TESTING INNOVATIVE SOFTWARE TOOL CALCULEAKATOR FOR WATER BALANCE EVALUATION AND WATER LOSS REDUCTION IN TUZLA PROJECT

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ABSTRACT

Tuzla is north Bosnia city 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. This paper presents project results achieved in the first 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 and 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 (LDE). During LDE 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

In accordance with the recommendations of the International Water Association (IWA), water losses in the water supply systems have been lately calculated by using the water balance method and presented through financial and technical indicators of success.

In order to determine the value of water balance elements, IWA has recommended the following two approaches:

1. Top-down approach, and
2. Bottom-up approach.

Although the top-down approach is much cheaper and faster – reasons why it is significantly preferred in Bosnia and Herzegovina, and this approach is still based on the number of estimates obtained from 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 regarding this approach is the lack of adequate software to be used for all projects. Taking into account that HEIS was involved simultaneously in 9 projects on the waster loss reduction in the last year, the necessity to create such software was stressed and the decision was made to develop such software.

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WATER BALANCE EVALUATION SOFTWARE - CALCULEAKATOR

CalcuLEAKator Programme (Leak engl.) was made in order to enable an easy and fast calculation of the elements of the water balance and performance indicators of success by the „bottom-up" approach. The tool was made in the well-known MS Excel programme which provides a possibility to be used by a wide range of users. CalcuLEAKator is a multilingual and except in the Bosnian language it is possible to be used in English, and it is planned in the future to be enriched by an option of adding a language according to the need of the user.

Work in the CalcuLEAKator starts on the dashboard of the programme. It is necessary to select the language of the programme, and import the basic data necessary for the operating: name of the water utility, the period when measurements are undertaken, number of the DMAs in the system (maximally 20 DMAs, and the last one shall be marked in red colour), the currency in which the financial indicators of success shall be presented, and after that the financial data shall be imported, water prices (according to the categories or the average), and the value of the annual operative costs and variable costs for the water production. The user of the programme must define whether the used water in the relevant water utility can be sold or not, on which depends will the financial indicators of the real losses will be shown trough the selling price of the water or production price of water.

After the mentioned data were imported, the program is ready to work. In the future work, the user has the possibilities to import the data for each DMA. The approach to the working part of the DMA is done through the dashboard of the programme, after which the "menu" for the selected DMAs open. In the following work the user shall import following data for each DMA.

The length of the network (length of the pipes, material and a diameter)

1. The length of the private network,
2. Night legal consumption (according to the categories of the users),
3. Legal billed metered consumption   (according to the categories of the users),
4. Legal billed unmetered consumption   (according to the categories of the users)
5. Legal unbilled metered consumption (according to the categories of the users)
6. Legal unbilled unmetered consumption (according to the categories of the users)
7. Number of the legal connections with the water meters (according to the categories of the users),
8. Number of the legal connections without water meters (according to the categories of the users),
9. Number of illegal connections according to the categories of the users (programme offers two options: determination of the number of illegal connections on the basis of certain percentage in relation to the legal number of connections in each consumers category, or import of the number of illegal connections for each consumers category in the DMA),
10. Measured flow values (possibilities of the import of results from 7 measuring points whether they are measuring the inlet or outlet flow).
11. Measured pressure values (possibility of the import of the result from 7 measuring places)
12. Measured values of the leakages on the connections (according to the pipes diameter),
13. Measured values of the leakages and overflow from the reservoirs (possibility of import for 4 reservoirs in the DMA).

All data are being imported in the tables, to which can be approached directly from the menu of the each DMA or by the use of the "wizard" which leads the user from the first to the last table. After that, it can be approached to the review of the values of the water balance elements or indicator of the success for reviewed measuring DMA.

The user shall implement the same procedure for all measuring DMAs in the system, and it is necessary to mention that in each moment it is possible to check the total results for water balance and indicators of success and a programme shall mark n which amount of imported data in the percentage the showed results are presented.

CalcuLEAKator will, except in the analytical form, present certain results as a graph as well, so it is possible to see a daily flow curve for each DMA separately, as well as a daily flow curve in 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 all system as well as in each DMA sorted from the highest to the lowest.

Infrastructure Leakage Index (ILI) represents the ratio between measured 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 category of success (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 daily values of the pressure in the system, as well as the ratio between the values of real and apparent losses in each measuring DMA in 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 results of a measurements, 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 which is established as a procedure through which the evaluation of the level of uncertainty of particular components of the water balance. This 95% margin of the safety originally comes from the uncertainty of the calculation, and it is based on the normal distributions which share the ability that 95% of the measurement belong to the range of ± 1,96 of the standard deviations (σ) around the mid-value.

TESTING CALCULEAKATOR

The software is a first time applied on the project for reduction of water losses in DMA Kužići in Tuzla. Tuzla is north Bosnia city 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. This paper presents project results achieved in the first DMA, having almost 1100 connections and more than 13 km of water supply network.

The project was implemented in the period October 2012 – April 2013. During the project, a two cycles of the hydraulic measurements were performed so the relevant conditions for the calculation of Water balance could be acquired by a method "bottom-up" in accordance with the recommendations of IWA.

The first calculation of the water balance was calculated on the basis of the measurements of the inflow and a pressure on three control points within the DMA as well as the result of simultaneous reading of the water meter in the relevant DMA in two cycles, at the beginning and at the end of constant seven-day measurement. On the basis of these data and results of the water balance, a relevant indicators of the success were obtained according to which the DMA „Kužići" is sorted in the worst category (category D) with the value of the Infrastructure Leakage Index (ILI) of 27,4. The minimum night flow measured during these measurements was 17,9 l/s.

