



H.F.R.I.
Hellenic Foundation for
Research & Innovation

Description of the funded research project
1st Call for H.F.R.I. Research Projects to Support Faculty Members &
Researchers and Procure High-Value Research Equipment

Title of the research project:

Probabilistic Modeling of Water Losses in Water Distribution Networks: Development of Innovative Tools for Statistical Estimation, Uncertainty Parameterization, and Optimal Sizing of Pressure Management Areas

Principal Investigator:

Dr. Andreas Langousis

Reader-friendly title:

ProMoWaterNet

Scientific Area:

Engineering Sciences & Technology

Institution and Country:

University of Patras, Department of Civil Engineering, Greece

Host Institution:

University of Patras, Department of Civil Engineering

Collaborating Institutions:

Municipal Enterprise of Water Supply and Sewerage of the City of Patras, Patras, Greece

University of Cagliari (Italy), Department of Civil, Environmental and Architectural Engineering



Budget: 188,813.45 €

Duration: 36 months

Research Project Synopsis

ProMoWaterNet intends to address the pressing problem of water loss estimation and effective leakage control in water distribution networks (WDNs), by developing an integrated framework for probabilistic modeling of water losses, and optimal sizing of pressure management areas (PMAs).

ProMoWaterNet develops an integrated, theoretically founded, and practically applicable methodology to:

- a) Statistically estimate base losses in water distribution networks (WDNs) as a function to their length and specific characteristics.**
- b) Parameterize the associated uncertainties using standardization techniques and detailed probabilistic models.**
- c) Address the demanding problem of optimal partitioning of WDNs into pressure management areas (PMAs) for improved pressure regulation and leakage control.**
- d) Demonstrate the efficiency of the introduced framework by developing a large-scale real world application of (a) - (c) above to the water distribution network of the City of Patras; i.e. the largest smart water network (SWN) in Greece.**

Ultimate goal and challenge, is to effectively reduce water losses in individual PMAs and the entire network and, consequently, minimize the associated operating costs and environmental footprint, without undermining the hydraulic resilience of the WDN to pipeline failures and/or increased consumption rates.

Project originality

The proposed research is conducted using flow-pressure time series from 79 local pressure regulation stations operating in the WDN of the city of Patras, which are part of the “Integrated System for Pressure Management, Remote Operation and Leakage Control of the Water Distribution Network of the City of Patras”, with the Municipal Enterprise of Water Supply and Sewerage of the City of Patras (DEYAP) acting as the competent Authority for its operation and management.

Currently, no methodological framework exists that holistically addresses:

- a) The pressing problem of probabilistic modeling of water losses in water distribution networks (WDNs).
- b) The optimal partitioning of WDNs into individual pressure management areas (PMAs) for effective pressure management and leakage control.
- c) Seeks for a full-scale validation of the developed concepts and methods in an existing WDN.

Expected results & Research Project Impact

Research findings and results:

- a) Development and testing of new methods and statistical tools for estimation of base losses in WDNs.
- b) New standardization procedures and fitting methods to describe WDN base losses in a probabilistic context.
- c) Development and implementation of a search algorithm for the optimal sizing and allocation of pressure management areas (PMAs) in WDNs.
- d) Application of (a) - (c) above to the WDN of the City of Patras and generation of detailed spatial maps of water losses and operating costs.

The anticipated research findings and results are expected to:

- a) Advance the current understanding and state-of-the-art modeling of water losses in WDNs.
- b) Promote the Greek entrepreneurship and technical expertise in the international scientific community (e.g. through presentation of findings in International Scientific Conferences and Assemblies, and peer-reviewed publications in International Scientific Journals).
- c) Allow the city of Patras to effectively estimate and reduce water losses in its water distribution network, thus minimizing the associated operating costs and environmental footprint without undermining the hydraulic resilience of the network.
- d) Promote the city of Patras as an international paradigm of large-scale effective leakage management and control using state-of-the-art modeling tools.

The importance of this funding

Irrespective of their age, Water Distribution Networks (WDNs) exhibit losses with important environmental and financial consequences; i.e. unnecessary reduction of fresh water, and increase of the non-revenue water volume. As an indication of the magnitude of the problem, please note that water loss ratios in old and poorly maintained networks are on the order of 70%.

The H.F.R.I. funding gave the opportunity to establish a well equipped and excellently qualified research group, which is based at the Hydraulic Engineering Laboratory of the Department of Civil Engineering at the University of Patras, working in the emerging area of water loss estimation in Water Distribution Networks, with particular emphasis on the development of innovative methods and tools for probabilistic modeling, statistical estimation and uncertainty parameterization of water losses in WDNs, and optimal pressure management for water loss reduction.



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