Chapter 7
Water Demand Forecast and Efficient Supply Management

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ABSTRACT

This chapter explores the use of artificial intelligence (AI) models for forecasting water demand and managing water supply systems efficiently. It highlights the need for accurate prediction models in urban areas, where fluctuating water demand poses significant challenges. Various AI techniques, including Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), and Long Short-Term Memory (LSTM) networks, are discussed for their ability to handle complex consumption data. The methodology for building these models is also addressed, covering data collection, preparation, and model training and validation. Optimization algorithms, such as Particle Swarm Optimization (PSO) and Genetic Algorithms (GA), are emphasized to enhance accuracy and robustness. Finally, a practical example illustrates the application of these AI methods in water management, highlighting AI's potential to improve the sustainability of water supply systems and identifying areas for future research to refine these models across various urban settings.

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1. INTRODUCTION

1.1. Context and Relevance of Water Management

Efficient water supply management is essential to ensure the availability and quality of water resources in urban areas. The use of artificial intelligence (AI) models for water demand forecasting has been highlighted as an innovative and effective solution. These models allow water consumption to be predicted with high accuracy, which is essential for the planning and operation of water distribution systems. The adoption of AI in this context not only improves the accuracy of predictions, but also facilitates more dynamic and adaptable management to changes in demand and environmental conditions (Herrera et al., 2010).

Traditional forecasting methods, such as time series analysis and regression, have been complemented and, in many cases, surpassed by AI techniques such as neural networks and expert systems. Research has shown that AI models, including artificial neural networks (ANN) and rule-based inference systems, offer better results in predicting short-term demand compared to conventional methods. These models are able to handle non-linear data and adapt quickly to new consumption patterns, which is crucial for effective water resource management in changing urban environments (Jain & Ormsbee, 2002).

Furthermore, the use of adaptive and continuously learning models, such as Evolutionary Artificial Neural Networks (EANN), has been shown to be particularly effective for real-time prediction of water demand. These models not only predict with high accuracy, but also continuously adjust to variations in consumption patterns, providing a robust tool for the daily management of water distribution systems. This adaptive capacity is crucial to meet the challenges associated with variability in demand and climatic conditions, allowing proactive and efficient management of water supply (Romano & Kapelan, 2014).

1.2. Problems of Water Demand in Urban Systems

Water demand in urban environments is subject to various challenges, particularly due to increasing populations and the unpredictability of climate and human behavior. As water usage fluctuates, it can create pressure inconsistencies within distribution systems, heightening the risk of contamination through infiltration of external substances. Traditional models, which typically fail to account for the dynamic variability of these factors, often struggle to provide accurate predictions, making them less effective for modern urban water management. The inaccuracies