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AI-enhanced urban water quality monitoring

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Motivation

Urban water quality monitoring is vital for protecting both public and ecosystem health. It supports the identification of hazardous pollutants and helps detect risks linked to specific water parameters. Moreover, reliable monitoring enables municipalities to detect water quality issues early, allowing faster responses and improved water quality management. Its importance is growing due to increasing urbanization, anthropogenic interference with natural water bodies, and climate change impacts. Fig. 1 presents the European case studies examined in this research, representing diverse urban environments and stressors.

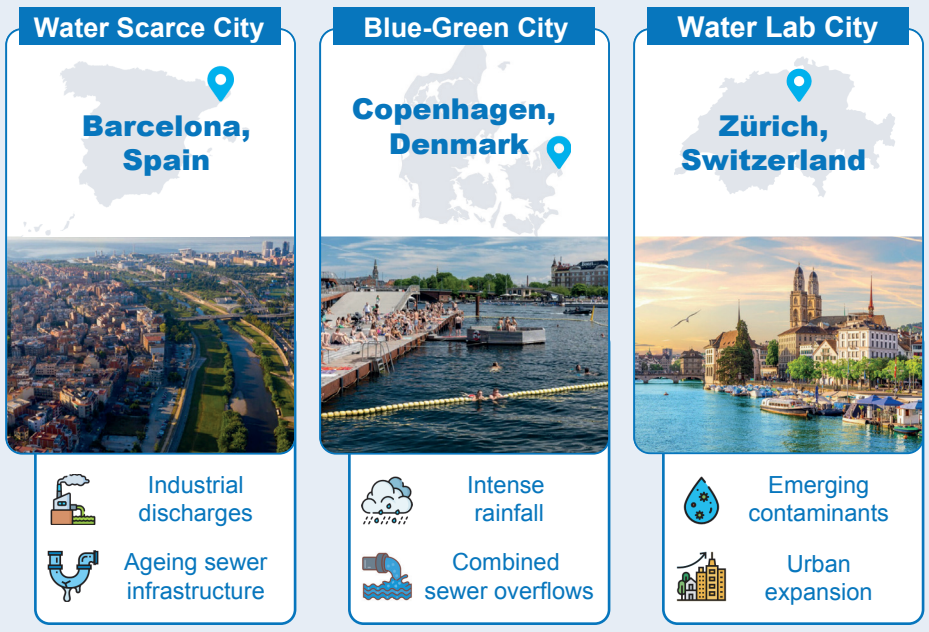

Fig. 1. Profiles of the three European case study cities.

Technological challenge

Despite this urgency, traditional water quality monitoring approaches face significant limitations. Lab-based (*ex-situ*) analysis is costly and introduces delays in providing results, while sensor-based (*in-situ*) monitoring provides near real-time results but remains limited in detecting complex contaminants. Moreover, achieving the same level of detail as lab analysis would require more advanced sensors, which would also be too costly.

Research goals

Illustrated in Fig. 2 is the proposed framework for the development of virtual sensors for water quality monitoring through combining Kalman filtering (KF) and machine learning (ML) to predict the concentrations of emerging water pollutants.

Building upon this proposed framework, the present work addresses the following primary objectives:

- Develop a robust, hybrid KF-ML framework for virtual water quality sensing.
- Predict the concentrations of unmeasured, emerging water pollutants.
- Assess the framework's generalizability across diverse urban environments and across data-rich to data-poor settings.

which directly contribute to:

- Reduced operational costs of water quality monitoring.
- Enhanced temporal resolution of water quality measurements.
- Real-time monitoring of emerging pollutants.

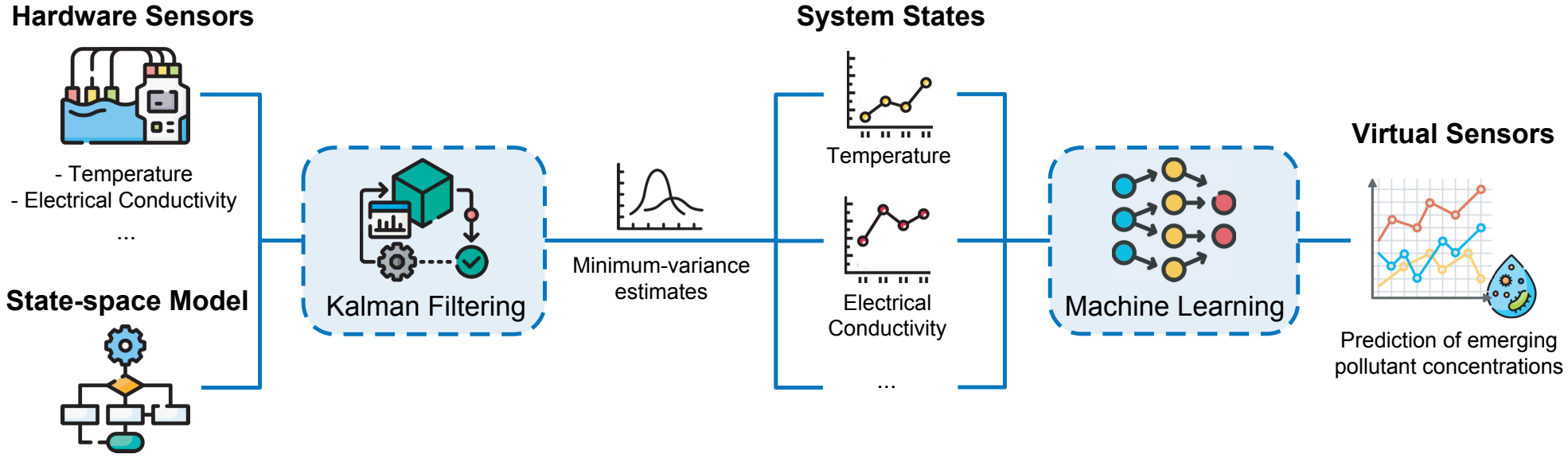

Fig. 2. Graphical abstract of the proposed framework.

Urban M2O

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