



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: *A stress testing platform for cyber-physical threats on urban water systems*

Principal Investigator: *Christos Makropoulos*

Reader-friendly title: *PROCRUSTES*

Scientific Area: *Engineering Sciences & Technology*

Institution and Country: *National Technical University of Athens, Greece*

Host Institution: *National Technical University of Athens*

Collaborating Institution(s): *Institute of Communication & Computer Systems (ICCS) of NTUA*

Project webpage: <http://www.procrustes.gr/en/>



PROCRUSTES



Budget: 185,833.10 €

Duration: 36 months

Research Project Synopsis

Water infrastructures, are Critical Infrastructures (CIs), essential for human society, life and health. However, like other CIs (e.g. energy or transport networks), they are vulnerable to cyber-physical (CP) threats, including accidental events and deliberate attacks. Such events in water systems may lead to catastrophic consequences that affect society, economy and most importantly, public health. Despite the recent advances in water systems security, further work is required towards a novel risk management framework that efficiently tackles CP threats, strengthen the capacities of water utilities to protect their systems, determines gaps in security technologies and improves risk management approaches and technologies. PROCRUSTES will address these challenges by developing a strategic risk-assessment framework and an associated toolkit able to analyse and evaluate CP risks (and their combinations) on water CIs and support the choice and evaluation of appropriate risk treatment options. The project will develop novel concepts and methodologies to assess risk in Cyber-Physical water systems (CPS), assemble a modelling toolkit for risk analysis and evaluation and develop a stress-testing environment for evaluating the effectiveness of different risk reduction measures. Moreover PROCRUSTES will develop a comprehensive risk reduction measures knowledge base recommending suitable actions to avoid or mitigate the occurrence of risk events for water CIs. The above will be integrated into a dynamic risk assessment framework able to represent the logic of risk assessment and support the choice of risk treatment options as well as ensure risk contextualization and risk treatment harmonization for physical-cyber threats hazards and their combination. The PROCRUSTES system will be accessible, as a service, by any water utility, and will be especially useful in the cases of smaller, less technically equipped water utilities, such as municipal water companies (DEYA) in Greece and around Europe that are currently vulnerable to cyber-physical attacks.

Project originality

Originality of the project stems from the contemporary challenges it addresses and the means it adopts to achieve it. PROCRUSTES work advances the state-of-the-art and is highly innovative by leveraging the ability of Agent Based Model (ABM) approaches to describe systems of complex adaptive nature that characterize behavioural (e.g. choice of target), socio-technical systems (e.g. water systems including human stakeholders) and their “real-world” interaction and creating an ABM tool for quantifying cyber-physical threats in the water sector. Additionally, the PROCRUSTES risk assessment tool will advance the state-of-the-art through the elaboration of an integrated risk assessment system capable of combining models and tools together from different scientific fields i.e. simulation tools of the physical water system and the cyber control logic based on the spatial and temporal situation combined with the operational purpose of the CI (situational awareness). The stress testing platform will aid in our understanding of the behaviour of combined cyber-physical systems beyond normal operational capacity, building on systems thinking and hydro-informatics for a more resilient water sector. PROCRUSTES will bridge the gap between physical and cyber threats to the water system and policy rhetoric, through the development of the framework for tactical and strategic risk assessment and intervention planning. Finally, on-site decision support at the tactical and strategic levels will be driven by semantics to contextualise and harmonise risk information (semantic interoperability), facilitating the discovery of cascading effects and achievement of systematic and systemic risk assessment. The need for such research is growing as the risk of cyberattacks is rising with the rise of instrumentation, Internet of Things (IoT) and other ICT-related developments in the water sector.

Expected results & Research Project Impact

PROCRUSTES will develop a dynamic risk assessment & treatment framework, capable of encapsulating state of art cyber-physical risk analysis approaches, support the selection of appropriate mitigation actions, as well as to ensure harmonization in the risk management processes for CP threats among different users. It will encompass:

(a) new methods for risk assessment for CP water systems,

(b) an advanced toolkit of models and KPIs of the physical and cyber sub-systems of water infrastructure, capable of analysing and evaluating risks and stress-testing mitigation options (essentially a modern 'Procrustes bed' for water systems) and

(c) a risk treatment database with advanced choice support capabilities.

The PROCRUSTES system will be accessible, as a service, by any water utility, no matter its size, and will be useful for both large water utilities that will be able to increase their resilience and support their operations and SMUs, such as municipal water companies (DEYA) in Greece and around Europe, which are less technically equipped and thus more vulnerable to cyber-physical attacks. PROCRUSTES aims to support water utilities and enable them to safeguard their core mission, to provide safe water to consumers and future-proof them against a new era of emerging CP threats. Through the development of novel safety and security planning methods and tools for the water sector, this research enhances the country's scientific and technological development and competitiveness of research and innovation and may foster economic growth for the emerging market of CI security, beyond the water sector (i.e. energy, oil, gas, transportation). By safeguarding the vital societal need of water supply, the impact of the proposed research extends to the protection of health, safety and the environment.

The importance of this funding

The H.F.R.I. funding for PROCRUSTES project grants us the opportunity to work on aspiring new ideas and expand the existing body of knowledge in the fields of resilience and risk analysis, uncertainty quantification, decision support and long-term policy scenario development and cyber-physical water systems stress-testing. It boosts the academic community by allowing PROCRUSTES to engage researchers and PhD candidates in cutting-edge research ideas that address contemporary, practical issues of the water sector and embrace the social dimension of contemporary urban water management, such as social needs, concerns and consequences under the dawning digital era. Furthermore, this funding allows to further pursue the personal vision for robust, novel and interdisciplinary approaches in the ever evolving field of hydroinformatics, with a view on resilient and cyber-prudent water infrastructures. Most importantly though, it gives us the opportunity to contribute towards the shared vision of a better and safer future for our societies.



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