ANALYSIS OF THE PERFORMANCE OF A COMMERCIAL SOFTWARE FOR PIPE BURST DETECTION

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Abstract In developing countries, 35% of treated water is lost before reaching households. Detecting more and faster pipe bursts reduces the physical losses. Aquasuite© BURST Alert is a data-driven heuristic model that uses as inputs (i) the prediction of flow and pressure from another model; (ii) measurements from WDS. This research aimed to investigate deeper which variables influence the computation of a burst alarm, and then determine their best setup. Statistical tests were used to analyze the parameters at an environment in Python. Results showed that adding weather data to BURST Alert would not improve significantly the software detection; however, they indicated the influence of DVG's average flow.

Keywords: water distribution systems, pipe burst, heuristic detection model, water demand forecasting.

Introduction

Aquasuite© BURST Alert ,developed by Royal HaskoningDHV, uses the prediction of flow and pressure and it compares with real-time data (Bakker *et al*., 2014). If the deviation is too high (*e.g*., the flow measured is higher than the threshold), a burst or leak most likely occurred, triggering an alarm to the water company. However, improvements are still needed to decrease the number of false alarms whilst detecting the maximum possible number of bursts.

Methods

- BURST Alert was reproduced in Python code, generating thresholds for flow and pressure, and alarms (Figure 1),
- Performance analysis of the software in 2019 at Oasen's areas,
- Logistic regressions: burst occurrence modelled by T, U, pipe D, Q avg,DVG and cause of burst.

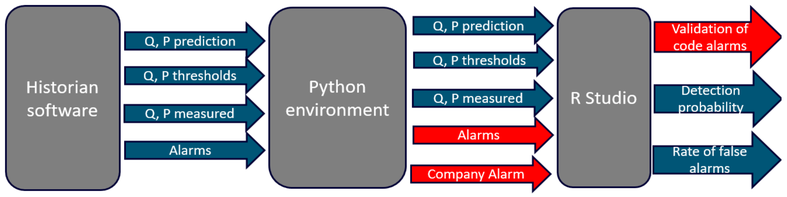

Figure 1: Input/output relation between software used.

Results

One of the limitations of the code is that the thresholds generated by the code are slightly different from the historian data, implying at different alarm triggering.

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Using the data provided by the water company, two methods were used to evaluate the performance of BURST Alert:

- Method 1: Burst is characterized as a single event,
- Method 2: Exploratory analysis, where all the observations (288 datapoints/day) are considered and both true positive and true negative events are correct answers.

Table 1: Performance evaluation of BURST Alert by method-1.

	Avg. flow (m³/h)	Bursts reported	Bursts detected	DP (%)	RF (%)
Alblasserdam	320	9	3	33.3	3.5
Alb.Vijfheerenlanden	1,250	93	0	0.0	6.8
Alphen	500	31	4	12.9	21.9
Gouda	1,900	126	2	1.6	7.6
Hazerswoude	525	59	5	8.5	8.0
Lekkerkerk	339	32	7	21.9	32.2
Nieuwkoop	300	31	8	25.8	11.8
Ridderkerk	323	15	3	20.0	9.1
Zwijndrecht	438	28	6	21.4	2.5
Total – Oasen	5,895	424	38	-	-
Average - Oasen	-	-	-	16.2	11.5

* DP: Detection probability; RF: Rate of false alarms

BURST Alert had a better performance at DVGs with average flows < 500 m³/h (Table 1). On average, the software has a low DP and RF, also compared to Bakker, Trietsch, *et al*. (2014).

On the other hand, method-2 demonstrates that the software triggered less alarms than expected (average of 99% of correct answers), thus having a high precision at the moments without bursts.

Logistic regressions were done with two bases: (i) all the observations, (ii) only bursts. At first, all the variables (temperature variables, humidity variables, diameter, DVG's average flow, cause of burst) were included in the model one by one, and a stepwise was done to find the best model. For the complete base, the best adjustment had an (AIC=305) and it was using average humidity, average temperature, diameter and cause of leakage. However, no statistical significance was found (p-value > 0.05). For the event base, the second-best model (AIC = 1150) indicated a significant effect on the DVGs Alb. Vijfheerenlanden, Gouda, Hazerswoude and Nieuwkoop. Thus, the bigger the DVG, the higher is the burst occurrence.

Conclusions

The choice of method to evaluate the performance leads to different results: DP=16.2%, RF=11.5% (low sensitivity, medium precision) versus 99% of right observations (low sensitivity, high precision). The logistic regressions showed that DVG's size has a significant influence at burst occurrence, while the weather variables were not significant. Future research should use weather data with more observations (e.g., T and U hourly measurements).

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