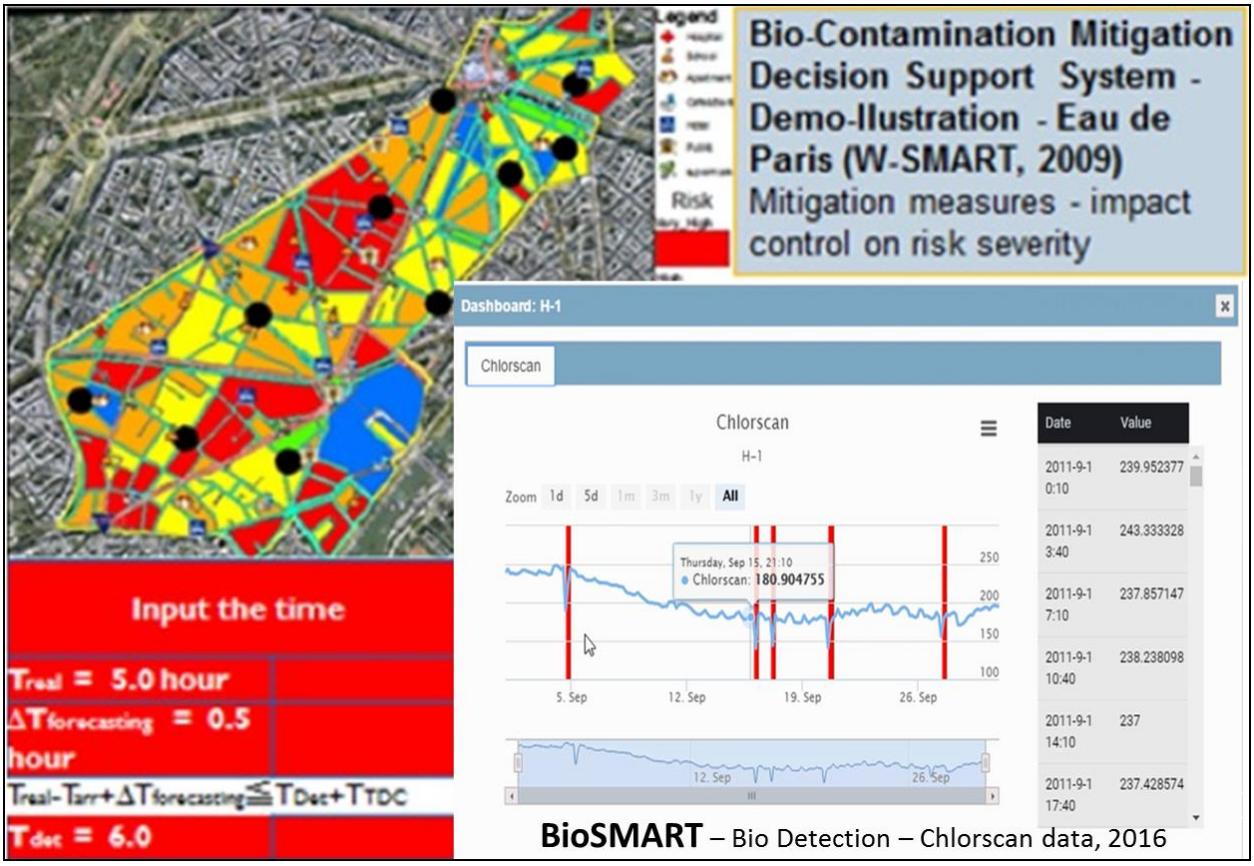
International Water Security Alliance of Water Utilities

BIO-SMART Project Summary

Artificial Intelligence based "Bio-Safety Monitoring And Risk conTrol (Bio-SMART)" Prototype System(s) for Real-Time Water Quality Control and Preemptive Consumers' Safety Management



BioSMART – Bio Detection

Location: Eau de Paris 'Synthetic Data'

Scientific Challenges: Technical and economic feasibility assessment and demonstration of Artificial Intelligence based "Bio-Safety Monitoring And Risk conTrol (Bio-SMART)" prototype system(s) for real-time water quality control management, early microbial and/or chemical contamination detection, preemptive rather than reactive incident mitigation measures, their impact monitoring and interactive consumers' information.

