Chapter 9
Data-Driven Aquatics: The Future of Water Management With IoT and Machine Learning

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ABSTRACT

The water management industry has undergone a sea change since the advent of machine learning (ML) and internet of things (IoT) technology. In this chapter, the utilization of ML and IoT applications for assisting with the fundamentals of water management data gathering and preprocessing will be explored. In order to make educated decisions toward water sustainability, sensors and gadgets connected to the IoT have improved monitoring and evaluation of water resources. In the initial paragraphs, the primary focus of the chapter is introduced: the importance of data collection in water management and the challenges of using traditional data collection techniques. However, before the data acquired from these sensors can be used for analysis and modeling, it must frequently undergo some form of preprocessing. Important data preparation tasks including data cleansing, outlier identification, and data fusion are

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discussed in this chapter. The reliability of future ML algorithms is enhanced by preprocessing the data to verify its correctness and consistency.

INTRODUCTION

Water is a finite resource that is crucial to human survival and important to a broad variety of human activities, from agriculture and industry to domestic duties and hygiene. However, complicated challenges in water management have arisen as a result of environmental alterations, population increase, and rising water demands. Examples of advanced technologies that can aid in this regard include the IoT and ML.

The benefits of applying ML to the subject of Water Resources Management (WRM) have recently seen an upswing in the study. The emergence of big data has been a major factor in this shift, as it has provided hydrologists with novel approaches to old issues and encouraged innovative applications of ML. By 2025, the world's data is expected to have ballooned to a staggering 175 zettabytes. This massive data deluge marks the beginning of a new era in WRM. The next challenge for hydrological researchers is to integrate established hydrology principles with these cutting-edge, data-driven methods. Various ML approaches are currently used to guide decisions ranging from the most fundamental to the most complex in the scientific realm. Machines are best suited to process and leverage big data because of their size, velocity, veracity, and variety Koditala and Pandey (2018). Hydrologists have not been immune to ML's appeal in recent years, with many adopting the technology across multiple domains to take advantage of its superiority in handling complex scenarios.

In the coming years, hydrologists around the world will need to innovate and strategize for WRM security in response to the challenges posed by climate change, increasing water resource constraints, expanding populations, and natural threats. The ninth phase of the Intergovernmental Hydrological Programme (IHP) (IHP-IX, 2022-2029) has recently begun. To ensure water security in a time of climate change, this plan puts hydrologists, academics, and policymakers in the driver's seat, with the goal of fostering a resilient and sustainable water ethos. Furthermore, new opportunities for refined hydrological assessments by simplifying complex issues are opening up as a result of the proliferation of available hydrological datasets and the development of sophisticated ML algorithms Sugumar, R, Phadke, Prasad, and R (2021).

There has been a shift from single-step to multi-step prediction, from short-term to long-term forecasting, from deterministic to probabilistic models, from univariate to multivariate systems, from structured to unstructured data utilization, and from simple spatial analyses to more complex spatiotemporal and geo-spatio-temporal environments Perumal et al. (2022). The unpredictability and complexity of natural hydrological processes are well captured by ML models, which have made great strides in supporting optimal decisions in WRM. Since ML is so effective at computational tasks, it can drastically reduce processing needs, making it possible to switch from physically driven models to ML-based ones for more complex problems. Therefore, new hydrological problems, such as droughts and floods, can be better understood and handled with the help of ML developments.