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I-WA BEST PRACTICE AND PERFORMANCE INDICATORS FOR WATER UTILITIES IN SERBIA – CASE STUDY PIROT

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Abstract. *Active water loss management has become one of the primary interests of the water utilities in the world. Due to efforts of the IWA Task Force in the last decade, traditional approach of water loss expression in percentage of system input values has been proven to be misleading in may cases, and new way of performance measuring and benchmarking is proposed. This paper presents the basic principles of this methodology and results of the first step in attempt to approach Serbian water utilities performance according to new standards. Pirot water supply system is used as a case study to estimate pressure reducing impact on technical performance indictor values before introducing active leakage control.*

Key words: *Water Utility, Performance Indicators, IWA Best Practice*

1. INTRODUCTION

The level of water losses, both real and apparent, is one of the most important efficiency issues for water utilities across the world. Commonly used practice amongst water supply utilities to express water losses as a percentage of the system input volume has been proven to be unsuitable as a technical performance indicator as it does not reflect many of the influencing factors.

During the last decade, IWA Best Practice Water Balance and Technical Performance Indicators (PI) recommended by Water Loss Task Force have proven to be more appropriate benchmarking merit. Application of this method is more demanding and makes water utilities install metering devices and perform new procedures to collect accurate data and introduce pro active leakage management in order to reduce damage and increase its own efficiency. Serbian water utilities need to change management style and make efforts to adopt IWA best practice, introduce pro active leakage management plan, improve own performance and meet standards of developed countries. Estimation of any proactive management measure impact on technical PI through numerical modeling is very useful tool to predict positive effects before its real implementation on the water supply system.

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2. IWA BEST PRACTISE AND TRADITIONAL PI

IWA Task Forces produced an international 'best practice' standard approach for Water Balance calculations, with definitions of all terms involved, as the essential first step in practical management of water losses [1], [2]. It is rapidly gaining international acceptance, and has already been adopted or promoted (with minor variations) by many national water utilities associations and consultants not only in developed, but in developing countries as well.

Definitions of principal components of the IWA water balance are as follows:

- System Input Volume (SIV): the annual input to a defined part of the water supply system;
- Authorized Consumption: the annual volume of metered and/or non-metered water taken by registered customers, the water supplier and others implicitly or explicitly authorized to do so;
- Non-Revenue Water (NRW): the difference between SIV and Billed Authorized Consumption;
- Water Losses: the difference between SIV and Authorized Consumption, consisting of Apparent Losses and Real Losses;
- Apparent Losses: Unauthorized Consumption and metering inaccuracies;
- Real Losses: the annual volumes lost through all types of leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of customer metering.

The following four traditional performance indicators for real losses are used:

1. Water Losses and Real Losses as a % of system input volume
2. Water Losses and Real Losses per property per day
3. Water Losses and Real Losses per km of mains per day
4. Water Losses and Real Losses per service connection per day

Water Losses, as a percentage of system input, is easily calculated and frequently quoted. In developing countries the concept of Non-Revenue Water is often used, sometimes with high levels of Unauthorized Consumption. Real Losses per property have to be rejected as the property (very often the customer) has very little to do with leakage. Leakage component analyses in water distribution systems across the world have shown that the greatest portion of annual real losses occurs at services connections, including the connecting point to the main.

The IWA Water Loss Task Force therefore recommended [2] that the basic traditional PI with the greatest range of applicability for real losses, to be referred to as the 'Technical Indicator Real Losses' (TIRL) is:

TIRL = Real Loss Volume/Service Connection/Day *w.s.p.*

TIRL is the best of these traditional indicators - but should always be calculated as 'w.s.p.' - when the system is pressurized. Leakage management practitioners recognize that it is impossible to eliminate real losses from a large distribution system. Therefore some value of 'Unavoidable Annual Real Losses' (UARL) could be achieved at the current operating pressures if there were no financial or economic constraints. In the most basic form, UARL in liters/day is

$$UARL = (18 \times Lm + 0.80 \times Nc + 25 \times Lp) \times P \; w.s.p.$$

where Lm is mains length in km, Nc is number of service connections, Lp is total length in km of underground pipe between the edge of the street and customer meters, and P is average operating pressure in meters. This equation, based on component analysis of Real Losses for well-managed systems with good infrastructure, has proved to be robust in diverse international situations [3], for systems with more than 5,000 service connections, connection density (Nc/Lm) more than 20 per km, and average pressure more than 25 meters.

