EXAMPLE OF IWA METHODOLOGY APPLICATION IN WATERLOSS REDUCTION PROJECT IN BOSNIA AND HERZEGOVINA

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ABSTRACT

Tuzla is a city in the north-east part of Bosnia and Herzegovina, being famous for salt production for centuries. But salt exploitation permanently causes soil subsidence, what effects leaks emerging as consequence. That was the basis for KfW bank to initiate water loss reduction project. This paper presents project results achieved in the selected District Metering Area (DMA), having almost 1100 connections and more than 13 km of water supply network. In order to achieve the best results consultant prepared innovative software tool named CalcuLEAKator, intended for Water Balance and Performance Indicators evaluation, in accordance with IWA recommendations using the "bottom - up" approach. CalcuLEAKator evaluation of water balance at project start indicated Infrastructure Leakage Index (ILI) in DMA of even 27.4, what was clear sign for implementation of comprehensive Sound Leak Detection. During Sound Leak Detection action 10 leaks and 19 illegal connections were detected. After leaks were repaired and illegal connections were shut down, another Water balance evaluation showed much better results with ILI reduced to only on 3.8. This result classifies this DMA into "A" Technical Performance Category (for BiH as developing country), and gave stimulus to the Utility to continue same activities in other DMAs, using the same software tool for water balance evaluation.

INTRODUCTION

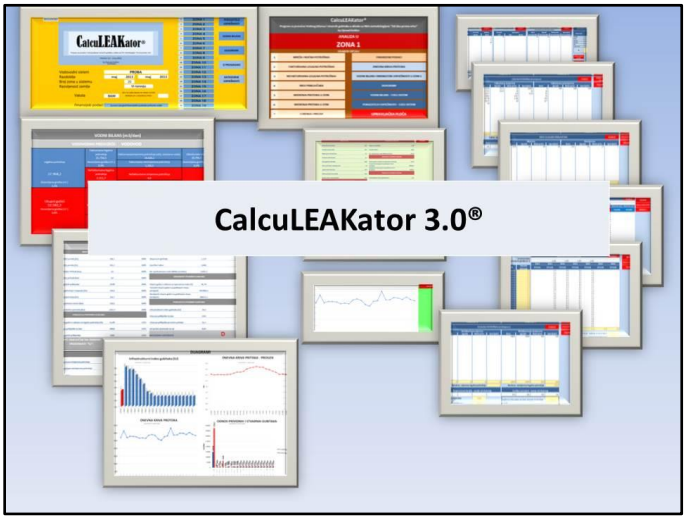
Tuzla is north-east city in Bosnia and Herzegovina famous for salt production since olden times. But salt exploitation permanently causes soil subsidence, what effects leaks emerging as consequence. That was the basis for KfW bank to initiate water loss reduction project in one selected DMA, within in the frame of Master Plan project for Tuzla municipality. DMA, Kuzici having almost 1100 connections and more than 13 km of water supply network.

During the project, two cycles of the hydraulic measurements were performed so the relevant conditions for the calculation of Water balance in-line with the IWA methodology using “bottom-up” approach could be acquired.

Although the top-down approach is much cheaper and faster (reasons why it is mostly preferred in Bosnia and Herzegovina), and this approach is still based on large number of estimates provided by the water utility companies, results obtained are usually unacceptable and incorrect. Therefore, for the majority of projects on the water loss reduction, water loss is calculated on the basis of data obtained by hydraulic measurements of flow and pressure, i.e. by using the bottom-up approach.

