Case studies in applying the IWA WLTF approach in the West Balkan region: Results obtained

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Jurica Kovac has 14 years of experience in the water industry. He is the technical manager of IMGD Ltd. Since 1997, IMGD Ltd. has been developing and promoting new ideas, technologies and methodologies for water loss reduction strategies. The Company specializes in water leakage reduction programs in water distribution networks (leak detection surveys, strategy development for the Utilities), measurements (instruments for flow, pressure, level,…), monitoring (data loggers, data transfer, district metering…), pressure control (pressure reduction valves, automatic control), management, training (courses regarding methodology and technology based on on-field experience for employees in water Utilities) and equipment reselling (cooperation with world's top manufacturers of equipment necessary for water losses reduction programs including full support, training and maintenance). IMGD has assisted more than 200 clients in the region of former Yugoslavia. In 2005 IMGD started active promotion of the IWA best practice methods regarding water losses. Pilot projects currently under way include Zagreb water and sewerage Utility, serving the capital of Croatia, one of the largest in the region. Jurica Kovac has published papers on issues related to water losses, and participated in internationally financed programs (Alliance to save energy, USAID Ecolinks program) regarding implementation of water losses reduction projects.
Keywords: Losses, NRW, CARL, UARL, ILI, Pressure control

Abstract:

The purpose of this paper is to present the results obtained so far in promotion and implementation of the IWA WLTF (International Water Association – Water Loss Task Force) approach in solving problems regarding losses in water distribution networks.
The situation in the region regarding losses is serious and it is necessary for all water utilities to consider implementation of plans and programs for proper quantification of losses and creation of water losses reduction strategies.
One of the most important steps in this program is the selection of an appropriate methodology. In the past, before the IWA WLTF approach, reliable benchmarking and evaluation of options was not possible because of the many different approaches used for calculations of water balance and performance indicators. Also, very often, these previous approaches were unsuccessful, and were associated with high costs, little sustainable reduction in losses, and low motivation to continue. In our region the losses are still presented in terms of % of non-revenue water (NRW). Some individual Utilities are now starting to use IWA terminology (or similar), but usually with some exceptions and modifications that sometimes produces more confusion.
Our intention is to present our experience in implementation of the IWA terminology and WLTF approach, to encourage others to follow. To help everyone with an interest in water losses problems to 'get started', we have translated a simple international software for calculation of the IWA Water Balance and basic performance indicators (CheckCalcs). The software is free of charge and can be an excellent first tool for quantification of losses, and for a first realistic benchmarking between water utilities. CheckCalcs helps in understanding where we really are, and priorities as to how to proceed (presentation of main measures needed and simple calculation of benefits regarding pressure reduction in the system). Our goals are to start with implementation of the IWA WLTF approach by individual water Utilities, and to promote acceptance nationally. This should result in a better understanding and faster improvements, and at the end saving of water that is so important for all of us. This paper will present the following:

- Presentation of results regarding analyses of real losses in water distribution systems from the region (ILI indicators, CARL, UARL, NRW)
- Case study 1: Pilot project Zagreb, Croatia (Reduction of leakage through pressure control development and results obtained)

- Case study 2: Project Gračanica, Bosnia and Herzegovina (Pressure : Burst frequencies relationship, development and results obtained)
- Promotional activities in the region regarding the IWA WLTF approach

Presentation of results regarding analyses of real losses in water distribution systems from the region

All our water utilities are public companies, owned by municipalities or towns. This means there are a large number of Utilities, quite small with weak financial strength and lack of qualified and trained staff (for example the Croatia population is 4,3 million with 116 public water Utilities). Also, the problem of losses in distribution system was for a long time considered less important than increasing the coverage of population with safe drinking water. Very often the same utility is responsible also for the sewers, and sometimes also for some other communal activities like waste collecting, maintenance of parks, cemeteries etc.
In the last couple of years many large water Utilities have invested in equipment for leakage detection and pipeline inspection (ground microphones, leak correlators, mobile flow and pressure meters). But very often they had not developed loss reduction programs based on pressure management, or active leakage control for awareness and location of unreported leaks. Some mid-size and small Utilities received some equipment through donations or by other kinds of international help (for example Bosnia and Herzegovina, Serbia, Monte Negro, Croatia); but in most cases equipment was purchased without proper selection and at the end often without proper (or without any) staff training.
Knowledge regarding district measuring areas (DMA) is getting more accepted in the region but is still not used enough. The reason is that old systems were developed with many interconnections for emergency supply and water quality objectives. However, the Utilities with lowest losses are using system zoning with installed control flow meters.
Installations for pressure control in the systems are rare, perhaps because we have lacked knowledge regarding the influence on pressure on leak flow rates and burst frequencies. We have cases where pressure reduction valves (PRVs) are installed because of very high pressures, but without proper maintenance they malfunction, resulting in higher losses and frequent bursts.
We have also, more recently, some positive examples where Utilities with lowest losses are implementing PRVs or other solutions in pressure control.
We must also underline a serious problem in our water Utilities : the lack of qualified, trained and motivated staff. Sometimes the problem is technicians who are responsible for the leakage detection and pipeline inspections (untrained or underpaid). More often, managers do not understand importance of managing losses, have lack of knowledge of practical effective methods, or are simply too occupied with other obligations; this sometimes results in the incorrect conclusion that losses can be effectively reduced only by replacing old pipelines.
From our experience it is most often the case that Utilities have the staff necessary for successful implementation of losses reduction program, but the staff are not adequately used.