3. ILI – INFRASTRUCTURE LEAKAGE INDEX

The ratio of TIRL to UARL becomes a non-dimensional Infrastructure Leakage Index (ILI), which allows overall infrastructure management performance to be assessed independently of the influence of current operating pressure. The ILI is a measure of how well a distribution network is managed (maintained, repaired, rehabilitated, etc.) for the control of real losses, at the current operating pressure. It is the ratio of Current Annual volume of Real Losses (CARL) to Unavoidable Annual Real Losses (UARL).

$$ILI = CARL / UARL$$

Being a ratio, the ILI has no units and thus it facilitates comparisons between countries that use different measurement units. As an excellent system can be rated one, with the ILI value close to 1, while system with high ILI value, for instance 10, can be rated as a poorly maintained one. Many practitioners prefer not to use the ILI for one or more of the following reasons:

- the accuracy of the UARL formula is questionable;
- data required to calculate UARL are not available;
- interested party neither use, nor understands the ILI
- the ILI is not needed - the classical performance indicators are sufficient;

In addition, there are other two reasons why the ILI is sometimes not used:

- 10% water losses always sounds acceptable - while the ILI in many cases highlights that the true leakage performance is far from satisfactory
- Warnings from the Task Force that the ILI should not be used for systems with less than 25 m average pressure or less than 5,000 connections.

In spite of that, ILI technical performance indicator can be used for benchmarking water supply systems in different areas and countries, and very practical categorization has been proposed by Liemberger [4].

4. IWA BEST PRACTICE APPLICABILITY TO SERBIAN WATER UTILITIES

Following collected data from 98% of the questioned water utilities [7], during the year 2004-05, water supply systems in Serbia are in the most of cases composed of pipes more than 40 years old, made of steel, asbestos cement, while the newer parts of the mains are constructed of plastic, polyethylene and ductile iron pipes. The similar set of problems was experienced as in the developing world:

- Not always reliable information on the true network length is present,
- Lack of reliable or absence of System Input Volume (SIV) metering,
- Accurate number of service connections is not known
- Neither pressure data nor pressure loggers available. Estimated average pressure usually too high ("wishful thinking"!),
- High level of apparent losses (difficult to estimate) and therefore unreliable and inaccurate volume of real losses.

Some approximations had to be done [8], [9]:

- Service connection lengths were often missing parameter and common value of 10 m was used for the estimation,
- Unbilled Unmetered Authorized Consumption was estimated for all utilities as 1% of System Input Volume (SIV),
- Unauthorized Consumption – Illegal connections and using water from hydrants was estimated for all utilities as 1% of SIV,
- Metering Inaccuracies due to low bulk meter sensitivity to minimal night consumption were estimated for all utilities as 1% of SIV,
- Number of days when system is pressurized was adopted as 365 days, but in reality, intermittent supply decreases UARL and increases ILI value.

Using collected data, traditional and IWA best practices performance indicators were estimated for 36 water utilities [9]. UARL average value, like as ILI value, calculated from the collected data with an error margin of 12%, does not fit to the IWA Task Force recommended 95% confidence interval.

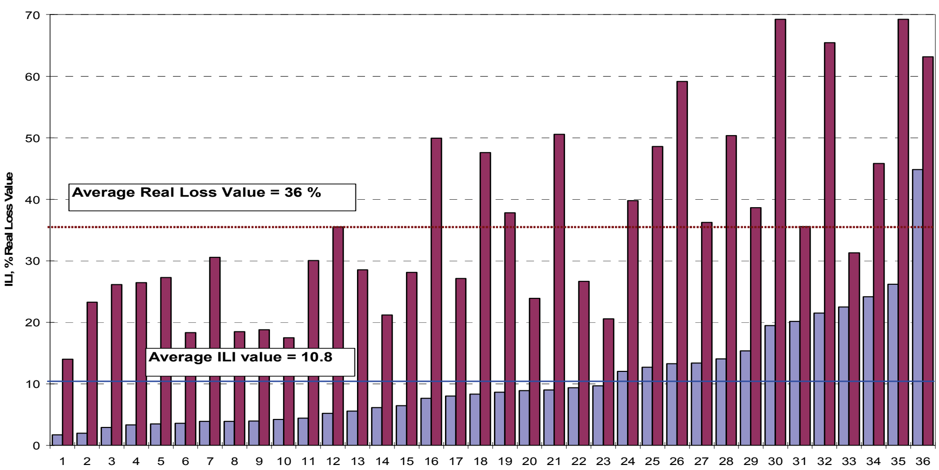

Fig. 1. % Real Water Losses and ILI in dataset of Serbian water works

Average Real Loss, expressed in percentage is 36%, while there were estimated some extreme values of almost 70%! The average ILI value is about 11 (Figure 1).