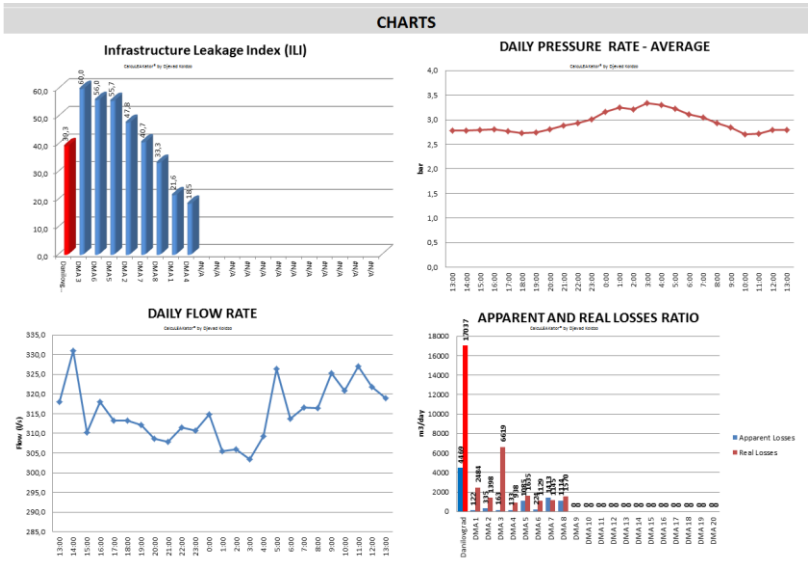
Major problem in applying the “bottom-up” approach regarded lack of adequate software to be used for all projectsthat would speed up the water balance evaluations. Recently HEIS was involved simultaneously in 9 projects on the water loss reduction during the same period.Taking that into account,the necessity to create such software was stressed and the decision was made to develop such software.

WATER BALANCE EVALUATION SOFTWARE - CALCULEAKATOR



CalcuLEAKator Programme was made in order to enable an easy and fast calculation of the water balance elements and success performance indicators by the „bottom-up“ approach. The tool was made using widely known MS Excel programme environment, which provides enables a wide range of users to use it. CalcuLEAKator is developed as a multilingual tool, presently enabling Bosnian and English language environment selection, while it is planned in the future to be enriched by an option of adding a language according to the need of the user.

CalcuLEAKator will, except in the analytical form, present desired results as graphs as well, as example it is possible to see a daily flow curve for each DMA separately, as well as a daily flow curve for the whole system. The Programme shall present in the form of the diagram the values of key technical indicator of success: Infrastructure Leakage Index(ILI) for the whole system, as well as for each of DMAs sorted.



Infrastructure Leakage Index (ILI) represents the ratio between measured annual real losses and unavoidable annual current losses. This index is a key index for „benchmarking“, and based on ILI and according to the recommendations of the IWA CalcuLEAKator shall define a belonging success category (4 categories, from A (the best) to D (the worst)), and present the general conclusion with the recommendation for further activities. Except of the already mentioned, the Programme shall present in the form of the diagram average hourly values for the pressure within the system, as well as the ratio between the values of real and apparent losses in each of the measured DMAs within the whole system.

The accuracy of the data depends on the accuracy of the data entered into the program. Regarding the fact that the “bottom – up” approach is based on the measurements results , the accuracy of the results shall therefore as far as possible depend on the accuracy of the measured values.

Allowed error in the programme CalcuLEAKator is defined trough the 95% safety of the accuracy, established as a procedure through which the evaluation of the level of uncertainty of particular components of the water balance is done. This 95% margin of the safety originally comes from the

uncertainty of the calculation, and it is based on the normal distributions characteristics where 95% of the measurement belong to the range of ± 1,96 of the standard deviations (σ) around the mean value.

WATER LOSS REDUCTION PROJECT IN DMAKUZICI (TUZLA)

At the beginning of the project, the DMA was visited in order to inspect the possibilities of its isolation, and to find adequate points for the installation of a portable ultrasonic flow meter and pressure probes for measuring the DMA inflow and water pressure within the system.

At the same time, a GPS was used to record the positions of all border points in the DMA in order to verify the altitudes, and it was determined that the DMA is situated at altitudes from 214 to 301 masl. The lowest point within the DMA is the one where the main pipeline enters into the DMA, and this point was selected for the purpose of incoming flow measurement (point for the installation of a portable ultrasonic flow meter).