Background: Metropolitan water quality monitoring is still generally conducted by systemic field sampling and laboratory testing. The lack of reliable, real-time specific microbial and/or chemical contamination monitoring raises major public concerns as the delayed detection accelerates the fast growing public health risk and significantly affects the efficiency of the mitigation response to the in-network propagating bio/chemical contamination. In practice, water quality issues are still often established by consumers' complaints and medical call centers rather than by the insufficient water quality control raising severe service reliability issues and consumers' safety concerns. The recent case of Flint, Michigan, is only one of the recent examples of the failure of local governments to ensure reliable and real-time water quality control to efficiently guarantee public water safety in the United States and the industrialized countries. With increasing climate change impacts in "water stress" countries, such as the Southwest states of the United States, Local Governments, Water Utilities and other stakeholders currently face, worldwide, critical needs for innovative smart water monitoring and reliable real-time quality control systems.

Research Objectives: The goal of the proposed research is to develop, adapt and demonstrate the technical and economic feasibility of an Artificial Intelligence (AI) based Bio-SMART prototype system(s) that will efficiently enable water operators, building management corporations and other stakeholders to ensure real-time water quality control management and early bio/chemical anomaly detection for risk assessment driven consumers' warning. The deployment of state-of-the-art, up-scalable, reliable, operationally sustainable and real-time online sensing systems, along with artificial intelligence based data management system(s) for sensors' health monitoring, data quality control and pattern recognition, is expected to provide the operators with innovative capabilities for upgrading their capacity to ensure early microbial and/or chemical contamination detection, efficiently filter false alarms, undertake preemptive incident mitigation measures, monitor their impact and engage interactive consumers' information.

The Bio-SMART system(s) development will demonstrate the feasibility of adapting and integrating smart infrastructure monitoring systems, that have been developed and are increasingly deployed for real time anomaly detection in the Nuclear and Electric Power industry, to substantially change the current practice of water systems management and implement preemptive rather than reactive water quality control and contamination event mitigation measures. The deployment of such systems is therefore expected to significantly contribute to alleviating consumers' bio/chemical contamination risks, guaranteeing sustainable drinking water safety, upgrading the metropolitan water supply reliability and improving the safeguard of water resources while ensuring the necessary quality control of integrated renewable resources in water stress countries.

The economic feasibility assessment is expected to include a decision support framework that will effectively integrate public health risk reduction, regulatory policy incentives and compliance requirements, as well as cost-benefit analysis of investments in innovative smart water monitoring. Its expected outcome should enable local governance policy makers, water industry executives, utility operators and other stakeholders to recognize the environmental, economic, operational and public health impacts of industry-wide transition towards preemptive rather than reactive water quality control and incident mitigation management. It is also expected to significantly affect current standards and practice of consumers' health risk assessment and public information services.

Scope of Research: The proposed research will build upon the current inter-university collaborative R&D program on "Smart Urban Networks for Resilient Infrastructure and Sustainable Ecosystems (SUNRISE)", which was jointly established at the University of Lille. The SUNRISE program is currently sponsored by the water utilities, the regional government and the European Community as one of the 4 demonstration sites for Smart Water Networks. It is focused on the technical and economic feasibility assessment of the adaptation and integration of Artificial-Intelligence (AI) based Bio-SMART systems for real-time water quality control using a variety of non-specific, affordable, multi-parameter chemical and biological online sensors for early bio-contamination detection, its geo-localization, mitigation impact recognition and preemptive warning systems.

Such AI based network management systems for incident detection and mitigation have been developed, adapted and successfully deployed in smart-grid solutions for the electric power industry (Anderson et al., 2008). They provide the system operator with a reliable real-time system response analysis and multi-source data driven "intelligent" process control for either automated or manmade incident mitigation decision-making and optimal lean operation management. The vision is that learning from the experience of the nuclear and the electric power industries will effectively lead to breakthrough solutions in responding to the water quality control challenges. For this purpose the French Commission of Nuclear Energy R&D Institute, CEA-LIST, a world leader in the development, adaptation and deployment of Artificial Intelligence based infrastructure monitoring systems has accepted to participate and support the W-SMART Research Team and its strategic partners.

More specifically, the proposed R&D program will involve off-line selected scenarios simulations of real-time Bio-SMART smart SIM system deployment for water quality monitoring and early chemical and/or biological contamination detection. Laboratory model tests using several innovative, multi-parameter, non-specific chemical and biological sensors will be conducted at the University of Lille as part of the SW4EU European Research project to provide the database for the off-line selected scenarios simulations. A risk matrix will be pre-established based upon water operators' experience, integrating the likelihood of contamination and its risk severity level. The Lille campus demo-site will be used for demo-simulation of the contamination propagation within the distribution network to illustrate: i) early bio/chemical incident detection with filtering of false alarms, ii) feasibility assessment of deploying preemptive mitigation measures that will effectively respond to temporal and spatial risk propagation and severity level, iii) their impact monitoring and visualization, iv) interoperable and secure information management system for interactive consumers' warning on personal communication platforms, such as smart phone and tablet applications.