

Non-Revenue Water in Water Supply Systems of Serbia and Montenegro [†]

Dejan Dimkić ^{1,*}, Marko Babalj ¹, Darko Kovač ² and Mira Papović ²¹ Department of Strategic Planning, Environmental Protection and International Cooperation, Jaroslav Černi Water Institute, 11226 Belgrade, Serbia² Waterworks Company Nikšić, 81400 Nikšić, Montenegro

* Correspondence: dejan.dimkic@jcerni.rs

[†] Presented at the International Conference EWaS5, Naples, Italy, 12–15 July 2022.

Abstract: Non-revenue water (NRW) can be expressed using different parameters (indices) in certain water supply systems (WSSs). The most used are percentages (as a share of NRW in system input water) and the infrastructure leakage index (ILI) based on the IWA methodology. The technical indicator of real losses (TIRLs) is also an index used for the estimation of certain WSS efficiency. Both real and apparent losses are significant in many WSSs in the Balkan region. Thirty-seven WSSs in Serbia and Montenegro, which differ in many aspects, were analyzed. After presenting the methodology and discussing the results, a conclusion is drawn, as well as general guidelines regarding the approach for the reduction of NRW for this region.

Keywords: non-revenue water; water supply system; pressure; network; losses



Citation: Dimkić, D.; Babalj, M.; Kovač, D.; Papović, M. Non-Revenue Water in Water Supply Systems of Serbia and Montenegro. *Environ. Sci. Proc.* **2022**, *21*, 10. <https://doi.org/10.3390/environsciproc2022021010>

Academic Editors: Vasilis Kanakoudis, Maurizio Giugni, Evangelos Keramaris and Francesco De Paola

Published: 19 October 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Global warming and an increase in water demand are present in the countries of the Balkan region, as in many other parts of the world [1]. Some cities and regions have already observed a reduction in water source availability. As a result, water supply efficiency [2,3] and water management in general have become more important than ever [4,5]. Serbia and Montenegro are developing countries, and their water utility companies (WUCs) are faced with many challenges. The present drinking water (DW) price in all WSSs only covers operational costs and, in some cases, partial maintenance costs, but system development (upgrading) is possible only with some outside investment. Therefore, the price of DW should be increased to meet the economic DW price [6]. However, a gradual DW price increase till full cost recovery requires time. One of the main problems is the condition of the infrastructure (which includes ageing) and/or a lack of funds for certain improvements, which is contributing to increased water losses and NRW in general. Exceptions are WUCs (primarily larger ones), which have found a way to upgrade their WSS or to repair their infrastructure. It is important to increase awareness that operational and maintenance of one WSS requires significant funds and that the necessary developments require both time and funds.

The WSSs differ in many aspects [7]: regarding topography conditions, the amount of precipitation, water availability, population density and their habits, industries and institutions which are connected to the WSS, and the degree of rationality in managing of certain WSSs (degree of apparent losses, average pressure in the network, etc.) [8]. This paper analyzes the state of NRW in 37 cities of Serbia (SRB) and Montenegro (MNE). NRW in their systems ranges from 25% to 70%, with some exhibiting even higher percentages. The causes of these high NRW values are different, but they are primarily the result of decades of non-investment or relatively low investment in infrastructure. The condition for a WSS can be obtained through appropriate indicators, such as the ILI or TIRLs, and by discussing the results, possible directions for solving the problems can be pointed out. It

has also been shown that the state of many WSSs is not as bad as perceived once they have been evaluated using some of these indices.

2. Methodology, Study Area, and Data

The International Water Association (IWA) has defined terms when calculating water balance components in a WSS. As various synonyms can be found in the literature for many of these [3,9] (such as entry in the system for system input volume or no-paid water for non-revenue water, etc.), in this paper, we shall use the terms defined in Table 1.

Table 1. Water balance components in certain WSS-IWA Standard Terminology; Source: IWA (2000).