Even though there is no correlation between these two indictors, both of them imply bad technical condition of water supply systems in Serbia and high potential for improvement. The ILI values seem much better than in many other developing countries, but comparing them with highly developed systems will make one conclude that Serbian water supply systems are currently in poor condition, with high potential for significant Real Loss reduction.

In spite of problems in the initial steps of IWA best practice and UARL, TIRL and ILI performance indictors application in Serbia, this methodology can help discover and establish a new merit point of view and make water utilities discover new facts about their functionality and potential to increase their own efficiency, as water resources are not always so plentiful in Serbia (in fact many small water utilities face serious problems both with insufficient water resources and high level of leakages from water supply system).

5. Pirot water utility – case study

The town of Pirot is situated in the Southeastern part of Serbia, nearby border with Bulgaria. There are about 46,000 people supplied by the Pirot Water Utility (PWU). Water sources still have enough yield to provide continual water supply during the whole year. Groundwater comes from the karst springs with very good quality during the whole year, with exception in the short periods of strong rainfall, when turbidity is increased. There are two main water springs used for water supply, Kavak and Krupac, while the third, Gradište, is alternatively used during summer months, or in the period when Krupac water is not clear. Two main pumping plants are installed: Kavak, on the location of the Kavak spring, (altitude 373 m), and Berilovac (altitude 372 m), which works as buster pumping plant on the common pipeline coming from Krupac and Gradište. The system is pressurized during the whole year, with exception of very short periods during some burst occurrence on the main pipelines, but the damaged part of the system is usually quickly isolated and repaired.

Configuration of Pirot water supply system (PWSS) is shown in the Figure 2. In the same Figure there is (still hypothetical) plan for introducing new zones for pressure control. This plan is used later for numerical simulation to estimate pressure reducing impact on PI.

The network is composed of various material pipes (AC, Iron, PCV, PE), with maximal diameter 600 mm. The average age of pipes is about 35 years. Due to the terrain configuration, currently there are three water supply zones. The main and the largest zone is in the central town area, supplying over 90% of consumers. There are two water tanks used for water storage for the central zone, Sarlah, 2,000 m^3 volume, with the bottom level at 420 m, and Pirot 5,000 m^3 volume with the bottom level at 420.50 m. Both of them are located opposite of the pumping plants and are hydraulically connected with the distributive network. Maximal water level for both is 5 m. The central town zone is rather flat, and the pressure varies in the range 4,5 – 5,5 bar in the distributive network. The other two supply zones (Zone 1 and 2) are very small, in fact two suburbs at the altitude higher than 390 m. One is supplied by the buster pumping plant Novi Zavoj which feeds the water tank Novi Zavoj (250 m^3) for a couple of hours daily. The third zone, Radin Do is supplied by the buster pumping plant installed in the water tank Pirot.

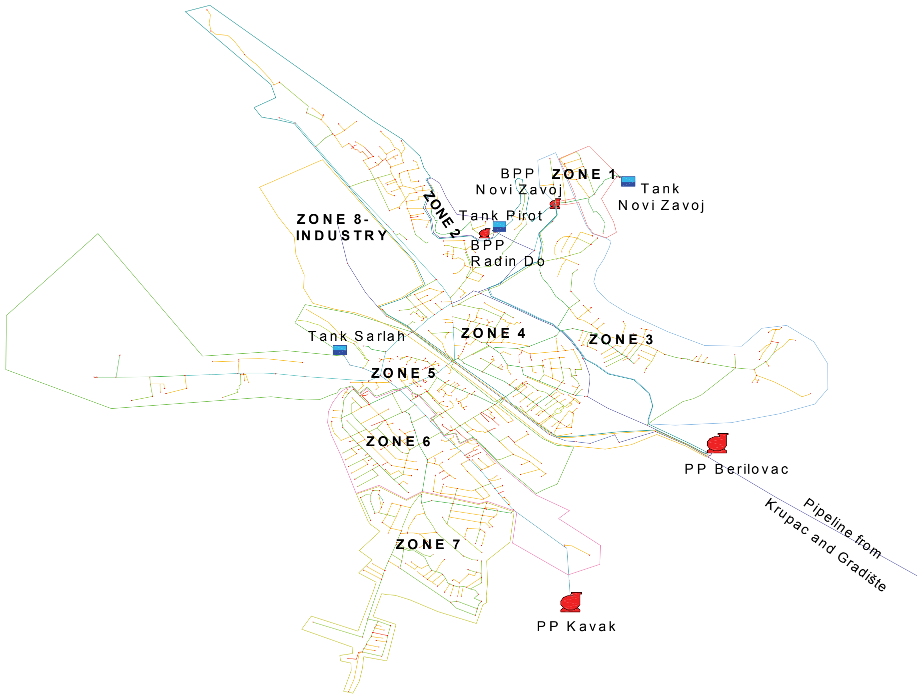

Fig. 2. Pirot WSS with Perspective Plan of Pressure Control Zoning

There is rubber industry giant, Tigar Pirot in the industrial area. The industrial area is water supplied with separate gravitational pipeline, with permanent flow about 15 l/s, without buster pumping plants. The other industrial subjects in the industrial zone have very low or no activities.