From the beginning of 2005. IMGD started to use the IWA terminology in calculations of all the components of the Water Balance, including Real Losses. Also, other concepts promoted by the IWA WLTF are now becoming part of our activities (BABE and FAVAD concepts, Active Leakage Control, Pressure Management etc.).
An important evolution was the introduction of the performance indicator ILI (Infrastructure Leakage Index), which is the ratio of CARL (current annual real losses) to UARL (unavoidable annual real losses. This was a major step forward for our water Utilities considering that for the first time we could assess unavoidable annual real losses on a system-specific basis, taking account of local characteristics (main length, number of service connections, meter location, pressure).
In Croatia, it has been traditional to consider NRW losses of less than 25% as being a good performance, without allowing for different system characteristics.

Figure 1.

In the table below, % NRW and ILI are calculated for 12 Croatian systems and one from Bosnia and Herzegovina (see also Figures 2 and 3.). *Note: some received data from some users are based on approximate data and some errors are possible (unbilled authorized consumption, unauthorized consumption, average pressure) but we assume that in all cases the confidence limit is acceptable for initial comparisons of this kind. In the future with more experience regarding the new methodology, the accuracy will be better (Note: ILI=CARL/UARL).*

Distribution system	Pipelines length	Number of service connections	NRW	CARL	CARL	UARL	Average Pressure	ILI
	Km		% WS	% WS	l/s.conn/day	l/s.conn/day	(m)	
1	142	6310	33	31	111	73	55	1,5
2	1500	42000	27	25	168	99	60	1,7
3	259	4834	39	35	259	96	45	2,7
4	991	30375	42	39	277	82	50	3,4
5	1500	23000	54	50	451	122	60	3,7
6	338	9000	37	33	290	82	60	3,7
7	713	33073	24	19	302	73	65	3,7
8	550	21700	41	35	230	55	40	4,2
9	435	12000	38	34	464	80	50	5,8
10	265	13995	52	46	346	47	40	7,4
11	97	4535	53	49	486	73	45	7,5
12	117	9184	49	43	345	40	35	8,7
13	769	42308	70	65	1069	63	50	17

Figure 2.

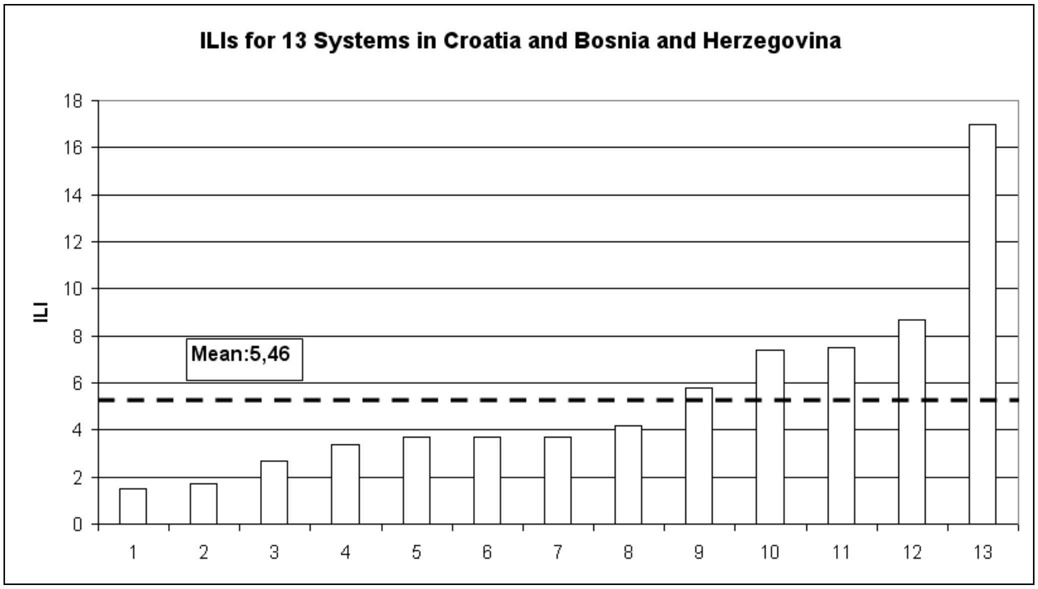

Figure 3.

When these data are compared with international data sets where we have mean ILI 4,38 (IWA Water 21, Aug 04, source Allan Lambert) it is evident that situation in our water distribution systems regarding real losses is similar to the world scale.

It is also important to emphasise that % NRW is not adequate for assessing performance in managing real losses (see Figure 4). For example, in systems 3 and 9, the %NRW is similar (39% and 38%), but the ILI provides more meaningful performance information for real losses management. Because each system has different specific characteristics and different unavoidable annual real losses, we can see from the ILIs that real losses management in system 3 (ILI=2,7) is twice as good as in system 9 (ILI= 5,8).