System Input Volume	Authorised Consumption	Billed Authorised Consumption	Billed Metered Consumption	Revenue Water	
			Billed Unmetered Consumption		
	Water Losses	Unbilled Authorised Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)	
			Unbilled Unmetered Consumption		
		Real Losses	Apparent Losses		Unauthorised Consumption
					Metering Inaccuracies
	Leakage on Transmission and/or Distribution Mains				
		Leakage and Overflows at Utility's Storage Tank			
			Lekage on Service Connections up to point of Customer Metering		

Non-revenue water (NRW) is calculated as the difference between system input volume (SIV) and billed authorized consumption, and they are often expressed as a percentage of SIV. Water losses (real + apparent) and unbilled authorized consumption compose NRW. Water losses, as well as NRW are generally higher in developing countries (to which Serbia and Montenegro belong), compared to developed countries. Expressed in percentages, the average NRW in a WSS in the analyzed regions of central Serbia is over 50%, while in Montenegro, it is higher—over 60% of SIV. When comparing different WSSs, NRW (in %) is not an adequate index as it does not consider all the relevant parameters. In addition to NRW (as % of SIV), two more indices are often used to express the efficiency of certain WSSs. These are the ILI and TIRL indices—the second is also abbreviated as RLB₂ in some papers [9].

The **TIRL** index is the quotient of CARLs (in m³/year or in L/day) and the number of connections (N_c) in a certain WSS (usually expressed in L/connection/day). CARLs are actual real losses in the system. For a WSS where the water balance has been calculated, the obtained value is used for CARLs. For the remaining WSSs (majority of the analyzed systems), CARLs are calculated with the empirical formula:

$$\text{CARL} = (23.25 \times \text{Ln}(\text{NRW in \%}) - 55.67) \times \text{SIV}/100 \quad (1)$$

This empirical formula is based on the analyses of the water balance components of several WSSs and is related to those WSSs that have NRW higher than 20% (a great majority of WSSs in the region).

Perhaps the most popular indicator of the success of a WSS is the infrastructure leakage index (**ILI**). This index represents the quotient of actual losses in the system—CARLs and unavoidable annual losses (UARLs) (both are usually calculated in m³/year or in L/day). The ILI is calculated using the following formula:

$$\text{ILI} = \text{CARL}/\text{UARL}; \quad (2)$$

where:

$$\text{As known, } \text{UARL} = (18 \times L_m + 0.80 \times N_c + 25 \times L_p) \times P; \quad (3)$$

where:

- L_m is the length of the water supply distribution network in km (existing data for all WSSs);
- N_c is the number of user connections (existing data for all WSSs);
- L_p is the total length of connection pipes from the street network to user water meters in km (the average length from the net to the user's water flowmeter is 5 m for all WSSs);
- P is the mean working pressure expressed in m—average values from 35 m (in the lowland) to 50 m (for very hilly areas) were adopted.

It can be seen from the formula that UARLs, as well as the ILI depend on the WSS's characteristics, such as the total pipe length, number of connections, average pressure, and total length of connection pipes.

According to the World Bank Institute classification system, Table 2 presents the criteria for the estimation of the efficiency of a certain WSS (regarding water losses) for developing countries (using the ILI and TIRL index values):

Table 2. TIRL and ILI criteria for the estimation of WSS efficiency.

Efficient Category		ILI	TIRL (L/Connection/Day) When System Is under Operating Pressure of:				
			30 m	35 m	40 m	45 m	50 m
Developing countries	A	1–4	<150	<175	<200	<225	<250
	B	4–8	150–300	175–350	200–400	225–450	250–500
	C	8–16	300–600	350–700	400–800	450–900	500–1000
	D	>16	>600	>700	>800	>900	>1000

A—very good state; B—good state; C—acceptable state; D—bad state.

The study area covering Montenegro (10 WSS) and 4 regions with 27 WSSs (in total) in Serbia is shown in Figure 1.

The lack of sufficiently accurate data is a real problem with some/many WSSs. In general, “safer” data include data on the network length (L_m), number of connections (N_c), and revenue water (RW). Input data related to the total length of connection pipes from the street network to the user water meters (L_p) and the mean working pressure in the network (P) are estimated to have acceptable accuracy. The most challenging data are those related to the system input volume of water (SIV). The absence of flowmeters is not uncommon, leading to a very rough estimation. One such example is related to a relatively new (20 years old) regional water supply system built for the Bojnik and Doljevac municipalities. Water is abstracted from the Brestovac reservoir and treated at the Brestovac water treatment plant (WTP), which is located at a distance of 15 km. Following treatment, water is delivered to these two municipalities. The only existing flowmeter is installed upstream of the WTP. Similar situations exist in some other WSSs.

In addition to the calculated values of the indices for all CWSSs, correlations between NRW (in %) and the ILI and the classification of the considered CWSS based on the ILI and TIRL indices are presented and discussed. Additionally, total water demand per capita and billed consumption per capita, as well as pipe length per inhabitant and the number of inhabitants per connection were calculated, also followed by a discussion.

