Chapter 5
Smart Water Systems for Sustainable and Participatory Urban Governance

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ABSTRACT

This chapter presents a critical analysis of smart water systems as strategic responses to water scarcity, quality decline, and distribution inefficiencies. It explores the integration of advanced technologies—including the Internet of Things (IoT), Artificial Intelligence (AI), Wireless Sensor Networks (WSNs), and remote sensing—across domains such as intelligent irrigation, leak detection, decentralised treatment, and urban water governance. Through case studies from Spain, Mexico, South Africa, and Singapore, it highlights the transformative role of data-driven, modular, and participatory models in enhancing sustainability, equity, and resilience. Emphasis

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is placed on predictive analytics, simulation tools, and real-time monitoring to support adaptive and efficient decision-making. The chapter also identifies technical, institutional, and socio-political barriers to implementation, offering strategic insights into the future integration of smart water technologies within Integrated Water Resources Management (IWRM) paradigms.

1. INTRODUCTION

Water is a finite yet fundamental resource essential to the preservation of life, the maintenance of ecosystems, and the stability of socio-economic development. In the context of the twenty-first century, escalating pressures stemming from climate change, urbanisation, population growth, and agricultural expansion have compounded the challenges associated with water security, availability, and quality. These pressures have necessitated the advancement and implementation of intelligent systems that optimise water management through the integration of modern technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Wireless Sensor Networks (WSNs), and advanced data analytics. This document provides a comprehensive examination of smart water technologies, with a particular emphasis on the use of intelligent monitoring, predictive modelling, decentralised systems, and case-based learning to enhance water governance. The discussion is structured into several key themes, each addressing a specific aspect of the smart water ecosystem: intelligent irrigation systems, watershed monitoring through sensors and remote sensing, leak detection and predictive maintenance, modular smart treatment plants, and smart city water infrastructure.

The deployment of smart irrigation systems represents a significant technological leap in the agricultural sector, aimed at enhancing water-use efficiency and crop productivity. The integration of IoT sensors, AI-based algorithms, and automated control mechanisms enables real-time monitoring of critical environmental variables such as soil moisture, temperature, solar radiation, and evapotranspiration. Studies including those by Touil et al. (2022), Sloat (2025), and Kunt (2025) demonstrate the effectiveness of such systems in reducing water consumption by up to 92% without compromising yield, highlighting their potential to mitigate the impact of water scarcity in agriculture. Simultaneously, advancements in watershed monitoring underscore the importance of remote sensing and IoT-enabled systems in the conservation and assessment of hydrological resources. These technologies facilitate precise data acquisition across vast and often inaccessible terrains, enabling early detection of anomalies and informed decision-making. Case studies from Greece and the United States illustrate the benefits of LoRaWAN-based architectures and cloud-integrated platforms in the automation and optimisation of irrigation in olive