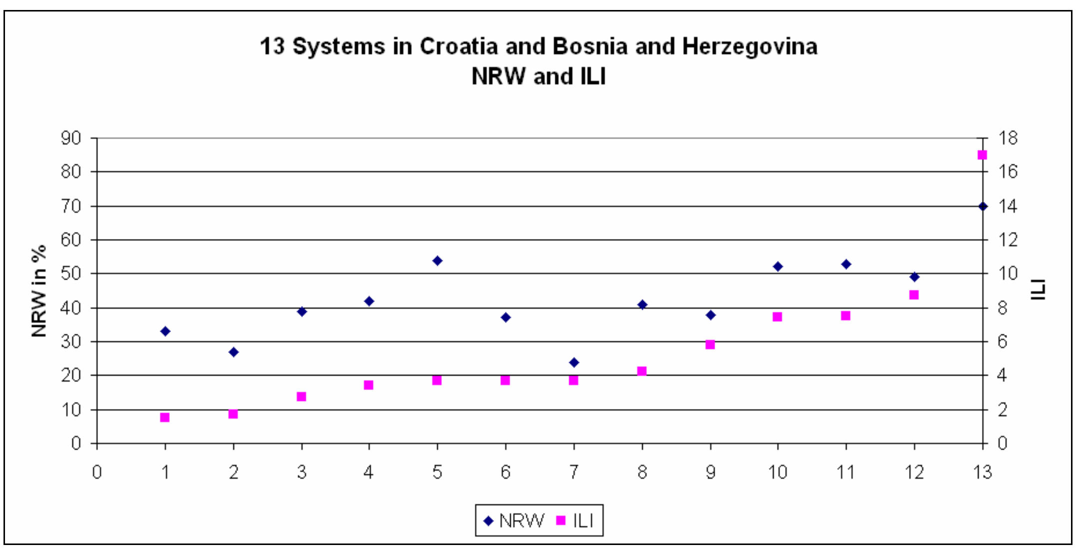

Figure 4.

Figure 5 shows the current annual real losses for the 13 analyzed systems in litres/service connection/day, which is the best of the traditional simple performance indicators for distribution systems with more than 20 service connections/km of mains.

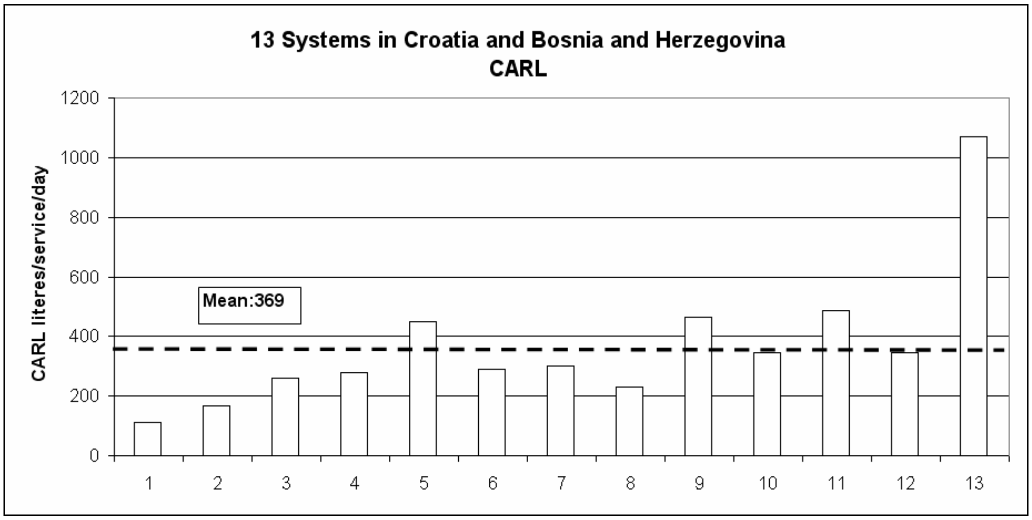

Figure5.

The following case studies are used to demonstrate how implementation of activities like zoning, pressure control etc. also supported by IWA WLTF approach, can be effective. We will present them briefly with the most important steps undertaken and the results obtained.

Case study 1: Pilot project Zagreb, Croatia
Reduction of leakage through pressure control - development and result obtained

The water distribution system in Zagreb city, the capital of Croatia, is one of the largest in our region (over 2.900 km of pipelines and more then 100.000 connections, serving a population of approximately 800.000). In October 2005 we have started a pilot project regarding pressure control for leakage (losses) reduction. The selected zone (see Figure 6. and Figure 8.) is a residential area with multi-storey buildings (averaging 10 floors), high pressures and a suspected high level of leakage. The zone has 13,5 km of cast iron mains, and 653 service connections (cast iron, galvanized iron and PEHD).

Figure 6.

The first step was initial measurement of flow and pressure within the zone (after all boundary valves had been closed and checked). IMGD selected the location, and specified all details regarding chambers, for installation of pressure reduction valves and all other equipment (PRV DN250, woltmann type flowmeter, valve controller and remote GSM monitoring – see Figure 7.).

Figure 7.

Also we have established 3 selected locations for pressure monitoring (with GSM data transfer) inside of the zone (see Figure 8.).