Table 1. % Water Balance in PWSS During the Period 2005/06

Water Balance Month 05-06	System Input m^3/day	Registered m^3/day	Unregistered m^3/day	Water Loss %
September	19,590.00	10,817.00	8,773.00	44.8
October	19,347.00	10,021.00	9,326.00	48.2
November	20,015.00	9,596.00	10,419.00	52.1
December	16,399.00	8,763.00	7,636.00	46.6
January	18,422.00	8,630.00	9,792.00	53.2
February	19,455.00	9,676.00	9,779.00	50.3
March	19,043.00	9,603.00	9,440.00	49.6
April	18,091.00	9,336.00	8,755.00	48.4
May	17,358.00	9,631.00	7,727.00	44.5
June	17,927.00	10,112.00	7,815.00	43.6
July	20,373.00	10,715.00	9,658.00	47.4
August	20,434.00	10,198.00	10,236.00	50.1
Average	18,871.17	9,758.17	9,113.00	48.2

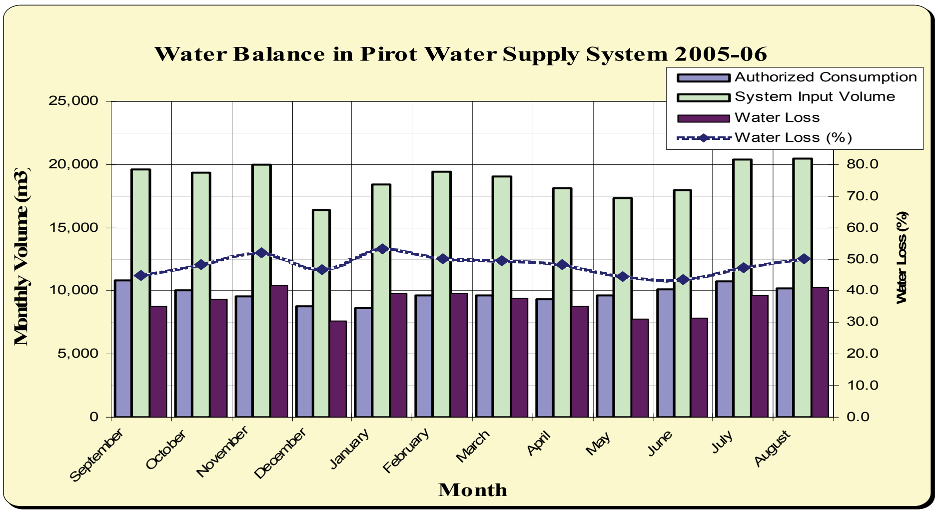

Fig. 3. Water Balance in Pirot Water WSS During the Period 2005/06

During the year 2005, flow meters have been installed at the pumping plants Kavak and Berilovac and little bit later level meters have been installed in the tanks Sarlah and Pirot and connected to the operational centre. Data on water levels in the tanks are used by the operator on daily basis to instruct actions to the staff on the pumping plants, to switch on/off pumps or to maintain constant flow.

Based on the registered data, the annual Water Balance was calculated upon IWA "Best Practice" standard and presented in the Table 2. Since reliable data for IWA best practice WB Calculation were not available before flow meters and level meters have been installed and there was a belief, or wishful thinking, that the Real Water Loss (RWL) was less than 20%! After revealing more accurate data, an imperative must be to decrease RWL. The similar approximations were done, like for all other systems in Serbia: Service connection average length is estimated to be about 10 m, and Unbilled Unmetered Authorized Consumption, Unauthorized Consumption and Metering Inaccuracies were all estimated as 1% of SIV.

Estimated PI indicators in the Table 3 makes PWU representative system for Serbia, with ILI value over 10, but average percent of water loss values of the SIV in the analyzed period of about 48%, significantly higher than average water loss % value in Serbia. Both indicators classify PWU into the Developing Countries Category C: "Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts" [4]. In fact, water springs in Pirot are not plentiful during the summer months, and they are hardly sufficient for continual water supply. Water production is not cheap, considering pumping, water filtering and chlorinating, system maintenance and other operative costs.