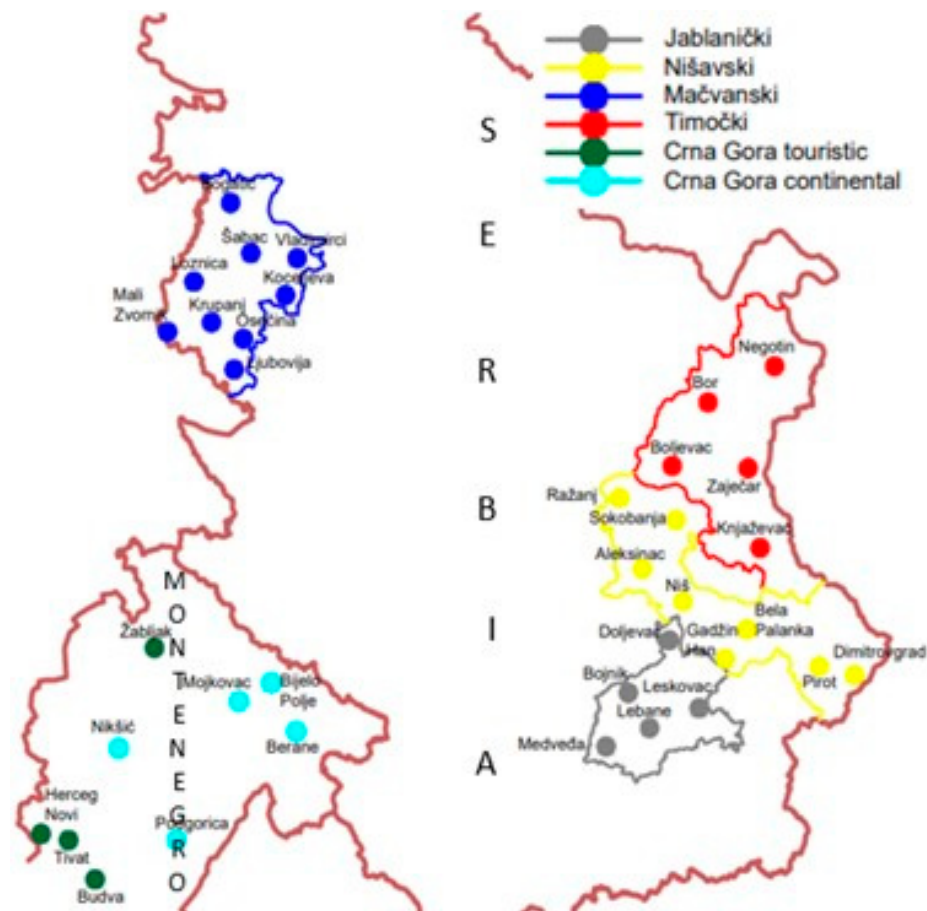


Figure 1. Locations of the cities where the CWSSs were analyzed.

3. Results

The following Tables 3–7 present the results of the calculations of the TIRL, ILI, NRW, and CARL indices for the analyzed regions (cities) in Serbia and Montenegro. The year of input data differs from system to system, but most of them are from one of the past five years. In a few cases, where certain input data were not clearly indicated or greatly differed depending on the sources, averages were applied or the most probable assumption was made. Cities with a significant number of tourists (visitors) are underlined.

Table 3. Number of inhabitants connected to the CWSS, input data, calculated parameters, indices TIRL and ILI (with classes), NRW, and CARLs (in %) for the central WSSs in municipalities of the Jablanički region—Serbia.

Central WSS in Municipality	No. of Con. Inhab.10 ³	Input Data		Calculated Parameters								Indices			
		Lm	Nc	Lp	P	SIV	RW	NRW	UARLs	CARLs	TIRLs	ILI	NRW	CARLs	
		km		km	m	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	L/con./d	-	%	%	
Leskovac	79.2	541	22,367	112	35	7.768	4.778	2.990	389	2.269	278 (B)	5.8 (B)	38.5	29.2	
Doljevac	2.5	80	704	4	35	152	114	38	27	29	113 (A)	1.1 (A)	25.0	19.2	
Lebane	10.0	107	3307	17	35	1.066	438	628	64	417	345 (B)	6.5 (B)	58.9	39.1	
Medveđa	3.7	50	1406	7	40	419	163	256	32	167	326 (B)	5.2 (B)	61.1	39.9	
Bojnik	6.5	84	2348	12	35	388	276	112	47	87	102 (A)	1.9 (A)	28.8	22.5	
Average values of indices for the Jablanički region													233	4.0	42.5 30.0

Table 4. Number of inhabitants connected to the CWSS, input data, calculated parameters, indices TIRL and ILI (with classes), NRW, and CARLs (in %) for central WSSs in municipalities of the Nišavski region—Serbia.