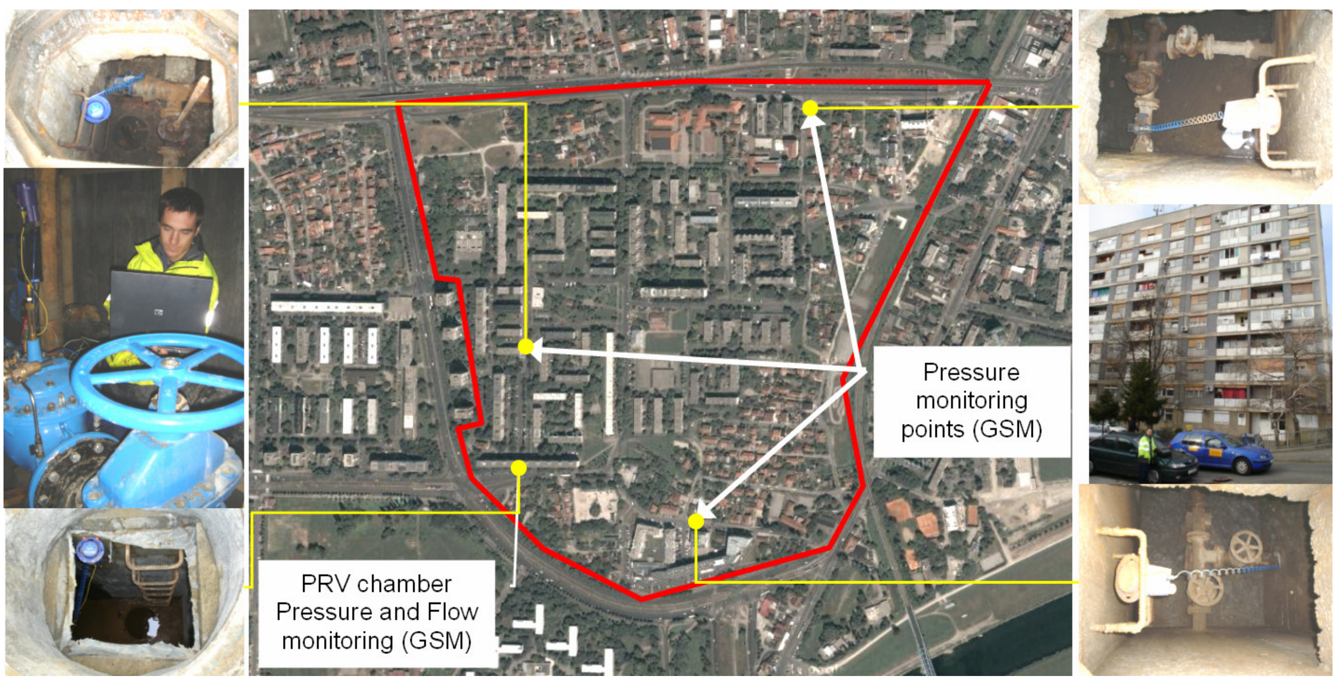

Figure 8.

Implementation of the project had the following outcomes:
Initial minimum flow: 44 l/s (160m3/hour)
Initial inlet pressure: 6,50 bar (day) up to 7,10 bar (night)

1st step of regulation: fixed outlet pressure (5,70 bar) (see Figure 9.)
Night flow reduced by 24% (total 24hour inflow reduced by 11%)

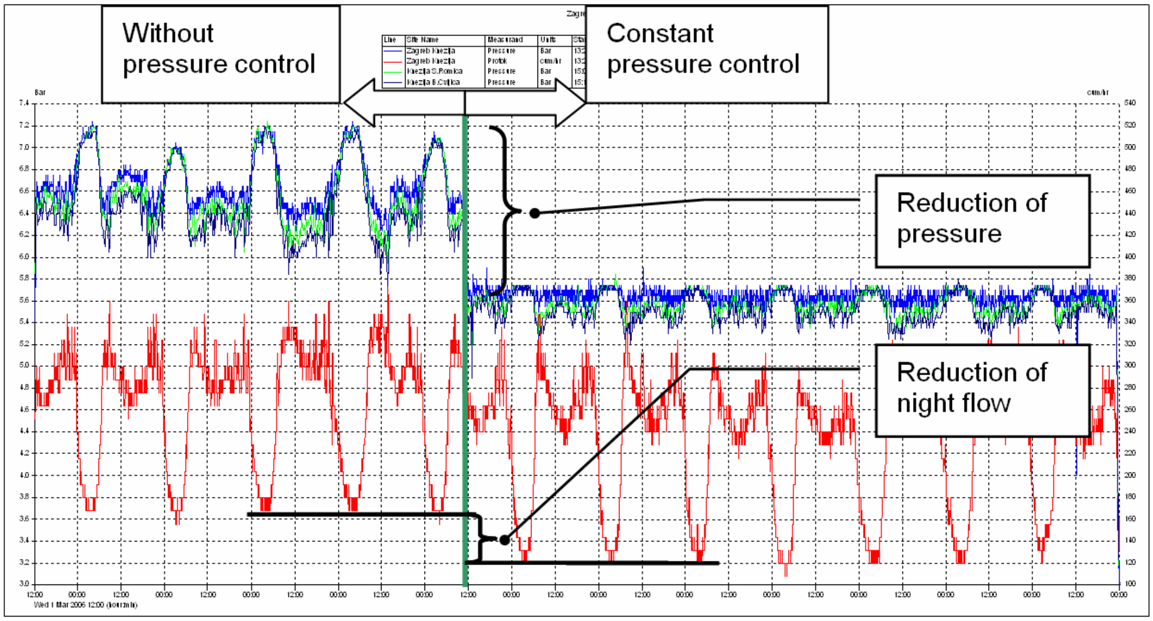

Figure 9.