Table 2. IWA Best Practice Water Balance in PWU 2005/06

<table>
<tr><td rowspan="9">A
System
Input
Volume
(corrected
for known
errors)
6,887,991
m^3</td><td rowspan="4">B1
Authorized
Consumption
3,996,403</td><td rowspan="2">C1
Billed
Authorized
Consumption
3,396,943</td><td>D1 Billed Metered Consumption
3,396,943</td><td rowspan="2">Revenue
Water
3,396,943</td></tr>
<tr><td>D2 Billed Unmetered Consumption
0</td></tr>
<tr><td rowspan="2">C2
Unbilled
Authorized
Consumption
599,460</td><td>D3 Unbilled Metered Consumption
530,581</td><td rowspan="7">Non-
Revenue
Water
(NRW)
3,491,048</td></tr>
<tr><td>D4 Unbilled Unmetered
Consumption
68,880</td></tr>
<tr><td rowspan="5">B2
Water
Losses
2.891.587</td><td rowspan="2">C3
Apparent
Losses</td><td>D5 Unauthorised Consumption
39,964</td></tr>
<tr><td>D6 Metering Inaccuracies
39,964</td></tr>
<tr><td rowspan="3">C4
Real
Losses</td><td>D7 Leakage on Transmission and/or
Distribution Mains 1,209,014</td></tr>
<tr><td>D8 Leakage and Overflows at
Utility's
Storage Tanks 56,233</td></tr>
<tr><td>D9 Leakage on Service Connections
up to point of Customer metering,
1,546,413</td></tr>
</table>

Table 3. Estimated PI for Pirot Water Supply System (PWSS) 2005-06

Number of inhabitants served	46,073
Number of registered service connection	14,384
Total length of distributive network (km)	108
Total length of service connection (km)	144
Average network pressure (m)	45
Technical Indicator Real Losses - TIRL (liter/connection/day)	**536**
Unavoidable Annual Real Losses (liter/connection/day)	**53**
Infrastructure Leakage Index	**10.1**

One of the main reasons for the high leakage record is topography and water supply system configuration, which makes it pressurized in the range 45-55 m all the time. Old pipes and service connections are prone to significant leak volume. Before any action is done, it is recommendable to check the effects of intervention on the system. Replacement of pipes and service connections without prior analysis is one measure that can make improvement, but often with not enough (or not at all!) satisfying results, while permanent system monitoring and active control could postpone expensive pipeline replacement, but also give significant or amplify positive effects of system reconstruction and prolong system life.

6. PIROT WSS – HYDRAULIC ANALYSIS

Conceptual hydraulic analysis for PWU is performed using professional software package AquanetS 7.2.10 [10]. As the most convenient months for hydraulic analysis March or April 2006 were considered, due to water loss percentage of average value for the recorded period. Daily demand time patterns are generated, for the total consumption (SIV=Authorized + Water Loss), for the period October - May. The shape of the daily time patterns, averaged on the monthly basis, is rather similar for all months. Since there were more reliable data recorded in April (less stoppage of water level metering), this time pattern was adopted for further analysis. Consumption of the industrial zone is not included, since water is neither pumped nor stored in the town water tanks. Industrial zone has separate pipeline and separate bulk water meters, and this quantity is not included in the previous consumption data.

Daily time pattern in the Figure 4 represents consumption of citizens, public institutions and small business. Average daily water consumption has almost identical values during working days and weekends and daily time patterns are similar in both cases. There is no significant patterns variation; for other months, there is even lesser variation. This fact points out high leakage level, because the peak consumption is only two times higher than minimal, during the night time.

A detailed mathematical model of the PWSS is generated, with all pipes in the network included, based on data recorded in the technical documents and data base on pipe material, age and diameters. Average value of the Authorized Consumption for March 2006, estimated from data collected at service water meters, is spatially distributed in the model nodes upon geographical position, street and address. Initially, daily time patterns for the SIV were used as representative for the Authorized Consumption.

