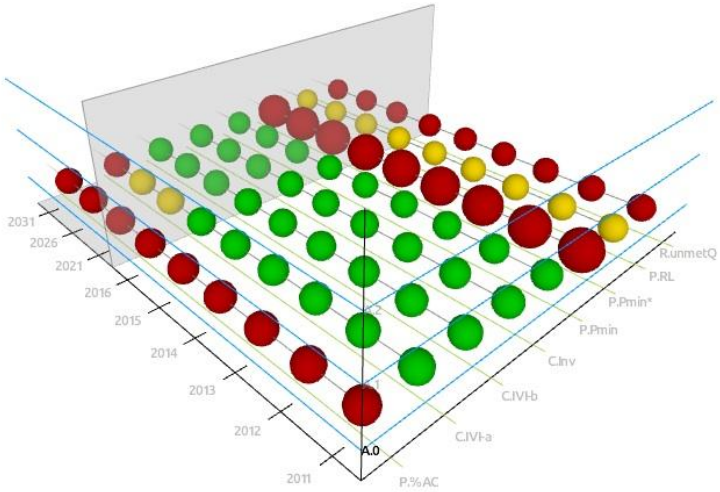
3 intervention alternatives

- Alternative A0 (*status quo* or base case)
  - Keep the existing network and the current reactive capital maintenance policy.
- Alternative A1 (*like-for-like* replacement)
  - Replace *priority pipes* by same-diameter HDPE pipes. The prioritized list was developed externally using pipe failure and consequence analysis and an ELECTRE TRI decisional method, taking into consideration municipal coordination.
- Alternative A2 (system-driven solution)
  - An IAM project based on an *ideal* redesign for the network, as if it were built from scratch for the planning context.

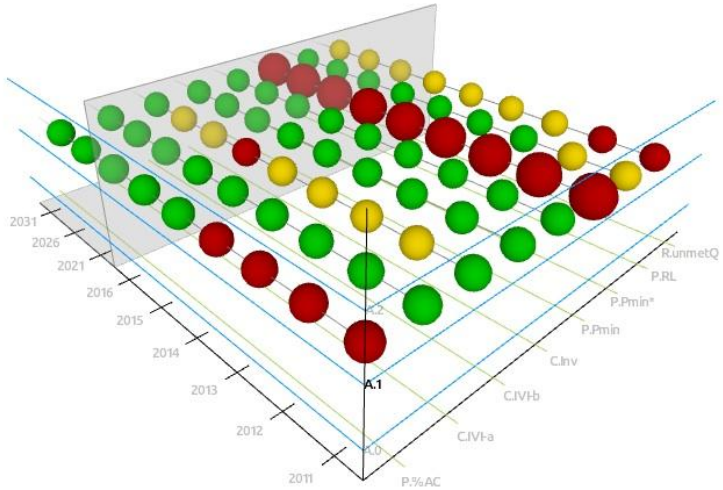
Alternatives	Assessment metrics						
	Inv (c.u.)	IVI (-)	P_{min} (-)	P_{min} * (-)	AC (%)	RL (l conn.$^{-1}$ day^{-1})	UnmetQ (m^3/year)
A0	0	0.47	2.88	0.00	37.2	116	36
A1	274	0.73	2.88	0.00	1.5	52	22
A2	350	0.70	2.99	2.99	8.5	54	18



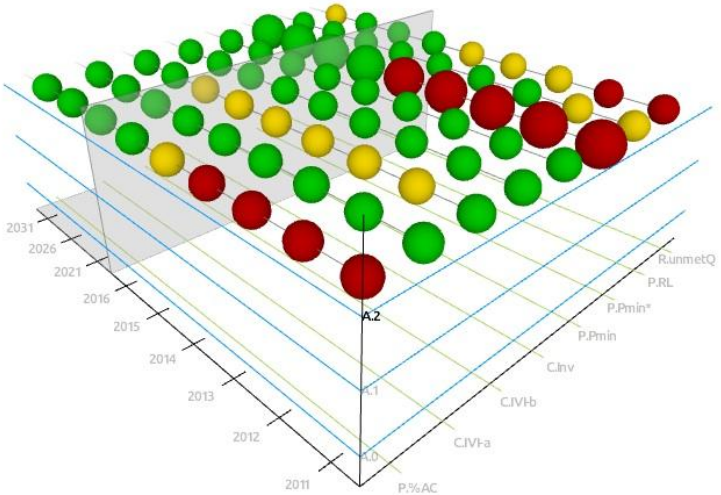
(a) 3D cube with metrics, time and alternative



(b) Alternative A0



(c) Alternative A1



(d) Alternative A2

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In short…

- The AWARE-P project aims at creating awareness to the need for effective IAM, by changing current practices, improving technical know-how in the industry and providing guidance tools and software.
- The objective of this approach is to encourage and assist urban water utilities in implementing a coherent, structured procedure for IAM.
- The AWARE-P software makes available the best tools for visualizing, diagnosing and evaluating an urban water system, through a portfolio of performance, risk and cost models.
- There is strong practical evidence that this standardized and flexible IAM planning framework can be successfully used to tackle water utility problems.

www.aware-p.org

www.iniciativaGPI.org

www.baseform.org