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Case Study: Leak Research Optimization in a Small Water Supply System Using Artificial Intelligence

Valladares, E., State University of Campinas, Brazil, Lima, G., COPASA, Brazil, and Martim, A,State University of Campinas, Brazil, and Manzi, D., Stattus4, Brazil .

Highlights:

- Global Non-Revenue Water (NRW) is 346 million cubic meters/day, wasting about $40 billion annually
- 4Fluid AI technology optimizes leak detection, reducing investigation áreas, and enhancing operations with geolocated visualization.
- In Araxá, MG, Brazil, 376 suspicious points and 112 confirmed leaks were identified, significantly reducing water losses in 106 days.

Keywords: Leak detection; Artificial Intelligence; Water supply system

INTRODUCTION

Efficient management of water supply system losses is crucial for sustainability and efficiency. Water losses, defined as the difference between the produced and consumed volumes (SABESP, 2023), pose a challenge for the sanitation sector. According to a study by Liemberger and Wyatt (2019), the global volume of NRW (Non-Revenue Water) was estimated at 346 million cubic meters per day. With a unit value of $0.31 per cubic meter, the wasted value would amount to approximately $40 billion per year.

Effective leak detection, especially hidden leaks, is essential to mitigate losses. The acoustic detection technique, which requires trained professionals and equipment like geophones to interpret sound signals from water flow through cracks or defective connections, stands out among the methodologies. According to Bezerra and Cheung (2013), this technique detects leaks in various structures and materials.

This article presents a case study on an innovative leak detection methodology, 4Fluid, which uses Artificial Intelligence to optimize the effectiveness and efficiency of the process. This advanced technology minimizes the investigation area required by specialists and improves operations management through geolocated visualization. Additionally, its flexibility allows it to be applied to any type of water supply system, including smaller ones. It highlights suspicious points, evaluates potential anomalies, and enables a targeted approach to solving problems in the water supply system.

METHODOLOGY

This study uses 4Fluid technology, powered by Artificial Intelligence (AI), to detect leaks in the water supply system in Araxá, MG, Brazil, which has 43,906 active water connections. The methodology adopted is structured into four main phases:

1. Data Collection: Initially, noises are captured in the pipelines using an electronic rod. This acoustic data is then transferred via Wi-Fi to a mobile device, such as a cell phone, where it is temporarily stored. This phase can be operated by non-specialized personnel, eliminating the need for advanced noise identification training. Figure 1 illustrates an operator using the 4Fluid tool.

Figure 1 - Operator using the 4Fluid tool.

2. Data Sending and Processing: The collected data is sent to the cloud, where a machine learning algorithm processes and analyzes it. The AI classifies these noises based on characteristics that may indicate the presence of leaks or other anomalies in the piping system.

3. Data Analysis on the Web Platform: The processed data is accessible through the 4Fluid web platform. This platform displays an interactive map with all collection points, including detailed information such as date, time, GPS coordinates, and field observations. From this interface, users can view AI-assigned ratings, which are visualized through colors and filters, and select specific points for detailed inspection. Figure 2 exemplifies the platform's visualization.

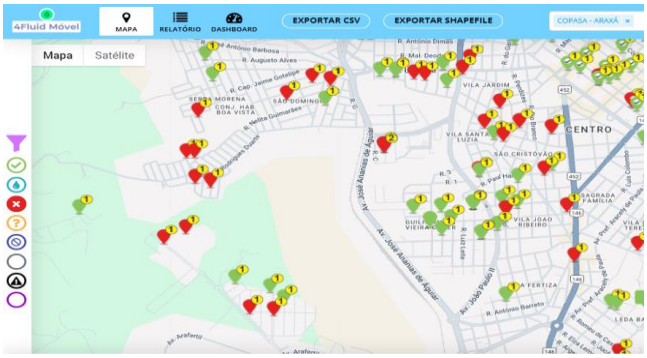
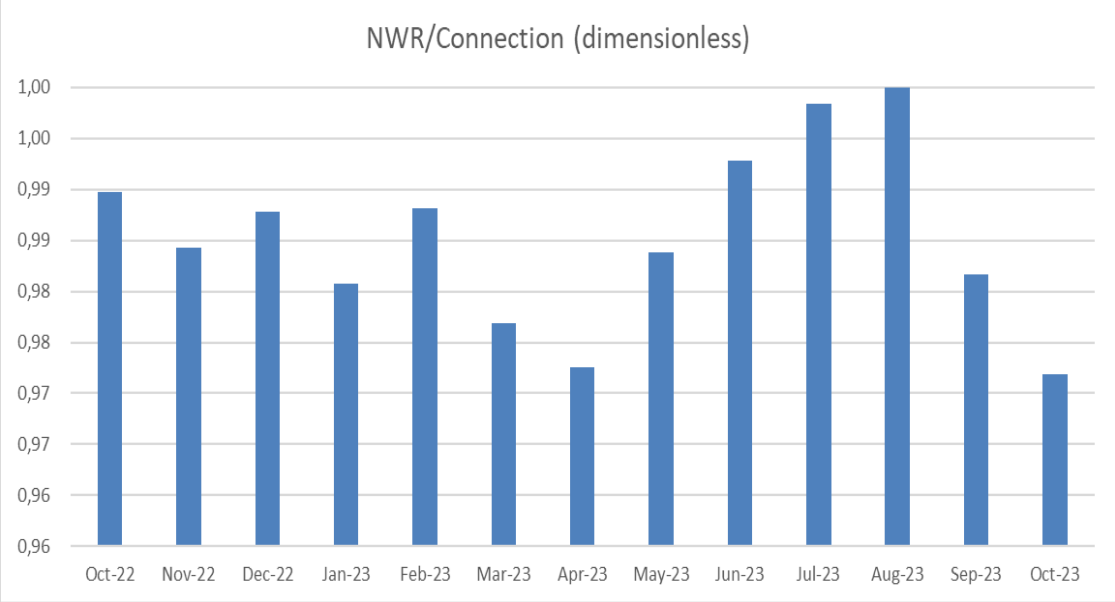


Figure 2 – exemple of the platform's visualization.

4. Field Confirmation: In the final phase, noise analysis experts use a specific inspection application to visit locations marked as "suspicious" by the AI. During these visits, experts conduct detailed assessments to confirm the presence of leaks and identify their causes.

RESULTS AND CONCLUSIONS

Data collection on all connections in the city required 106 days of work, carried out between 10/27/2022 and 03/29/2023. During this period, 44,146 samples were collected in the field, resulting in the detection of 376 suspicious points through Artificial Intelligence (AI) analysis. Of these, 112 leaks were confirmed and promptly repaired. Graph 1 illustrates, in a unitless way, the evolution of the Non-Revenue Water (NRW)/Connection indicator, providing a clear visualization of the system's performance in reducing losses over time, showing a significant reduction in water losses during the research period. The analysis of these results allows for a deep reflection on the effectiveness of the strategies adopted in managing water losses, highlighting the importance of maintaining a routine of research and repairs to ensure the stability of indicators and the preservation of water resources.



Graph 1 - NWR/Connection (dimensionless)

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