

Integrated Data-Driven Approach for Early Pollution Detection and Management in the Thames River Ecosystem

Saeid Najjar-Ghabel^{1,3}, Farzad Piadeh^{2,3}, Kouros Behzadian^{3,4} and Atiyeh Ardakanian³

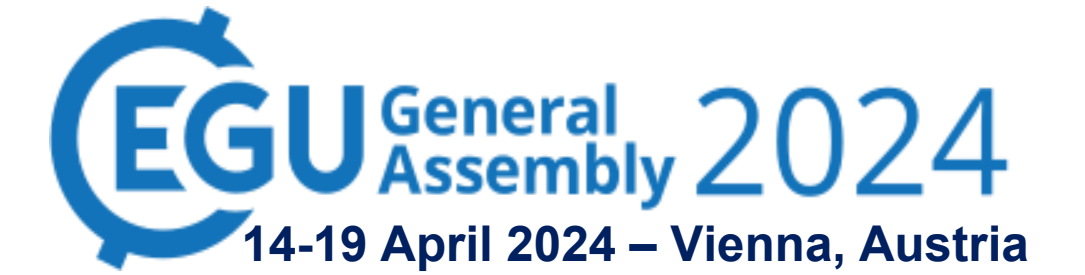


1 Faculty of Civil Engineering, University of Tabriz, Tabriz, Iran

2 School of Physics, Engineering and Computer Science, University of Hertfordshire, Hatfield AL10 9AB, UK

3 School of Computing and Engineering, University of West London, St Mary's Rd, London, W5 5RF, UK

4 Dept of Civil, Environmental and Geomatic Engineering, University College London, Gower St, London WC1E 6BT



Introduction

The increasing pollution levels in rivers have become a serious concern worldwide due to their detrimental impact on ecosystems and human health. Recently, there has been a growing recognition of the need for early warning systems (EWS) to monitor and manage water quality in river ecosystems [1]. EWS is a method that is used to detect and predict potential risks or hazards before they occur. It helps alert individuals, organisations, or communities and provides them with timely information to take necessary precautions and actions to minimise the impact of the anticipated event [2]. EWS for water quality management also can be efficient when real-time data (both water quality and quantity) can be combined with real-time flood forecasting [3].

Aim and Objectives

This study presents a new method based on data-driven models for early warning pollution detection in the Thames River. The proposed method collects and analyses various types of data, including weather data and water quality parameters obtained from water samples and sensing systems. These inputs are integrated into a robust computational framework to forecast and identify potential pollution incidents in the Thames River system. The data-driven model incorporates real-time weather data to encompass the dynamic nature of pollution levels. The model can identify high-risk situations and issue timely warnings to prevent further pollution by analysing historical weather patterns and their correlation with pollution incidents. The system's computational framework utilises a Deep Neural Network (DNN) to analyse and interpret the collected data. The model is fine-tuned and calibrated using historical data, allowing it to effectively recognise and predict pollution events in real-time for every flood event through combined sewer overflow structures. By integrating historical and real-time data, the model can enhance predictive capabilities of pollution spread in the river system and hence prepare the relevant bodies to take appropriate actions in time.

Methodology

The methodology of this study revolves around the development and implementation of a data-driven early warning system (EWS) for pollution detection in the Thames River. The approach is structured in Figure 1.