Central WSS in Municipality	No. of Con. Inhab.10 ³	Input Data						Calculated Parameters					Indices		
		Lm	Nc	Lp	P	SIV	RW	NRW	UARLs	CARLs	TIRLs	ILI	NRW	CARLs	
		km		km	m	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	L/con./d	-	%	%	
Niš	230.3	875	41,860	209	40	31.222	16.843	14.379	795	10.420	682 (C)	13.1 (C)	46.1	33.4	
Niška Banja	12.3	48	2300	12	40	1.734	867	867	44	612	729 (C)	14.0(C)	50.0	35.3	
GadžinHan	1.4	22	750	4	35	323	129	194	14	128	466 (C)	9.2 (C)	60.0	39.5	
Pirot	44.8	225	16,700	84	45	6.500	3.712	2.788	320	2.062	338 (B)	6.4 (B)	42.9	31.7	
Dimitrovgrad	7.6	55	4117	21	40	1.397	495	902	70	576	383 (B)	8.2 (C)	64.6	41.2	
B. Palanka	7.7	42	2950	15	45	1.289	388	901	57	555	516 (C)	9.7 (C)	69.9	43.1	
Aleksinac	31.6	205	11,906	60	40	2.718	1.506	1.212	215	887	204 (B)	4.1 (B)	44.6	32.6	
Sokobanja	7.9	48	3500	18	50	1.500	681	819	75	560	438 (B)	7.5 (B)	54.6	37.3	
Ražanj	1.8	31	1485	7	35	173	72	101	25	67.4	124 (A)	2.7 (A)	58.3	38.9	
Average values of indices for the Nišavski region												431	8.3	54.6	37.0

Table 5. Number of inhabitants connected to the CWSS, input data, calculated parameters, indices TIRL and ILI (with classes), NRW, and CARLs (in %) for central WSSs in the municipalities of the Timočki region—Serbia.

Central WSS in Municipality	No. of Con. Inhab.10 ³	Input Data						Calculated Parameters				Indices			
		Lm	Nc	Lp	P	SIV	RW	NRW	UARLs	CARLs	TIRLs	ILI	NRW	CARLs	
		km		km	m	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	L/con./d	-	%	%	
Bor	37.9	400	11,074	55	40	7.000	2.500	4.500	255	2.879	712 (C)	11.3 (C)	64.3	41.1	
Boljevac	6.1	105	2075	10	40	1.200	270	930	56	546	720 (C)	9.8 (C)	77.5	45.5	
Zaječar	47.7	320	18,076	90	40	5.600	2.500	3.100	328	2.108	320 (B)	6.4 (B)	55.4	37.7	
Knjaževac	22.1	277	8500	43	40	3.400	1.030	2.370	188	1.462	471 (C)	7.8 (B)	69.7	43.0	
Negotin	18.4	110	10,346	52	35	2.000	1.100	900	148	657	174 (A)	4.5 (B)	45.0	32.8	
Average values of indices for the Timočki region												479	8.0	62.4	40.0

Table 6. Number of inhabitants connected to the CWSS, input data, calculated parameters, indices TIRL and ILI (with classes), NRW, and CARLs (in %) for CWSSs in municipalities of the Mačvaski region (SRB) and averages for Serbia.

Central WSS in Municipality	No. of Con. Inhab.10 ³	Input Data						Calculated Parameters					Indices		
		Lm	Nc	Lp	P	SIV	RW	NRW	UARLs	CARLs	TIRLs	ILI	NRW	CARLs	
		km		km	m	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	10 ³ ·m ³ /y	L/con./d	-	%	%	
Ljubovija	7.1	162	2469	12	40	650	378	272	76	203	225 (B)	2.7 (A)	41.9	31.2	
M. Zvornik	7.0	47	2810	14	40	1.332	314	1.018	50	601	586 (C)	12.0 (C)	76.4	45.1	
Šabac	69.4	413	30,750	154	35	6.437	4.534	1.903	458	1.485	132 (A)	3.2 (A)	29.6	23.1	
Krupanj	4.2	96	2348	12	40	830	232	598	57	363	424 (C)	6.4 (B)	72.0	43.8	
Bogatić	5.7	43	2555	13	35	567	358	209	40	160	172 (A)	4.0 (B)	36.9	28.2	
Koceljeva	4.5	310	3366	17	35	920	540	380	111	284	231 (B)	2.6 (A)	41.3	30.8	
Osečina	3.9	88	1310	7	40	490	232	258	41	179	375 (B)	4.4 (B)	52.7	36.5	
Loznica	54.3	898	32,573	163	40	8.116	4.040	4.076	676	2.872	242 (B)	4.2 (B)	50.2	35.4	
Average values of indices for the Mačvanski region												298	5.0	50.1	34.0
Average values of indices for 27 CWSSs in Serbia												364	6.5	52.5	35.4

