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Drinking Water
Engineering and Science
Discussions

Interactive comment on "Prelocalization and Leak detection in water drinking distribution network using modeling-based algorithms: Case study: The city of Casablanca (Morocco)" *by* Faycal Taghlabi et al.

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Responses to Reviewer 1: On behalf of the authors, I would like to thank the Editor-In-Chief and the reviewer 1, The comments are the addresses below. They will be incorporated into the revised version of the manuscript. Line 10: "water drinking distribution network (WDDN)"??? Should be "drinking water distribution network (DWDN)". This remark is integrated in the revised version of the manuscript (line 10,13,23,46,and 53)

Line 12: "on the field" must be "in the field This remark is integrated in the revised version of the manuscript (line 12)

Line 25: don't use CC for Climate Change This remark is integrated in the revised version of the manuscript (line 25, 27,28 and 30)

Line 39: don't use capitol after comma This remark is integrated in the revised version of the manuscript

Line 41: "DHS" must be "DHS"' This remark is integrated in the revised version of the manuscript

Line 61: So there is no flow meter at each inlet?? Each of the three inlet of the zone has its own flow meter in diameter 300, and the hydraulic model was calibrated at each inlet.

Line 81. End with " This remark is integrated in the revised version of the manuscript.

Line 96. What is N Empirical research has repeatedly shown that the Fixed and Variable Area Discharges (FAVAD) principle, which demonstrates the fact that most discharges from pressurized pipelines vary with pressure to a greater or lesser extent. This concept, via the definition of an exponent N1, defines the relationship between the leakage rate and the pressure in case of pressure modulation. According to (Lambert, 2000) and (Rozental, 2010) the leakage exponent N1 varies from 0.5 for a ïňĄxed area in rigid pipes as metallic pipes and 1.5 for a ïňĆexible area in plastic pipes as shown in Equation below L1/L0=×(P1/P0)ˆN1 where L1 and P1 are respectively the leakage rate and the average pressure in the DHS during the day, L0 and P0 are respectively the leakage rate and average pressure at the minimum night flow (MNF) time, between 2:00 AM and 4:00 AM.

Line 119-120. No, this is not dynamic simulation; this is consecutive static simulations. Epanet can only do static calculation, no dynamic calculation including dynamic aspects of accelerating and slowing down of water (This response will be incorporated in the revised version of the manuscript) The authors agree that this aspect needs more explanation . What we would like to mention in this section is that, Epanet predicts the dynamic hydraulic behavior within a drinking water distribution system operating over an extended period of time. the pressure changes due to discharge, pressure calculating and changes according to base demand and daily consumption patterns at each node. Figure 1 bellow shows an example of daily consumption patterns in the study area.

Figure 1 daily consumption patterns in the study area the pressure drop during a peak period of consumption is due to higher consumption patterns in the DHS (The pattern provides multipliers that are applied to the Base Demand to determine actual demand in a given time period).

Line 130 and 139. I don't understand. How can you vary the Emitter Coefficient? Do you suggest that you keep pressure constant and leak size constant, and let Emitter Coefficient determine the leak flow? Why did you choose this method? How do you model a leak in Epanet? (This response will be incorporated in the revised version of the manuscript)

There are two ways to model a water leak in a hydraulic network model EPANET (i) as an additional nodal demand, and (ii) by adding a leak valve to each node Fig 2a and 2b.

Figure 2 Ways to model a water leak in a hydraulic network model where QDi is the node base demand (consumption), QADi is the node additional demand , Pi is the node pressure, Ci is the leak valve coefficient and Qi is the leakage flow. According to Cobacho et al., 2014 the best way to represent leakage in a hydraulic network model is not by means of an additional demand, but rather by adding a leak valve to each node, the dynamic behavior of leakage is appreciated in this case rather than the case as an additional demand. In Epanet, the closest element to a leak valve is the emitter, which presents an open valve to the atmosphere, the emitter behaviour equation is shown in

equation below: "Qleak j = C x Pj" ˆN where Qleak is the leakage flow rate at node j, Pj is the pressure, C is the emitter coefficient, and N is the pressure exponent. The emitter coefficient is placed at the junctions, 4 emitter coefficients (0.8, 1.6, 2.4 and 3.2) were used in this simulation step at each node, which correspond respectively to approximate flow leaks: 5, 10, 15 and 20 l/s, the objective of this simulation step is to vary the leak rate at nodes, to calculate and generate the new profile of pressures at each changes in flow rate. The simulation results obtained constitute the training data for our machine learning model. But before launching the simulations, the model must therefore be calibrated against measured data of pressure and flow rate (as mentioned in line 240).

Line 144. Why 1972 simulations? The purpose of this 1972 simulations was to stimulate the pressure behavior at each node, the area contains 493 nodes, thus, we simulated 4 leaks with emitter coefficients equal to 0.8, 1.6, 2.4 and 3.2. This makes a total of 1972 simulations. Each time, the leakage rate, the emitting coefficient, the location of the leak, the distances from the four sensors P14, P57, P58 and PC are noted, as well as the maximum, minimum and average pressures at these measuring points. the authors would like to record the maximum data of pressure variations in the case even if the leaks are triggered in the looped far part on the network. A completely new base for data learning.