Total water losses are obtained by subtracting the authorized consumption in the DMA (billed and unbilled, which was obtained by reading all water meters in the DMA at the start and at the end of measurements) from the total water quantity entering into the DMA. During the meter reading campaign in the DMA, the number of unmetered connections was checked and their water consumption during the reference period was properly estimated. The incoming water quantity was obtained by permanent flow metering at the entrance pipe into DMA during a period of seven consecutive days.

The real losses are derived from the measurement of the minimum night flow. The real losses are evaluated by subtracting the actual night water consumption in the DMA from the measured minimum night flow rate and by multiplying the resulting volume by the Night/Day factor.

Night consumption is metered by a control measurement of a certain number of randomly selected samples concerning 4 defined consumer categories in the zone.

- private houses – 10 samples,
- residential buildings - 3 samples,
- small-scale economy - 7 samples,
- special consumers - 2 samples.

The measurement was carried out by reading the consumers' water meters at 24:00 and 5:00 a.m., after which average hourly water consumption in the consumers' installations was obtained.

During the sampling selection of consumers, due account was taken of those who possessed newer water meters. Based on the results obtained, the night water consumption in the DMA was determined.

This measurement activity lasted for one whole week, and during the same period, in addition to the hydraulic measurement, a detailed visit to and reading of all consumers’ water meters was done.

All data collected (obtained by measurement or received from ViK) were processed by CalcuLEAKator programme, and the water balance components parameters are derived as follows.

CalcuLEAKator® by Djevad Koldzo	Software for Water Balance and Real Losses calculation from "Bottom to up" in accordance with IWA methodology			
WATER BALANCE (m3/day)				
WATER UTILITY: TUZLA				
Water Supplied 2.016,4 Margin of Error (+/-) 0,1%	Authorized Consumption 475,0 Margin of Error (+/-) 1,9%	Billed Authorized Consumption 475,0 Margin of Error (+/-) 1,9%	Billed Metered Consumption (inc. water exported) 475,0	Revenue Water 475,0 Margin of Error (+/-) 1,9%
			Billed Unmetered Consumption 0,0	
		Unbilled Authorized Consumption 0,0 Margin of Error (+/-) #DIV/0!	Unbilled Metered Consumption 0,0	Non-Revenue Water (NRW) 1.541,3 Margin of Error (+/-) 0,6%
			Unbilled Unmetered Consumption 0,0	
	Water Losses 1.541,3 Margin of Error (+/-) 0,6%	Apparent Losses 133,9 Margin of Error (+/-) 6,9%	Unauthorized Consumption 35,1	
			Customer Metering Inaccuracies 19,8	
			Systematic Data Handling Errors 79,0	
		Real Losses 1.407,4 Margin of Error (+/-) 0,1%	Leakage on Transmission and/or Distribution Mains NO DATA	
			Leakage and Overflows at Utility's Storage Tanks NO DATA	
			Leakage on Service Connections NO DATA	