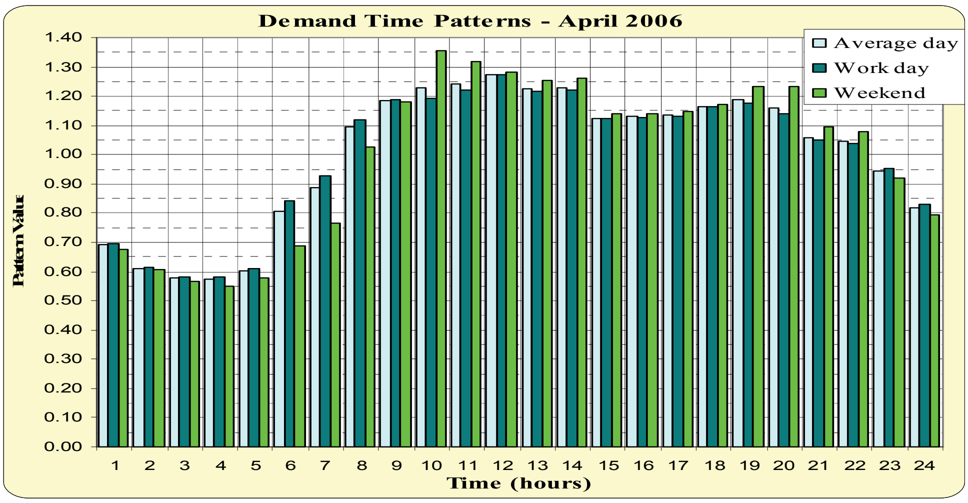

Fig. 4. Daily Demand Time Patterns in Pirot Water Supply System

Unit Loss for the distributive network is calculated after a couple of iterations 16.88 m^3/km/day for 1 bar pressure upon the volume of average daily Real Loss. Water Loss is then distributed spatially in the network nodes, depending on the relevant pressure in the node.

Hydraulic calculations were done for the extended time simulation for 7 days period, using daily average time pattern, with the discrete calculation time interval of 15 min, in order to ensure system periodical states (pump flow and water tank levels). In the equation for the Leakage Rate $L = C_d\ A\ x\ (2gP)^{0.5}$, where P is pressure, the effective area (C_dA) varies with pressure in some situations, depending on the pipe material. The most appropriate general equations for simple analysis and prediction of relationships between pressure (P) and leakage rate (L) in distribution systems are: L varies with P^{N1} and $L_1/L_0 = (P1/P0)^{N1}$. It was proven by the international experience in laboratory and terrain work that the exponent N1 is different than theoretical (0.5) in the most cases, and depends on percentage of rigid pipes in the system and ILI value [7].

Values for N1 were varied in the range 0.8 – 1.15. Value of 1.15 for N1 is recommended and adopted by practitioners in Japan and United Kingdom. There are also diagrams recommended to estimate N1 value, in the range of 0.8-1.5, depending on the percentage of rigid pipes and estimated ILI value [8]. Regarding ILI value of 10.1 and network pipe material, the first probe started with exponent N1 value of 1.0 (which is also recommended in the absence of knowledge of pipe materials and leakage level, to assume a linear relationship between leakage level and pressure value).

Demand time pattern for the Authorized Consumption was then recalculated by subtracting Water Loss from the SIV. After couple of trials, the best fit was achieved (for Water Loss daily volume and % of SIV Water Loss, SIV daily demand time pattern for April, pumping rates and tanks level variations) for the N1 value of 0.95. Estimated Authorized Consumption daily time patterns are shown comparatively with daily SIV time patterns shown in the Figure 5.

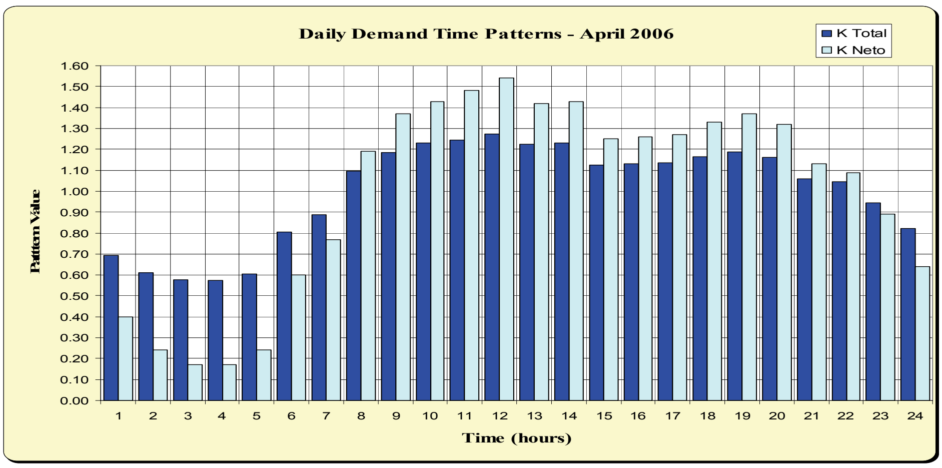

Fig. 6. Daily Demand Time Patterns in PWSS – SIV and Real Consumption

Obviously, during the day there is high variation of the Authorized Consumption (maximal value about 8 times higher than minimal), comparing to the SIV variation (maximal pattern value 2 times higher than minimal), pointing high leakage levels during night hours. These data are used to investigate the effect of the simplest measure of active leakage control: fixed pressure reduction. The hydraulic analysis is done for the first

PWSS network zone divided in 5 pressure control zones, and 8 PRV (Pressure Reduction Valves) installed, with fixed outlet pressure values during the whole day. The adopted criterion was that no node could be pressurized less than 20 m in any period of day.