Table 7. No. of inhabitants connected to the CWSS, input data, calculated parameters, indices TIRL and ILI (with classes), NRW, and CARLs (in %) for CWSSs in cities in continental (first 6) and touristic (last 4) regions in Montenegro.

Central WSS in Municipality	No. of Con. Inhab.10 ³	Input Data				Calculated Parameters					Indices			
		Lm km	Nc	Lp km	P m	SIV 10 ³ ·m ³ /y	RW 10 ³ ·m ³ /y	NRW 10 ³ ·m ³ /y	UARLs 10 ³ ·m ³ /y	CARLs 10 ³ ·m ³ /y	TIRLs L/con./d	ILI -	NRW %	CARLs %
Nikšić	65	750	23,700	119	50	11,300	3,700	7,600	646	4766	551 (C)	7.4 (B)	67.3	42.2
Podgorica	175	1200	68,000	340	40	32,300	16,985	15,315	1,234	10,998	443 (C)	8.9 (C)	47.4	34.1
Mojkovac	3.5	36	3300	17	40	620	280	340	54	232	193 (A)	4.3 (B)	54.8	37.4
Berane	20	170	9200	46	50	4000	1400	2,600	211	1655	493 (B)	7.8 (B)	65.0	41.4
Bijelo polje	25	170	8000	40	50	3500	1100	2,400	191	1492	511 (C)	7.8 (B)	68.6	42.6
Danilovgrad	18	600	8000	40	45	3100	1400	1,700	299	1160	397 (B)	3.9 (A)	54.8	37.4
Žabljak	2.5	43	1600	8	45	630	320	310	37	220	377 (B)	5.9 (B)	49.2	34.9
Budva	25	300	30,000	150	40	8000	3500	4,500	484	3042	278 (B)	6.3 (B)	56.3	38.0
Tivat	13	100	8100	41	35	2643	1192	1,451	119	990	335 (B)	8.3 (C)	54.9	37.5
HercegNovi	22	204	21,500	108	45	14,024	2130	11,894	387	6671	850 (C)	17.2(D)	84.8	47.6
Average values of indices for 10 CWSS in Montenegro											443	7.8	60.3	39.3
Average indices for CWSSs for cities in the continental part of Montenegro											431	6.7	59.7	39.2
Average indices for CWSSs for cities in the touristic part of Montenegro											460	9.5	61.3	39.5

Tables 3–7 show that class A was recorded 14 times, B is the most frequent—36 times, C—23 times and D once (in sum, 74 classes = 2 indices × 37 CWSS). It could be said that classification is much more accurate when using the ILI and TIRL indices as opposed NRW (%). This is most likely due to the great pipeline length and numerous connections (low population density). When the ILI and TIRL classes of indicators are compared in Tables 3–7, there is practically no difference between them—24/37 have the same class. For 6/37, TIRLs reflect a better class, and for 7/37, and ILI reflects a better class (and all values in such cases are close to the boundary between the two classes). By applying an empirical formula (1) for the CARLs' (%) calculation, the majority of obtained values (31/37) varied from 30% to 46%. If we compare the ILI and NRW% (Figure 2), only Nišavski district and, to some extent, Montenegro continental cities did not show any correlation between two indices.