2nd. step: outlet pressure varies with flow (day pressure 5,70 bar; night pressure down to 4,80 bar)
Night flow reduced by 39% (total 24 hour inflow reduced by 14%)
Reduction of losses (leakage) by approx. 25%!
(detailed estimation is underway – using FAVAD method and calculating ICF Infrastructure condition factor)
Total 24h inflow reduced from 6300m3 to 5400m3 (900 m3/day savings)

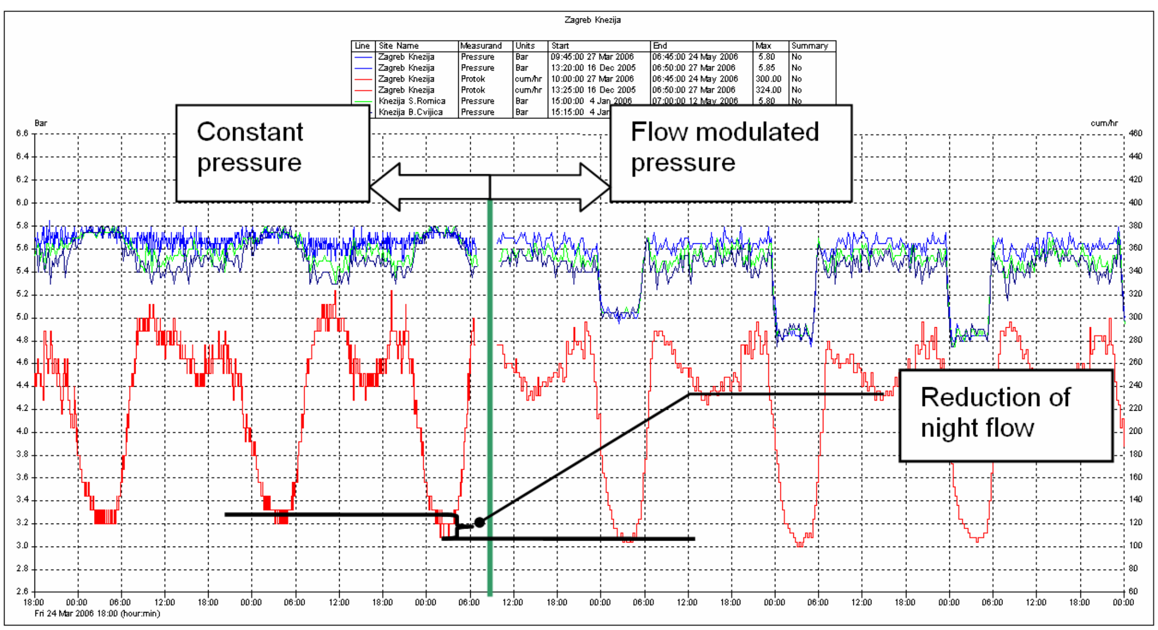

Figure 10.

This reduction in pressure had no influence on consumer's standard of service for water supply.

Case study 2: Project Gračanica, Bosnia and Herzegovina
Pressure : Burst frequencies relationship, development and results obtained

The gravitational water distribution system in the town of Gračanica, north Bosnia and Herzegovina has 70 km of mains and 4500 service connections, mainly private houses with 2 floors, and a population of approximately 15000), and has for a long time experienced water shortage, especially in summer time. In the first half of 2005 we analyzed the system and concluded that pressure control is most favorable regarding short-time benefits. The key objective was to reduce current leakage, but we also wished to explore the relationship between pressure reduction and burst frequency.

Figure 11.

The first step was initial measurements of flow and pressure and separation of the system into 6 zones. The system was already separated into 3 areas based on elevation, of which Grad was the biggest with a pressure range from 1,00 bar (close to the reservoir) to 8,00 bar at the end of the system. See Figure 12.

Areas	Consumption (m3/day)	Consumption (%)	Pressure range (bar)	Minimum flow measured (l/s)	Length of pipelines (km)
GRAD	3500	87	1,00 … 8,00	30,00	45
MEJDANIĆ	120	3	1,00 … 3,00	0,50	10
ČIRIŠ	400	10	1,00 … 5,00	2,50	15
Total:	4020	100		33,00	70

Figure 12.

Separation of the system in 6 zones was made in order to implement flow and pressure control in more detail (introduction of DMA – district measuring areas), and especially to separate Grad into 3 smaller zones (see Figure 13. and Figure 14.).

Zone	1	2	3	4	5	6
Name	Grad north	Grad center	Grad south	Čiriš north	Čiriš south	Mejdanić

Figure 13.