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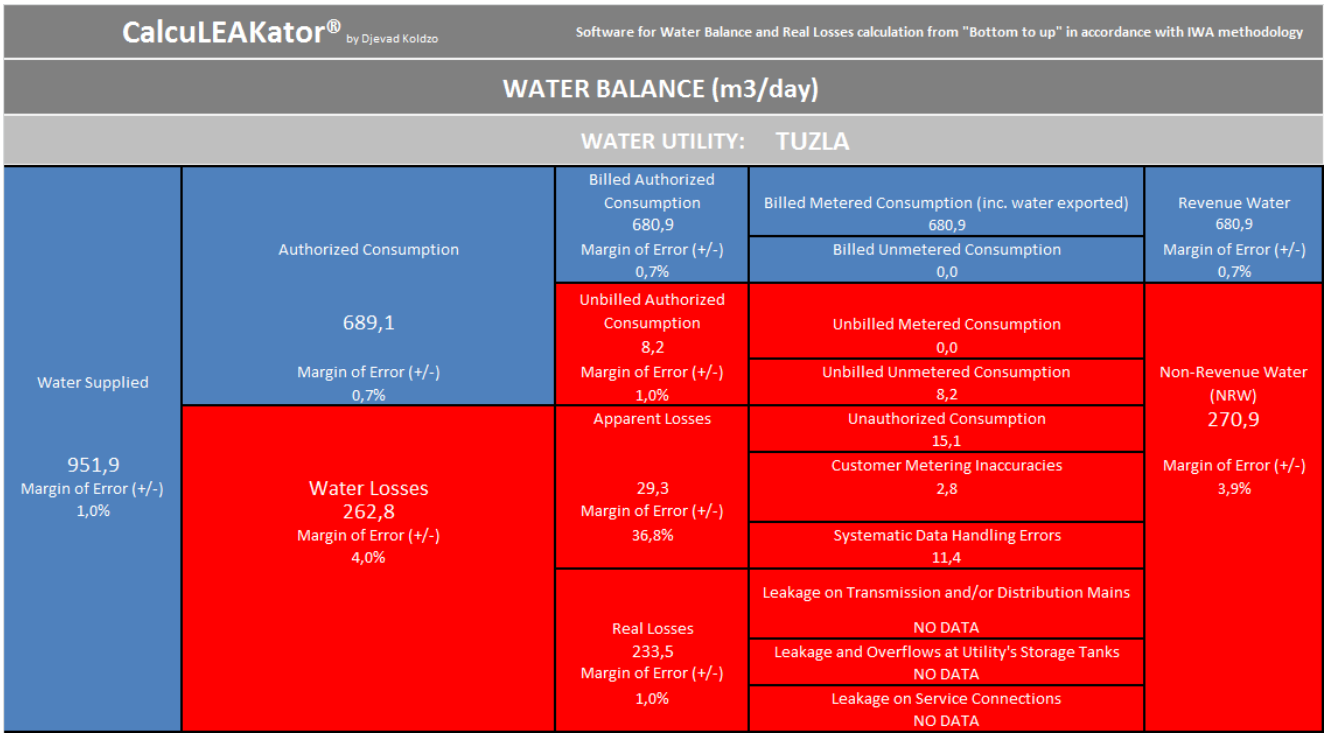
After Water Balance and Performance Indicators calculation, Infrastructure Leakage Index (ILI) was found to be 27.4. Thus, this zone is positioned within the Category D, which is the last one of the set of categories (where for developing countries ILI is higher than 16).Based on the obtained ILI of 27.4, a general conclusion was made that the water losses are very high, and that the implementation of a water loss reduction programme is an imperative and priority.

After first circle of measurements and water balance calculation, sound leak detection was conducted. During the detection process, 10 underground leaks and 19 illegal connections were detected.

The ViK Repair Service repaired all of the detected leaks within the shortest possible time, after which the control hydraulic measurement and water balance calculation were carried out at the same measurement points as in the previous phase. The goal of these activities was to evaluate the savings effectuated (if any) from these water leak repairs.

During second circle of measurement the minimum night flow rate was registered around 2:00 a.m. and it was 3,6 l/s, which is an expected decrease of 14,3 l/s resulted by the repairs of 10 detected leaks.



All key performance indicators have been improved, and the Infrastructure Leakage Index (ILI) has decreased from the earlier recorded 27.4 to only 3.9, thus classifying the DMA into Category A. Based on the IWA recommendations for water supply systems in the developing countries, the conclusion concerning the above mentioned is as follows: Further reduction of losses may not be cost effective unless there is a shortage of water. It is necessary to identify cost effective improvements through a detailed analyses.

The water loss reduction action, carried out in the Tuzla DMA, resulted in the water loss reduction to such an extent that at the beginning of the project the system management quality in this zone was classified in the worst category (Category D), in line with the IWA recommendations, while at the end of the project, it was classified within the best category (Category A).