The estimated reduction of daily Water Loss volume is about 17%. Achieved average Water Loss value is 42.1% of SIV, which is 7,286 m^3 daily, what makes daily saving of 1,469 m^3, i.e. 300 Euro/day (compared to the cost of water production), what makes saves in the budget about 110,000 Euro/year that could be invested in the further system modernization. Figure 7 shows average day SIV (Water Consumption), compared to the calculated SIV values after simulated reduction.

Water Loss volume has very low variation in the system during the time in both cases. Water Loss is expressed in % of Authorized Consumption in the Figure 7, to emphasize that during night hours in extreme case water is 5 times more wasted than really consumed. This fact implies that pressure or flow modulation (either time programmed or proactive) has potential to create much higher savings of water volume.

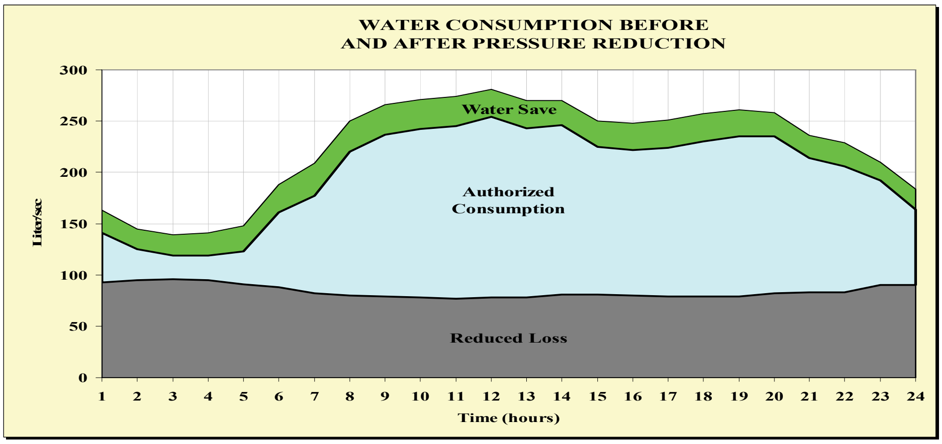

Fig. 7. Potential for Water Saving During an Average Day Consumption

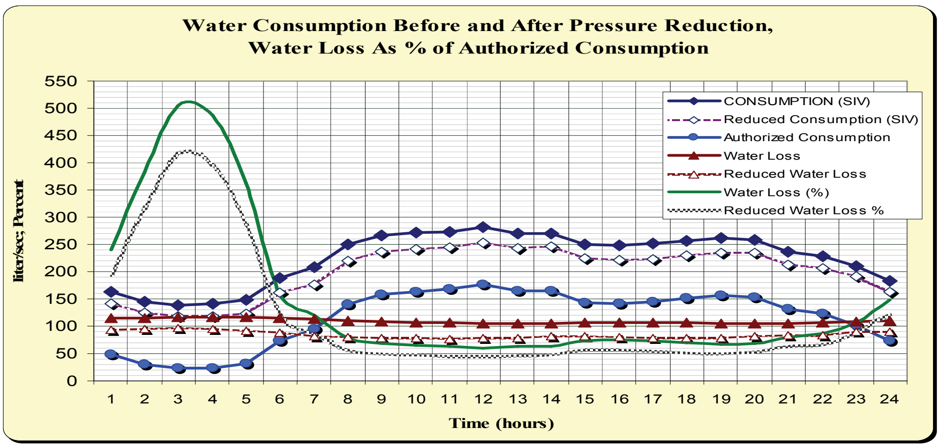

Fig. 8. Water Consumption (SIV) Before and After Pressure Control

7. Performance indicators for PWU - revision

Upon simulated pressure reduction, new technical performance indicators are estimated. While advance was observed in the reduced values of Water Loss, TIRL and UARL, which can obviously be reduced in order to the modus of system operation without pressure reduction, ILI value has appeared slightly higher, due to reduced average pressure value. This slight increase comes from the assumption that the Authorized Consumption in simulation remained the same, while in reality it should be expected that it could be also reduced by pressure reduction. Still, if this effect would be considered, significant ILI change can not expected in this case study. Flow or pressure modulation during a day would probably reduce Water Loss, and the ILI value too. Estimated ILI values in both cases point out bad infrastructure condition of the distributive network and need to examine parts of the system, the most prone to leak, and to make proper reconstruction.