Line 144. Did you also simulate leaks at different times? E.g. at 6 am; at 3 pm; et cetera (This response will be incorporated in the revised version of the manuscript)

To simulate the artificial leaks in the study area, the leakage rate was created by opening fire hydrants on three locations at three times (during night-time hours, peak time and during off-peak periods of the day) with a leak size of 6 l/s and 17 l/s. The Table below illustrate the leakage information. Table 1 Leaks information in the study area

During the leaks simulation, the results are recorded and localized with four pressure measurement sensors placed on fire hydrants. We then simulated these leaks on

EPANET model by taking stock of the time interval of real simulations, taking a time step of 5 min equal to the recording step of the sensors in the field.

Line 172. This seems very precise. How large is the area the you researched? This response will be incorporated in the revised version of the manuscript to answer this question, we would like to remind the existing techniques of leak detection. the following figure 3 summarizes the existing pre-localization stages, these stages make it possible to go from hundreds of km of network to tens of m, by proceeding by elimination: In the identified leaky zones, the night flow of sectors is measured then sub-sectors to identify leaking sections and precisely guide acoustic detection and then the location of leaks. this system presents a high operation cost and high equipment cost for leak detection.

Figure 3 Stages of sectorization In the line 172 we have quoted "The objective of the location is to define the position of a leak with a precision of the order of one meter". in comparison with existing techniques like acoustic correlation, The correlation consists in positioning 2 sensors on access points of the network (if possible on both sides of the leak) and to seek the similarities between the noises which they record. When a leak noise is identified, it is possible to calculate its position, knowing: - the distance between the two sensors. The objective of this correlation is to define the position of a leak with a precision of the order of one meter, to avoid extra cost of earth work without leak. in view of the cost of this approach mentioned above, we worked on this approach of virtual leaks research, without the closure the valves in the field, without sectorization, only through a well-calibrated hydraulic model, the data of pressure due to the conditions of the leakage experiments, are compared to the pressure of the previous day without leakage, this data will be associated with an algorithm that predict the location of the leak. Our goal was to skip some stages, especially all the steps of sectorization, presenting a high day operation cost of the network and achieve directly the last step of prelocalization. The purpose was to prelocalise a leak within a 100 to 150m radius

Line 187. Change “number of sensor node” to “sensor node number” This remark is integrated in the revised version of the manuscript.

Line 210-2015. Why is this? Why simple linear band? we imposed this error range to avoid false results. According to the field tests we carried out, a leak of 6 l/s implies a minimum pressure drop of 0.3 m. the band is a translation of +/- 0.3m, those 7 references cases are added to pressure profiles without leak.

Line 225. What is the average demand in the area? Can you show a graph of an average day of measured water demand? the following figure 4 illustrates the system flow balance in this study area: (This response will be incorporated in the revised version of the manuscript)

Figure 4 curve of the average demand in the study area Line 225. For how long was de leak simulated? 15 minutes? 1 hours? ?? (This response will be incorporated in the revised version of the manuscript)

As I mentioned above, the flow rate at each fire hydrant was controlled by a CPI for flow rate and pressure tests on fire hydrants. The hydrants were kept opened for around 30 minutes to collect data. The time of simulation was limited to 30 minutes for reasons of water conservation and safety considerations.

Line 240. What is simulated (red line?) and what is measured (green squares?)? Please explain (This response will be incorporated in the revised version of the manuscript)

In line 240 the Fig. 10 shows an example of comparison between modeled pressure and measured pressure in the study area at sensor P14. The red line is the simulated pressures in Epanet and the green squares is the measured pressure. The comparison shows that the results of the simulation are very close to what is measured, the model is calibrated and is ready for simulation.

New Reference: Lambert, A.: What do we know about pressure-leakage relationships

in distribution systems. In Proceedings of the IWA Conference in Systems Approach to Leakage Control and Water Distribution System Management, Brno, Czech Republic, 16–18 May 2001

Please also note the supplement to this comment:
https://www.drink-water-eng-sci-discuss.net/dwes-2020-3/dwes-2020-3-AC1-supplement.pdf

Interactive comment on Drink. Water Eng. Sci. Discuss., https://doi.org/10.5194/dwes-2020-3, 2020.