CONCLUSION

After the detection of 19 illegal connections within the DMA and 10 underground leaks, out of which three were very large, the conditions were created for this zone that any further leak detection would not be cost effective.

All further activities within the DMA that are carried out by ViK will concern monitoring, and will be implemented through a control flow measurements at the inflow points into the zone.

The high level of non-revenue water identified after the first water balance was caused by several different reasons.

Ten leaks were not detected earlier, regardless that ViK has quality staff for sound leak detection, but is still lacking a consistent measurement strategy. The measurement strategy is supposed to guide leak detection team in areas with recorded high night flow levels.

PERFORMANCE INDICATORS	December 2012.	April 2013.	SAVINGS/ IMPROVEMENTS ACHIEVED
LEVEL OF SERVICE			
Minimal Flow (l/s)	17,9	3,6	**14,3**
Average Flow (l/s)	23,3	11,0	**12,3**
Maximal Prssure (bar)	3,9	4,1	**-0,2**
Average Pressure (bar)	3,8	4,0	**-0,3**
Authorised Connections Number	973	1080	**-107,0**
Night Consumption and Wastage (l/s)	0,6	0,6	**0,0**
Authorised Consumption (l/s)	5,5	8,0	**-2,5**
APPARENT LOSSES PERFORMANCE INDICATORS			
Apparent Losses in regards to Authorised cons. (%)	28,2%	4,3%	**0,2**
Liters per connection per day	137,6	27,1	**110,5**
Unauthorised Connections Number	44	0	**44**
LOSSES PARAMETERS			
Leakage Exponent	0,77	0,774	**0,0**
Night to Day Factor	0,97	0,984	**0,0**
Non Revenue Water (NRW) (m3/day)	1541,3	262,8	**1278,6**
VOLUME OF REAL LOSSES			
Real Losses in regards to Water Supplied. (%)	69,8%	24,5%	**45,3%**
Current Annual Real Losses (CARL) (m3/year)	513707,7	85210,5	**428497,2**
Unavoidable Annual Real losses (m3/year)	18755,7	21956,2	**-3200,4**
REAL LOSSES PERFORMANCE INDICATORS			
Infrastructure Leakage Index (ILI)	27,4	3,9	**23,5**
Liters per connection per day	1446,5	216,2	**1230,3**
Liters per connection per day per metter pressure	38,4	5,4	**33,1**
m3 per km mains per hours	4,8	0,8	**4,0**
PERFORMANCE GROUP	D	A	
FINANCIAL PREFORMANCE INDICATORS			
Unbilled Metered Consumption (Euro /year)	0	0	0
Unbilled Unmetered Consumption (Euro /year)	0,0	1857,8	1740,0
Real Losses (Euro /year)	64804,8	10686,6	54118,2
Apparent Losses (Euro /year)	30423,1	6869,6	23553,5
TOTAL VALUE OF NRW (Euro /year)	95227,9	19414,1	75813,9
Volume of NRW expressed in % of System Input Volume	38,5%	14,3%	24,2%
Value of NRW expressed in % of Annual Operating Cost	1,3%	0,3%	1,0%
Liters per connection per day (Euro /year)	797,7	124,3	673,5

Considering that VIK Tuzla possesses its own calibration station, it was expected that all water meters in the DMA are in line with the law obligations. Evidence that it is the case is that during the sound leak detection campaign no leaks or irregularities with the house connections in the DMA were detected. This the situation is very rare in BiH utilities.

After final report KfW bank, encouraged by results, made decision to extend project for another DMA, considering also the option to extend the to the whole water supply system in Tuzla.

This project also proved that application of the programme CalcuLEAKator has enabled a quick and accurate data processing, showing that the programme is applicable for all projects where calculation of Water Balance is done by a “bottom-up” approach. Programme CalcuLEAKator can be downloaded free of charge at: www.waterloss.com.ba.