Table 4. Benchmarking Criteria for Real and Simulated System Operation

Category	Real	Simulated
Number of inhabitants served	46,073	46,073
Number of registered service connection	14,384	14,384
Total length of distributive network (km)	108	108
Total length of service connection (km)	144	144
Average network pressure (m)	45	40
Water Loss of SIV (%)	**48.4**	**42.1**
Technical Indicator Real Losses - TIRL	**536**	**493**
Unavoidable Annual Real Losses	**53**	**47**
Infrastructure Leakage Index	**10.1**	**10.5**

8. Concluding remarks

The ILI has, in recent years, proved to be a very useful performance indicator when benchmarking leakage in water distribution systems. IWA best practice water balance and methodology were used to estimate performance indicators in Serbian water utilities. In spite of lack of accurate data, the first step was done to estimate values of the IWA recommended performance indictors, but other traditional PI were calculated too, like Real Loss %. Similar results have been found like in other countries and ILI applicability can be rated as very useful tool for assessing and pointing out real problems in Serbian water supply systems.

Data collected from the case study - Pirot WSS were analyzed. Regarding ILI value, this water supply system can be representative system for Serbia. After installment of flow and pressure meters at the pumping plants and level metering devices in the water tanks, IWA best practice Water Balance could be estimated more accurately, and water loss has appeared to be significantly higher than grasped in the previous period. Analysis is done to estimate daily demand time patterns both for System Input Volume and for Authorized Consumption. These data can reveal time and level of water loss against registered water consumption. Estimated value 0.95 for leakage exponent N1 is in the international experience range, differing from theoretical value (0.5), and water loss almost linearly increases with the pressure increase.

Numerical simulation on PWSS division in 7 pressure control zones with the PRV (Pressure Reducing Valves) has pointed that significant water savings could be achieved, and that further analysis can be done with more advanced time modulating techniques to increase positive effects of water saving. On the other side, on the PWSS numerical model with simulated pressure control, the ILI value did not change value, like other performance indicators, pointing to bad infrastructural state of the system. Water network, prone to leak, should be carefully reconstructed in phases with permanent proactive system monitoring and managing. Considering the fact that the most intensive water loss happens during the night, more advanced techniques with modulation of pressure and flow have potential to make more efficient water savings. Terrain investigations and further hydraulic analysis should support decisions for actions and time schedule in active leakage management plan.

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TEHNIČKI POKAZATELJI USPEŠNOSTI FUNKCIONISANJA VODOVODNIH SISTEMA U SRBIJI U SKLADU SA PREPORUKAMA IWA – STUDIJA SLUČAJA VODOVODNOG SISTEMA U PIROTU

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U svetu se smatra da je aktivna politika upravljanja gubicima u vodovodnim sistemima od suštinskog interesa za normalno i racionalno gazdovanje vodnim resursima. Ova politika može doneti velike uštede, što je dokazano u praksi i ulaganje u zahvatanje novih količina vode se može smatrati opravdanim samo ako su uvedene mere aktivne kontrole gubitaka vode iz sistema.

Obzirom da se gubici ne mogu u potpunosti eliminisati, treba odrediti njihov minimalan, tj. neizbežan nivo. Zahvaljujući aktivnostima radne grupe međunarodnog udruženja za vodu IWA u poslednjoj deceniji, predložena je nova metodologija određivanja sveobuhvatnih pokazatelja uspešnosti rada vodovodnih sistema, kako bi svaki system mogao da proveri svoju efikasnost, a pored toga mogao i da uporedi svoje tehničke karakteristike sa drugim sistemima u okruženju i u svetu. U Srbiji su učinjeni prvi koraci ka uvođenju IWA metodologije. Metodologija je pokazala primenljivost i na srpske sisteme vodosnabdevanja. Pokazale su se i određene manjkavosti u smislu verodostojnosti podataka koji su prikupljeni od vodovodnih sistema, zbog ograničene tačnosti i načina prikupljanja, pa je potrebno uložiti nove napore ka poboljšanju stanja vodovoda u Srbiji.

Na Primeru vodovodnog sistema u Pirotu je detaljnije prikazan postupak proračuna tehničkih pokazatelja uspešnosti i na numeričkom modelu simuliran rad sistema sa ugrađenim ventilima za kontinualno smanjenje pritiska na fiksnu vrednost. Dokazano je da se mogu ostvariti značajne uštede, ali da one mogu biti i znatno veće ukoliko se uvede modulacija pritiska tokom dana, jer se očigledno najveći gubici stvaraju tokom noćnih sati. Nakon terenskih merenja i daljigh hidrauličkih analiza, treba definisati optimalne mere i sačiniti dinamički plan realizacije programa aktivnog upravljanja gubicima u sistemu.