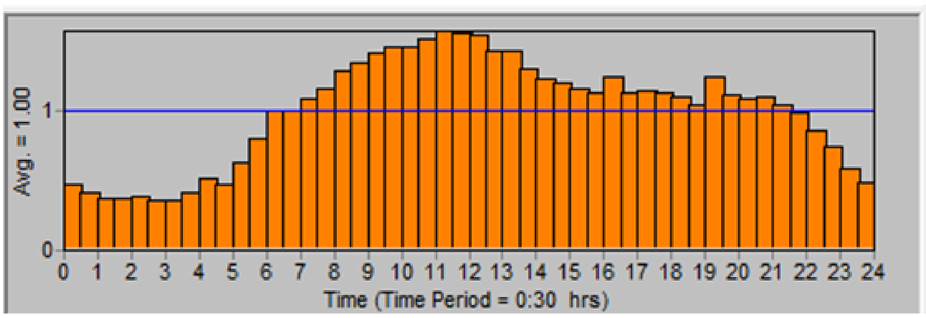

Fig. 1.

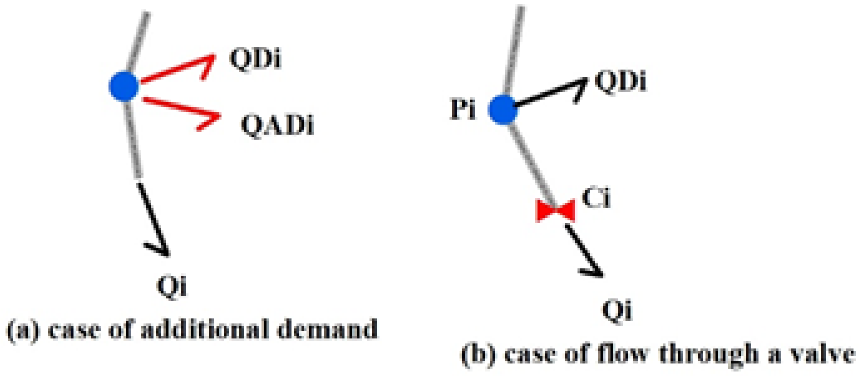
QDi
QADi
Qi
(a) case of additional demand
Pi
QDi
Ci
Qi
(b) case of flow through a valve

Fig. 2.

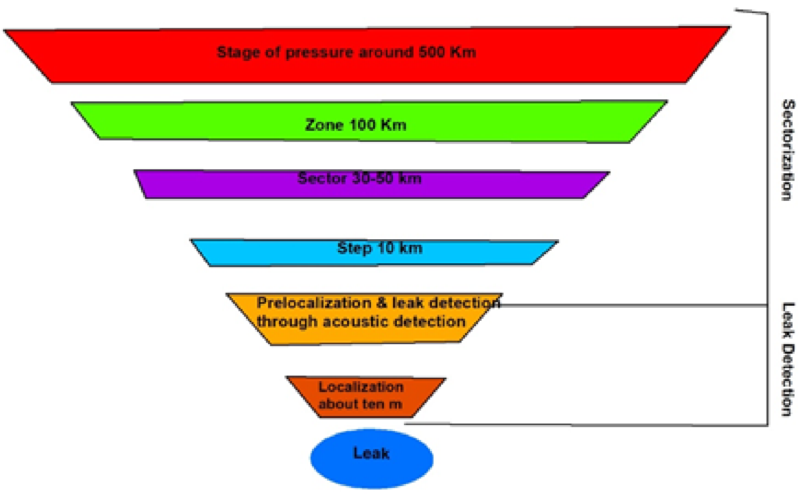
Stage of pressure around 500 Km
Zone 100 Km
Sector 30-50 km
Step 10 km
Prelocalization & leak detection through acoustic detection
Localization about ten m
Leak
Sectorization
Leak Detection

Fig. 3.

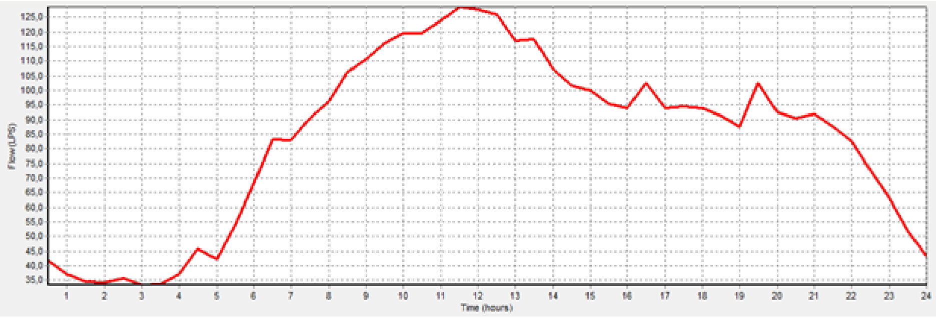

Fig. 4.

ID of hydrants	Emitter Coefficient	leak flow rate at 04:00 am	Duration of simulation (min)	leak flow rate at 11:16 am	Duration of simulation (min)	leak flow rate at 05:00 pm	Duration of simulation (min)
PI A	0.8	6 L/s	30	6 L/s		6 L/s	
PI A	3.0	17 L/s	20	17 L/s	30	17 L/s	30
PI B	0.8	6 L/s	20	6 L/s		6 L/s	
PI C	3.0	17 L/s	30	17 L/s		17 L/s	

Fig. 5.