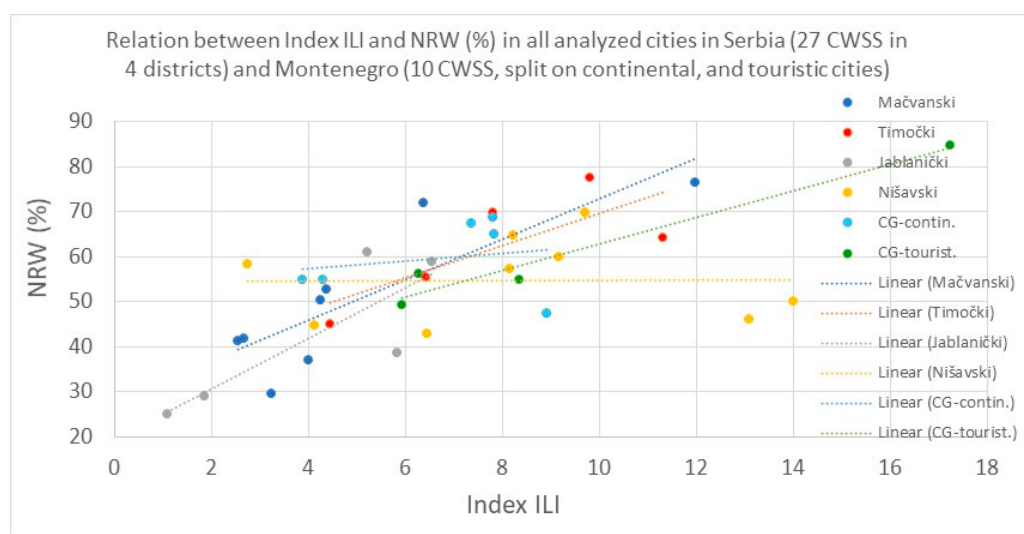


Figure 2. Relation between ILI and NRW (%) indices in all analyzed cities of Serbia and Montenegro.

Total water demand per capita (calculated as the quotient of SIV and No. of connected inhabitants) and billed consumption per capita (calculated as a quotient of billed authorized consumption and No. of connected inhabitants) are presented in Figure 3, while total pipe

length per inhabitant and number of inhabitants per connection are presented in Figure 4, for all analyzed CWSSs in the two countries. Table 8 presents the same data obtained as averages of all CWSSs for each of the six groups of regions (cities) in Serbia and in Montenegro.

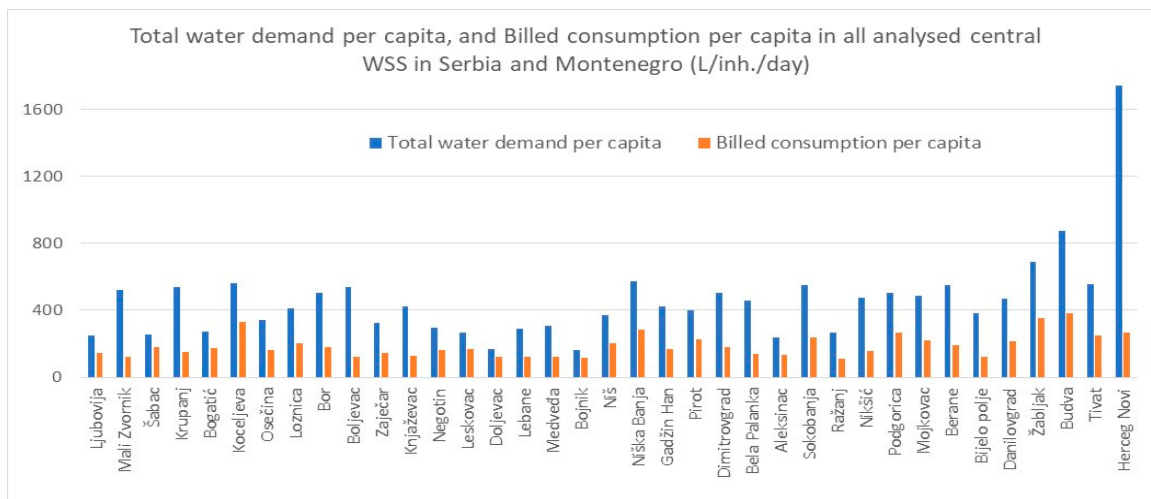


Figure 3. Total water demand per capita and billed consumption per capita in 37 analyzed cities in SRB and MNE.