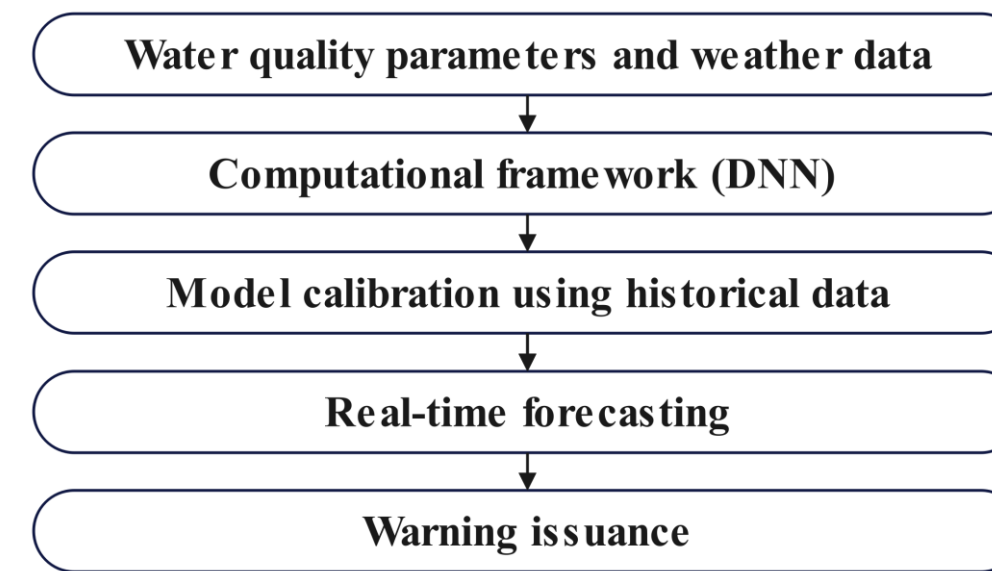


Figure 1. Methodology for the data-driven early pollution warning model

Study Areas and Data

As Figures 2a and 2b show, the downstream water quality station of the Crane water body located in River Thames is used in this study to develop the DNN model. Upstream rainfall station and water level and 5 water quality parameters including biochemical oxygen demand (BOD5), total suspended solids (TSS), dissolved solids (DS), total solids (TS), nitrate, and phosphate are used to predict the water quality index.

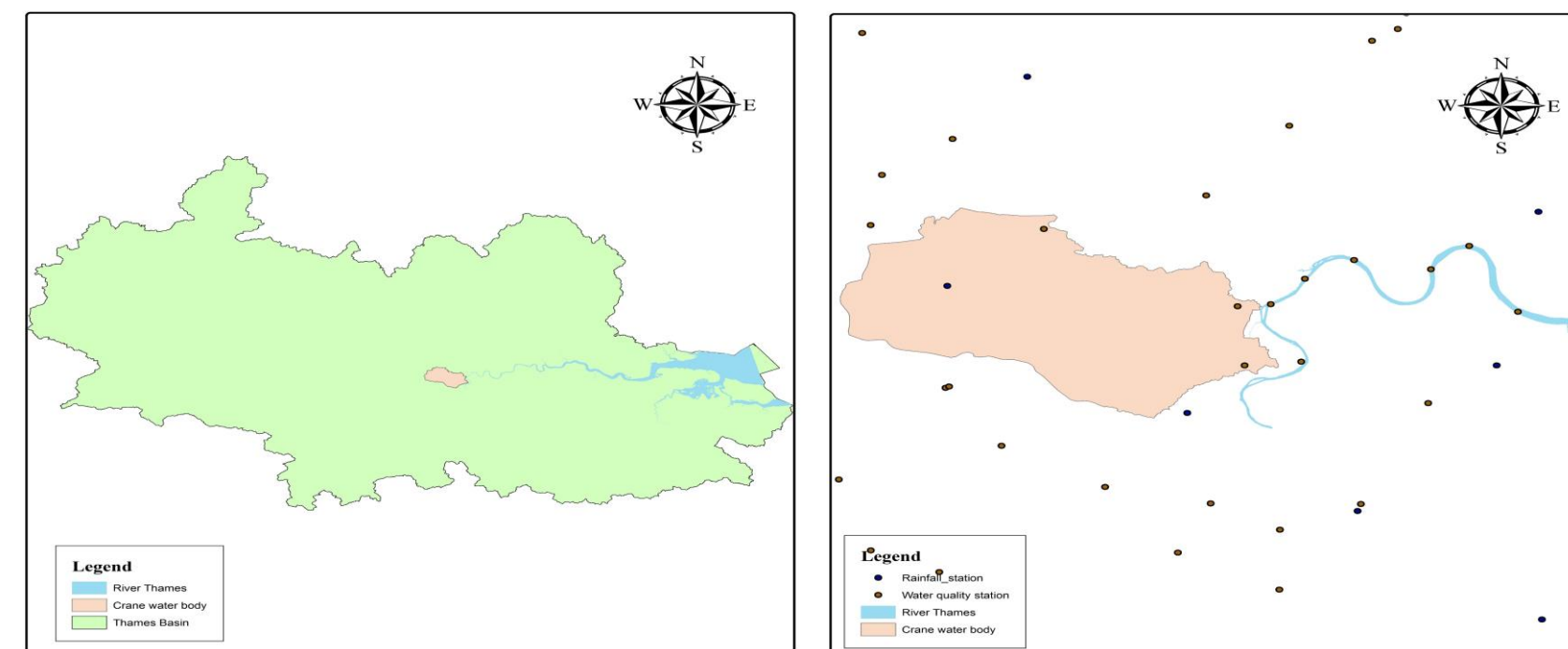


Figure 2a

Figure 2b

Figure 2a. Location of Crane Water body in the Thames Basin; Figure 2b. Water quality and rainfall stations around the Crane