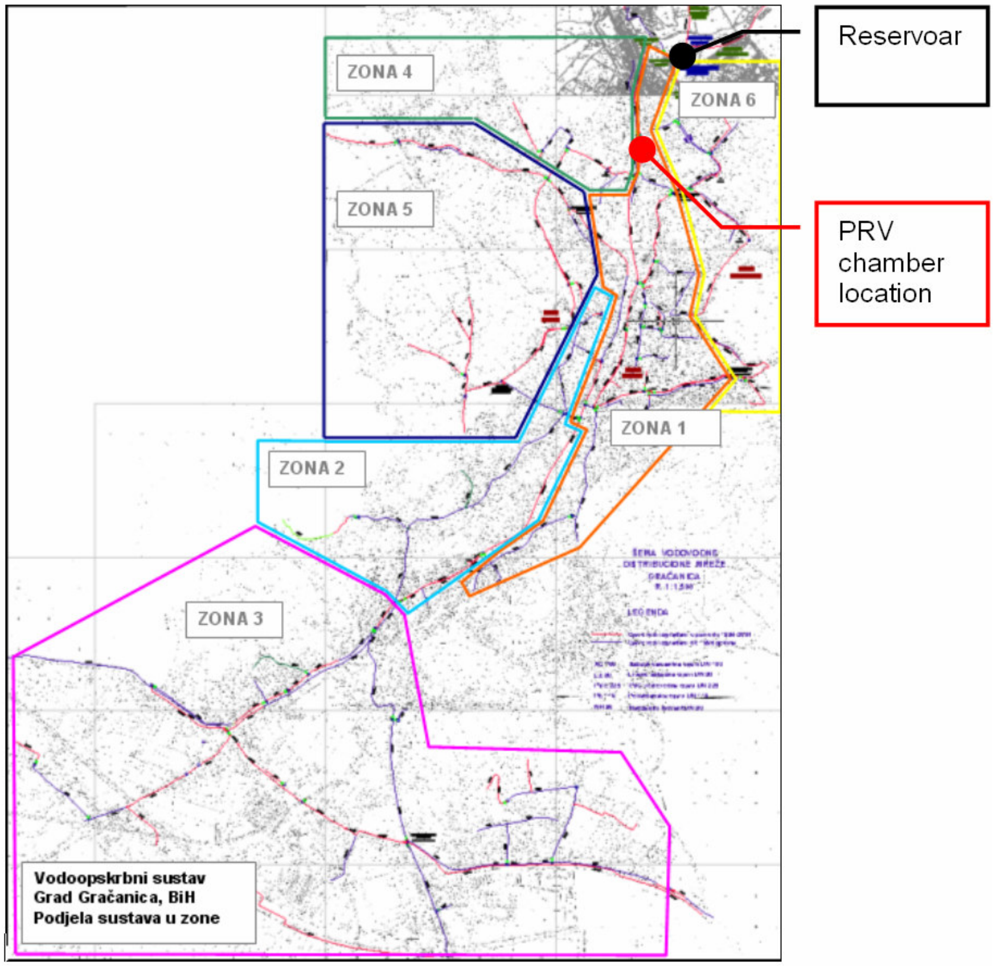

Figure 14.

Pressure control was implemented in the zone Grad (in our new zoning this area covers zones 1,2,3 see Figure 14.) with pressure reduction by 20%. IMGD selected the location, and specified all details regarding chambers, for installation of pressure reduction valves and all other equipment (2 PRVs DN150, woltmann type flowmeter, valve controller and remote GSM monitoring – see Figure 15.).

Figure 15.

Pressure before implementation of control and reduction was in the range between 4,80 and 5,30 bar. (average 5,00 bar). Reduction of pressure and control was tested in two steps; first step with constant pressure at PRV outlet of 4,00 bar, and second step with pressure modulated by PRV controller according to current flow registered by flowmeter inside of the chamber (see Figure 16.).

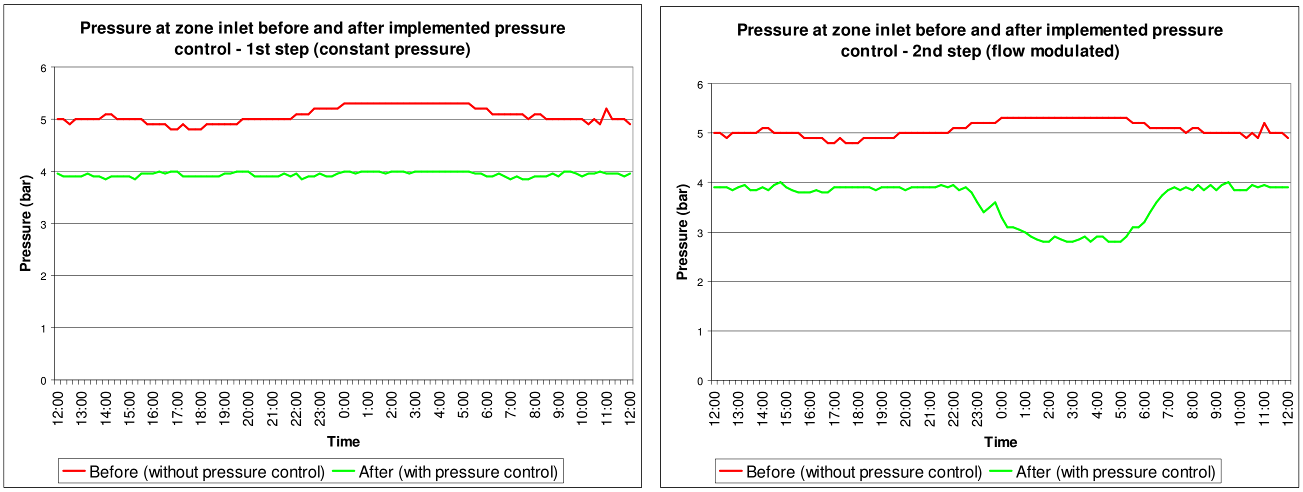

Figure 16.

