Chapter 8
Optimising Water Use Through Smart Models and Artificial Intelligence

Jaime Aguilar Ortiz
Universidad Politécnica de Pachuca, Mexico

Víctor Manuel Zamudio-García
Universidad Politécnica Metropolitana de Hidalgo, Mexico

ABSTRACT

This study examines the use of advanced AI techniques to optimize water management in three key areas: water quality prediction, leak detection, and water distribution. By applying ensemble learning models like Random Forest, Gradient Boosting, AdaBoost, and Bagging, the research addresses the complexities of managing water resources, such as non-linear data patterns and the need for high predictive accuracy. Integrating AI models with real-time data and IoT technologies enhances the adaptability of water management, enabling real-time monitoring and decision-making for efficient and sustainable resource use. These AI-driven approaches improve operational efficiency by optimizing water distribution and minimizing losses from leaks while ensuring accurate water quality predictions. This contributes to better decision-making, crucial for public health and environmental sustainability. The study highlights the transformative potential of AI in water management, advocating for its broader adoption to meet the challenges posed by urbanization, population growth, and climate change.

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1. INTRODUCTION

1.1. Context and Relevance of Water Management

Water management is crucial due to increasing urbanization and rising water demand in cities. Proper management of water resources in urban contexts is essential to ensure global sustainability, as it directly affects quality of life, economic development and environmental health. More than half of the world's population lives in urban areas, making it imperative to ensure adequate supply and quality of water to support social well-being and sustainable development.

Water management is also facing a significant paradigm shift, moving from purely technical solutions to integrated approaches that consider social, cultural and governance factors. The importance of cultural adaptation and social learning has become crucial in water resources management, highlighting the need for a more holistic approach that integrates technical aspects with human behaviors and beliefs to achieve sustainable and adaptive water resources management (Pahl-Wostl et al., 2008).

In addition, water demand management is being redefined to include not only reducing the amount of water used, but also improving efficiency and managing the timing of use to mitigate demand peaks. This integrated approach considers water use efficiency, equity, environmental protection, and public participation, making water demand management an essential governance strategy to address water scarcity and promote sustainable development at various stages of economic development (Brooks, 2006).

1.2. Objectives of the Study

The main objective of this study is to improve water management by applying artificial intelligence (AI) models in three key areas: water quality prediction, leak detection and location, and water distribution optimization. For water quality prediction, ensemble models such as decision trees and Random Forest will be used, which have proven to be effective in handling non-linear data and improving the accuracy of predictions (Shah et al., 2021).

In water leak detection and location, the study will apply ensemble methods such as Gradient Boosting and AdaBoost. These methods have been successfully used in various studies to improve the accuracy and speed of leak identification, which is critical to reducing water losses and the costs associated with repairs (Hu et al., 2014).

For the optimization of water distribution, models based on Bagging and Boosting will be used, which are capable of handling large volumes of data and diverse variables, thus optimizing the use of water in complex distribution networks. The