In the period between the measurements, in the DMA, a comprehensive action of the sound leak detection and reparation of the discovered leakages was undertaken. An action resulted with discovering of 24 unmeasured connections, 7 illegal connections which were not registered in the Water Utility data base, and 19 illegal connections, together with ten ground leakages of which three were very significant. After reparation of the all leakages and disconnection of illegal connections from the network, in the same way as a first time a Water balance was calculated and obtained indicators of success have clearly shown much better results in the management of NRW with the reduction of ILI coefficient from 27,4 at the beginning of the Study on 3,9 after.

This result selects this DMA in the category „A" which is a great success for each water utility in the developing countries where Bosnia and Herzegovina belongs as well.


Picture: Detected leakage in the pipe of diameter 200 mm

All data and results of these measurements were processed in the programme calcuLEAKator and after that, a manual calculation was performed in order to check the accuracy of the programme, and identical results were obtained.

On the basis of above mentioned, it was determined that the programme CalcuLEAKator is ready for use in all future projects, and KfW Bank, after accepting the report on water losses reduction, has approved a financial assets for project extension by using the same methodology in all system in Tuzla.

CONCLUSION

Application of the programme CalcuLEAKator on the project of water losses reduction in Tuzla, has enabled a quick and accurate data processing and it was also shown that the programme is applicable in all projects where calculation of Water Balance is done by a "bottom-up" approach. Besides that, all data were presented in the form which can be instantly inserted into the report. In B&H, as well as in the other countries in South-Eastern Europe, reports are written in two languages (English and local language). By use of this programme it is not necessary to translate the tables with the results which was the case before. Programme CalcuLEAKator can be downloaded free of charge at: www.waterloss.com.ba
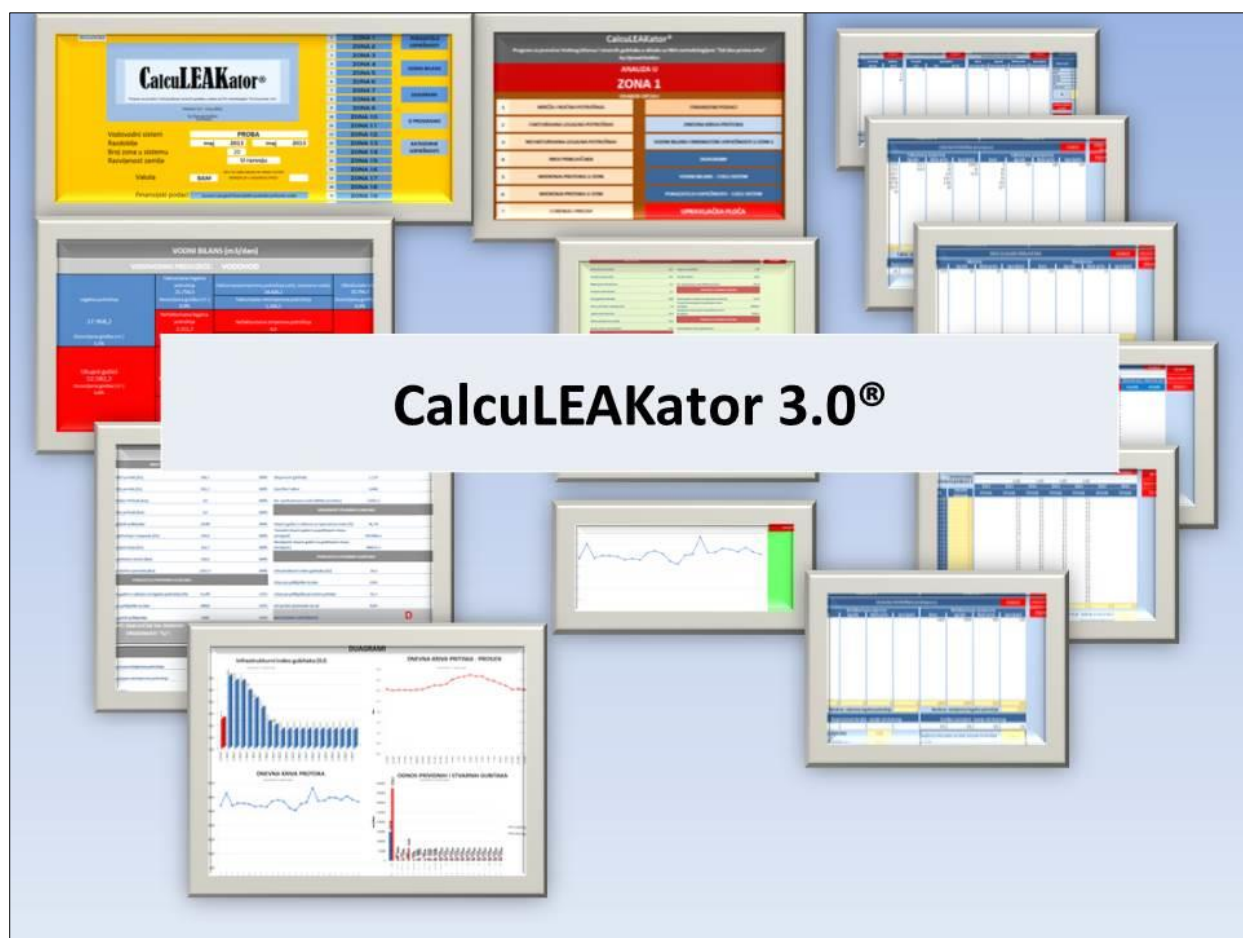
Picture: New version CalcuLEAKator 3.0 is available for download free of charge a (source: www.waterloss.com.ba)