Figure 17 clearly demonstrates the existence of a pressure : burst frequency relationship. With reduction and control of pressure, the number of bursts is dramatically reduced. *Note: presented bursts in Figure 17. are for the whole distribution system but pressure control was implemented for zones 1,2,3. Determination of results only for zones 1,2,3 is currently under way.*

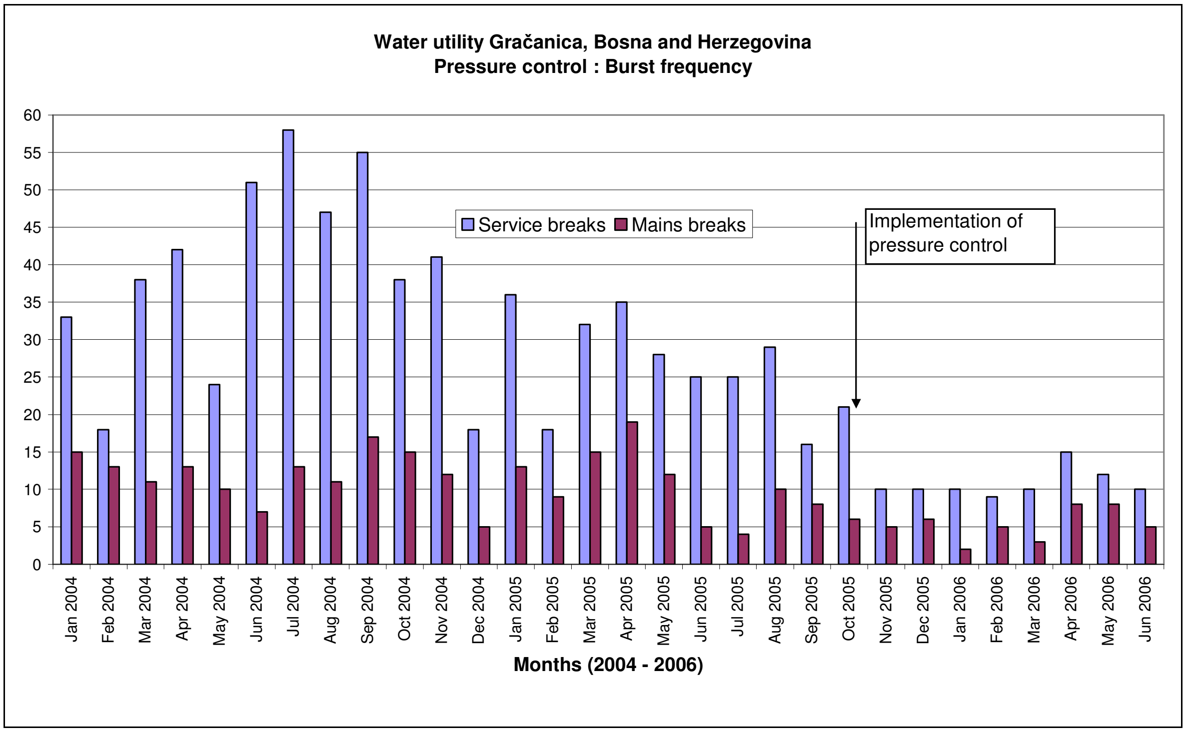

Figure 17.

Accomplished results for a 20% reduction of inlet pressure in area Grad (Zones 1,2,3); for complete system: Mains bursts reduced by 59%; Service connection burst reduced by 72%

(% reductions based on PressCalcs software calculation comparing bursts rate 638 days before pressure control and 272 days with pressure control)

Another important outcome of pressure control was reduction of losses (leakage) (see Figure 18.). **Daily inflow was reduced by 12% (average savings 450 m3/day)** – for the complete system

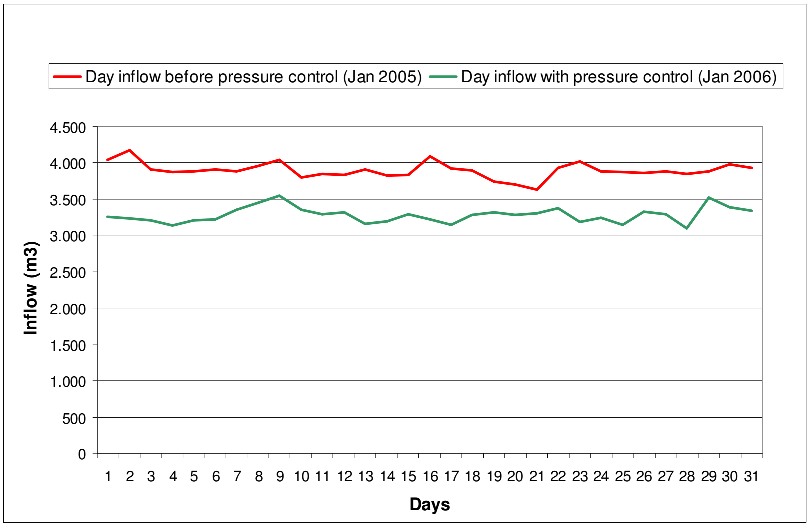

Figure 18.

Figure 19 presents data received by remote monitoring via GSM, showing how pressure control (blue line) is modulated by current flow (red line). This mode of pressure control secures adequate pressure according to current demand (for example in case of fire fighting, the system recognizes the rise in flow and automatically increases the pressure). This mode of operation can be used to ensure that all consumers will always have enough pressure. It is also important to have remote monitoring of modulated systems, because new leaks and bursts will also produce a rise of flow and a rise in inlet pressure, and such events may not be noticed if they do not generate customer complaints of low pressure or no water.