By incorporating real-time weather data, the model remains sensitive to the dynamic nature of the river ecosystem. Figure 3 shows the real-time rainfall measured by the sensors at Richmond Station.

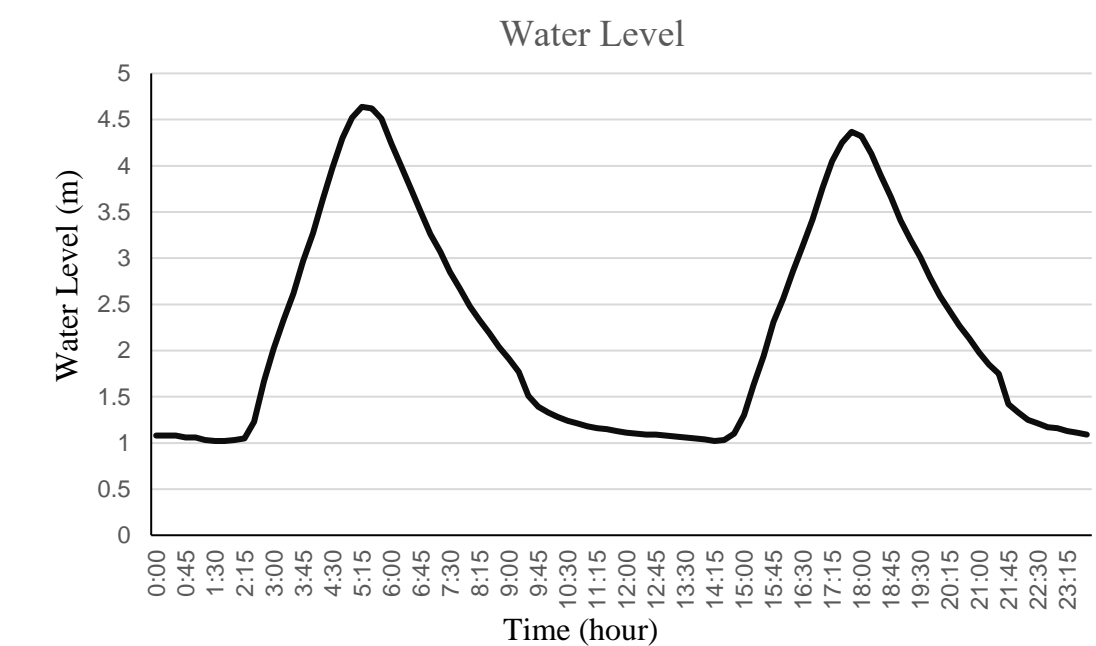


Figure 3. The most recent daily water level at Richmond Station

Summary and Conclusion

- ✓ The proposed method holds great promise in mitigating the adverse impacts of pollution on the river's ecosystem and the surrounding communities. By integrating diverse data sources, including in-situ measurements, sensing systems, and weather information, the model provides a holistic understanding of pollution dynamics and enables proactive pollution control measures.
- ✓ Implementing this model can contribute significantly to preserving the health and ecological integrity of the Thames River, serving as a blueprint for other river systems facing similar pollution challenges worldwide.

References

- [1] Yuxi, X., Weihua, Z. and Jie, Q. (2023). Integrated water risk early warning framework of the semi-arid transitional zone based on the water environmental carrying capacity (WECC). *Journal of Arid Land*. 15 (2), 145–163.
- [2] Waidyanatha, N. (2010). Towards a typology of integrated functional early warning systems. *International Journal of Critical Infrastructures*. 6 (1), 31.
- [3] Piadeh, F., Behzadian, K. and Alani, A.M., (2022). A critical review of real-time modelling of flood forecasting in urban drainage systems. *Journal of Hydrology*, 607, 127476.