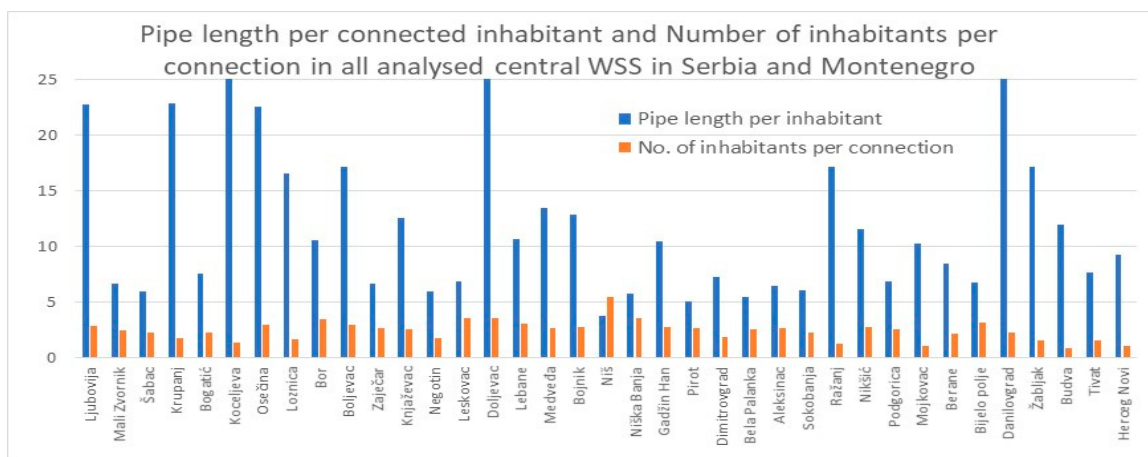


Figure 4. Total pipe lengths per inhabitant and No. of inhabitants per connection in all 37 analyzed CWSSs.

Table 8. Total water demand per capita, billed consumption per capita, total pipe length per inhabitant, and number of inhabitants per connection—averages of 6 groups of all analyzed 37 CWSSs in Serbia and Montenegro.

Group of Regions in Serbia and Group of Cities in Montenegro	Total Water Demand per Capita (L/Con.Inh/Day)	Billed Consumption per Capita (L/Con.Inh/Day)	Total Pipe Length in WSS/No. of Connect. Inhab. (m/Con.Inh)	No. of con. inh./No. of User Connections (Inh/Con)
Jablanički region in Serbia	240	129	15.2	3.1
Nišavski region in Serbia	420	186	7.5	2.8
Timočki region in Serbia	417	147	10.6	2.7
Mačvanski region in Serbia	394	183	21.7	2.2
Continental cities of Montenegro	478	194	12.9	2.3
Touristic cities of Montenegro	968	313	11.5	1.3

Cities with the lowest billed consumption per capita (primarily households) are in the Jablanički district—the reasons for this are lower pressures in the network and the habits of people in this district, as well as the lack of water in two CWSSs during the driest parts of the year. As expected, the highest total water demand per capita and billed consumption per capita have touristic cities. This is similarly valid for the number of inhabitants per connection. Pipe lengths per inhabitant differ substantially (values higher than 25 are not shown for three CWSSs in Figure 4) and depend on the source's locations and population density.

NRW (expressed in %) in CWSSs in cities in Montenegro is a little bit higher compared to CWSSs in central Serbia. Higher average pressure in the distribution network and higher levels of apparent losses, among other things, are likely the most important factors. Billed consumption (predominantly households) is also slightly higher in MNE, due to warmer climate conditions, which impact higher consumption [10].

Pressure in the network is a very important factor for WSS rationality and efficiency [8]. When all 37 CWSSs were grouped into a category depending on the estimated average pressure in the network (35 m, 40 m, 45 m, 50 m), the following average values for the ILI and NRW (%) were obtained (Table 9).

Table 9. Average values for the ILI and NRW% depending on estimated average pressure in the net.

List of Cities with Approximately the Same Average Pressure in the Net, by Category	Average Pressure (m)	Average ILI	Average NRW (%)
Leskovac, Doljevac, Lebane, Bojnik, Gadžin Han, Ražanj, Negotin, Šabac, Bogatić, Koceljeva, Tivat	35	4.5	43.4
Medveđa, Niš, Niška Banja, Dimitrovgrad, Aleksinac, Bor, Boljevac, Knjaževac, Zaječar, Ljubovija, Mali Zvornik, Krupanj, Osečina, Loznica, Podgorica, Mojkovac, Budva	40	7.6	57.9
Pirot, Bela Palanka, Danilovgrad, Žabljak, Herceg Novi	45	8.6	60.3
Sokobanja, Nikšić, Berane, Bijelo Polje	50	7.8	64.5

As the pressure in the network increases, the values of the considered indices also increase, and the average values for the cities with the lowest average pressure (35 m) show the importance of this parameter in regulating the state of certain water supply systems.