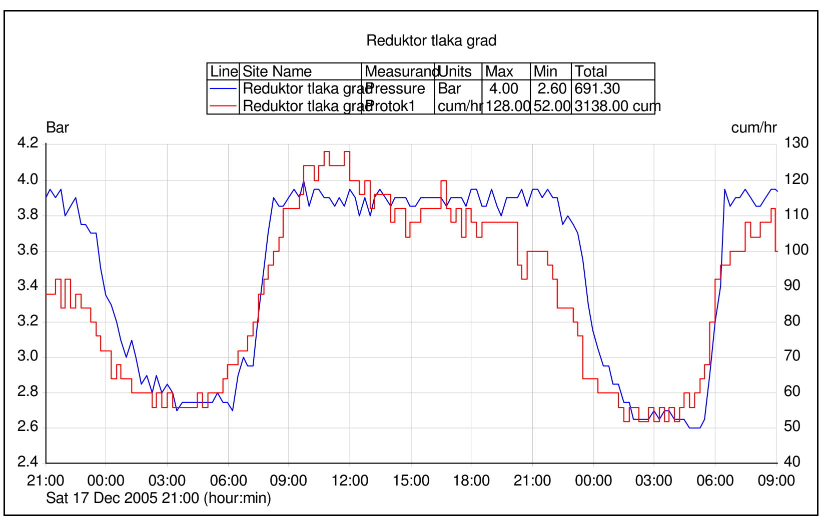

Figure 19.

Promotional activities in the region regarding IWA WLTF approach

Our case studies and many others from around the world are good examples of benefits that can be achieved, and we hope that others will follow our way. In most cases, implementation of the IWA WLTF approach is also cost effective in the short-term, which is one more argument to start as soon as possible.
The first important step regarding this approach is familiarization with the basics of the IWA WLTF methodology and terminology. For this purpose, different computer softwares have been developed. The free CHECKCALCS was developed by ILMSS Ltd. – Allan Lambert – as part of the LEAKS software suite. With this software a water Utility can quickly and easily calculate basic indicators according to both old (%NRW) and new methodology (current annual real losses – CARL, unavoidable annual real losses – UARL, Infrastructure Leakage Index – ILI) and benchmark their own performance with others from around the world or in the region. Also this software uses evaluation (ranking) recommended by the World Bank Institute. The software explains all basic terms and gives explanations how to proceed further with more advanced softwares in the LEAKS Suite..
Our goal is to help everyone interested in IWA WLTF approach. CheckCalcs software is already translated into the Croatian language but other language versions of the software for the region are also underway. CheckCalcs is available free of charge from IMGD (requiring only user registration) and because it is in Microsoft Excel it can be widely used.

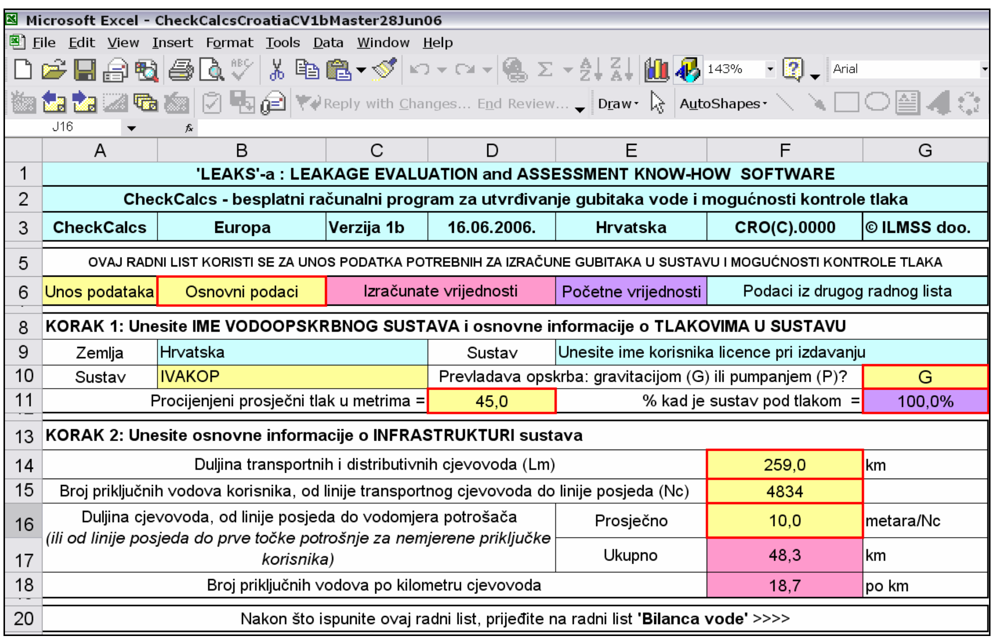

Figure 20.

Besides promotion through free software IMGD will undertake other steps in our region.
First is cooperation with the government agency Croatian Waters on promoting the IWA WLTF approach in Croatia. Our goal is to integrate this approach at a national level and to improve the traditional existing approach which uses % NRW as the main performance indicator.
The second step is already undertaken and consists in the transfer of knowledge through our services for water utilities.
The third step involves promotion of the improved concepts in Bosnia and Herzegovina. This has already started with a seminar about losses in water distribution systems held in Sarajevo in May 2006.. It is also important that we have a local case study (Gračanica) that can serve as an example for others.

The fourth step is our contribution to this conference, that is important for this part of the region (especially Macedonia, Serbia, Romaina, Bulgaria, Albania,…). Also, we have raised interest in Slovenia too, and we plan to participate in seminars there.
The fifth step is to create a web site that will serve as a meeting point for all interested in this subject (news, case studies, questions, explanations, etc.). The Web domain name reserved is www.gubici.net.

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