4. Conclusions

Insufficient funds for the maintenance and development of water supply systems have led to an increase in losses (NRW) for the majority of systems in both countries. Expressed as percentages, these are on average over 50% in central Serbia and over 60% in Montenegro. These are certainly high values, but if they are compared to the values obtained using the ILI, the situation is much more favorable. The reasons for this should be sought regarding the extensive network lengths and the large number of connections in relation to the number of inhabitants.

Due to insufficient funding, problems in reducing the losses of certain WSSs are generally greater in smaller systems than in larger ones. In addition to the apparent losses, which are slowly decreasing in most systems, the situation with real losses is much more difficult. Competent persons from WUCs often cite age and inadequate material used for pipelines as the main problems. The configuration of the terrain is also very important. The importance of pressure management in certain networks is neglected, as the results presented in this paper show. Quite often, there are large losses on the main pipeline, from the source to the treatment plant.

The situation in water supply systems is not satisfactory, but there is room for improvement with a good approach to troubleshooting—first maximizing the reduction of apparent losses, then systematically repairing, and reducing actual (real) losses, with adequate zoning and network pressure management.

Incidentally, it is noted that water quality issues, which are often the most significant of all issues in a certain water supply system, were not discussed in this paper.

Author Contributions: D.D. wrote the paper. M.B. helped in writing and preparing the figures. D.K. and M.P. gave relevant data and checked the paper. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by IPA funds for the Adrian-Ionian region, through the MUHA Project.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: To International Project MUHA (2020–2022) and UNESCO center II category Water for Sustainable Development and Adaptation to Climate change (WSDAC)—Belgrade.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. López-Ballesteros, A.; Senent-Aparicio, J.; Martínez, C.; Pérez-Sánchez, J. Assessment of Future Hydrologic Alteration due to Climate Change in the Aracthos River Basin (NW Greece). *Sci. Total Environ.* **2020**, *733*, 139299. [\[CrossRef\]](#)
2. Tsitsifli, S.; Papadopoulou, A.; Kanakoudis, V.; Gonelas, K. Water Use Efficiency Current Status Assessment in the Context of WATenERgy CYCLE Project. *Proceedings* **2018**, *2*, 602. [\[CrossRef\]](#)
3. Radivojević, D. Technical Indicators for Assessment of the Situation and Proposal of Measures for Improving the Performance of Smaller Water Supply Systems in the Republic of Serbia. Ph.D. Dissertation, University of Niš, Niš, Serbia, 2013.
4. Bou-Zeid, E.; El Fadel, M. Climate Change and Water Resources in Lebanon and the Middle East. *J. WR Plan. Manag.* **2002**, *128*, 343–355. [\[CrossRef\]](#)
5. Curk, B.C.; Vrhovnik, P.; Verbovšek, T.; Dimkić, D.; Marjanović, P.; Tahy, A.; Simonffy, Z.; Alessandro, C.; Nistor, M.M.; Cheval, S.; et al. Vulnerability of Water Resources to Climate Change in South-East Europe. In Proceedings of the AQUA 2015 42nd IAH Congress, Rome, Italy, 13–18 September 2015.
6. Dimkić, D.; Milovanović, M.; Dimkić, M.; Milojković, S. Current and Economic Price of Water in Serbia. In Proceedings of the 4th EWaS International Conference: Valuing the Water, Carbon, Ecological Footprints of Human Activities, Online, 24–27 June 2020. *Environ. Sci. Proc.* **2020**, *2*, 45. [\[CrossRef\]](#)
7. Kujundzic, B. *Large Water Supply Systems*; Association for Water Technology and Sanitary Engineering: Belgrade, Serbia, 1996; ISBN 86-82931-01-X.
8. Babić, B.; Đukić, A.; Stanić, M. Managing Water Pressure for Water Savings in Developing Countries. *Water SA* **2014**, *40*, 221. [\[CrossRef\]](#)
9. Ociepa, E.; Mrowiec, M.; Deska, I. Analysis of Water Losses and Assessment of Initiatives Aimed at their Reduction in Selected Water Supply Systems. *Water* **2019**, *11*, 1037. [\[CrossRef\]](#)
10. Dimkić, D. Temperature Impact on Drinking Water Consumption. In Proceedings of the 4th EWaS International Conference: Valuing the Water, Carbon, Ecological Footprints of Human Activities, Online, 24–27 June 2020. *Environ. Sci. Proc.* **2020**, *2*, 31. [\[CrossRef\]](#)