

EVALUATION OF SURFACE WATER IN ŽITAVA CATCHMENT UNDER THE ASPECT OF ANTHROPOGENIC IMPACT

OCENA WODY POWIERZCHNIOWEJ W ZLEWNI ŽITAVA W KONTEKŚCIE ODDZIAŁYWANIA ANTROPOGENICZNEGO

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Abstract. Water quality in streams primarily affects human. A recent assessment of the characteristics of environmental indicators in the three sub-catchments basins Drevenica, Čerešňový Creek and Žitava (District Zlaté Moravce), we showed this effect. The sixteen villages in the sub catchments do not expect an increase in demographic trends, even a decrease in population compared to year 2000 to 228 people. In terms of water consumption in the villages we have seen that the consumption is even smaller than the specified minimum hygiene. Four municipalities haven't own public water, are connected to group water conduit Zlaté Moravce. Average water consumption in 2010 was $68.84 \text{ liters} \cdot \text{s}^{-1} \cdot \text{day}^{-1}$. The removal and treatment of waste water situation is different in each sub catchments. In the sub catchments Drevenica one of four communities has built a wastewater treatment plant, the Čerešňový Creek from four municipalities, three with treatment plant. In Žitava basins of the seven municipalities have three community wastewater treatment plants, one is under construction and one is connected to the existing sewerage treatment plant. Status of water quality in river basins also affects non-point sources of pollution. The largest percentage of acreage in the villages is currently agricultural land. In the Drevenica basin is agricultural land 51.12%, in the Čerešňový Creek basin 53.09% and 46.38% Žitava basins.

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Streszczenie. Jakość wody w badanych potokach ma duże znaczenia dla ludzi zamieszkujących dane tereny. Przeprowadzono ocenę właściwości wskaźników środowiskowych w trzech zlewniach dorzeczy: Drevenica, Čerešňový Potok i Žitavy (region Zlaté Moravce). W szesnastu wioskach w zlewniach cząstkowych nie przewiduje się wzrostu tendencji demograficznych, a nawet zanotowano spadek ludności o 228 osób w porównaniu z rokiem 2000. Pod względem poboru wody w badanych miejscowościach zaobserwowano, że zużycie wody jest nawet poniżej poziomu wymaganego do utrzymania higieny minimalnej. Cztery gminy nie mają publicznego dostępu do wody, ale są podłączone do grupowego zaopatrzenia w wodę Zlaté Moravce. Średnie zużycie wody w 2010 roku wyniosło $68,84 \text{ dm}^3 \cdot \text{s}^{-1} \cdot \text{dzień}^{-1}$. Sposoby oczyszczania ścieków w analizowanych zlewniach są zróżnicowane. W zlewni Drevenica jedna z czterech gmin wybudowała oczyszczalnię ścieków, zlewnia Čerešňový Potok posiada trzy oczyszczalnie na cztery gminy. W dorzeczcu Žitavy na siedem gmin istnieją trzy oczyszczalnie ścieków, jedna jest w trakcie budowy, a pozostałe są podłączone do istniejącej sieci kanalizacyjnej. Na stan jakości wody w dorzeczczach mają również wpływ niepunktowe źródła zanieczyszczeń. Największy odsetek w użytkowaniu i pokryciu terenu przypada na grunty rolne, które w dorzeczcu Drevenicy stanowią 51,12%, w Čerešňovym Potoku 53,09%, a w zlewni Žitavy 46,38%.

Key words: Zlaté Moravce, demographics, flood, surface water, surface water quality.

Słowa kluczowe: Zlaté Moravce, demografia, powódź, woda powierzchniowa, jakość wody powierzchniowej

INTRODUCTION

Surface water quality is clearly dependent on specific land use plans. The European Union attaches great importance to restore the state of environmental quality, as evidenced by the adoption of a considerable number of framework directives based on the quality of the environment. Directive 2000/60/EC of the European Parliament and Council (the Water Framework Directive) which entered into force in December 2000, defines water as not a normal commercial product, but rather the natural wealth that is inherited and must be protected, defended and according to him behave. Member States shall ensure by this Directive establish programs for monitoring water status in order to establish a coherent and comprehensive overview of water status within each river basin. Similarly, the cleaning and sewage disposal is adopted Council Directive 91/271/EEC of 21 May 1991. The Directive addresses only agglomerations with more than 2,000 inhabitants. The exception is Article 7, which deals with small agglomerations with collecting system. Cleaning in place (in situ) or other alternatives can be used instead collecting system, if the establishment of a collecting system is not rational, it is economically difficult and would benefit the environment. This is probably the case in most small settlements with less than 2,000 inhabitants [Christensen 2007]. The legislation on surface water quality in Slovakia is a new Government Regulation. 269/2010 Z. of establishing the requirements for achieving good water status [Jurík 2009]. To qualify, which were defined by adopting the Water Framework Directive, Water Plan was created in Slovakia in 2011 was approved by Government Decree additional č.279/2011 Z. of. of 17 August 2011, valid from 1 September. This Regulation is declared binding part of Slovakia's Water Plan contains a program of measures to achieve environmental objectives. To achieve good water status, we assure the quality of water falling into at least a second class of

environmental quality. Many streams in Slovakia doesn't reached this state (2015) and technical infeasibility with a combination of economic reasons, the term shifted to the year 2021, respectively. 2027 (Jurík, 2011).

Extraordinary influence on the quality of surface water is a human population living in concrete basins and especially its water supply with discharge and handling of household water. Currently in the Slovak Republic, the development of public sewerage system lags behind the development of public water supply. Yet the situation is less favorable for abstraction and wastewater treatment. In both cases, the decisive factor in securing funds (Report on Water Management in the Slovak Republic in 2008, 2009). In 2010, the situation in the development of public sewerage improved slightly, namely 60.4% of the population of the total population were connected to public sewer. Contrast, public water was supplied in 2010, 86.6% of the population with drinking water. Due to the European Directive on the quality of surface waters, we show in 3 sub-catchments, what was the human impact on water quality in catchments in the last 20th years. We evaluate the supply residents with drinking water, connecting residents to public sewers and wastewater treatment plant. At the same time point out the use of land resources (forests, arable land, meadows and pastures, gardens) and its impact on water quality in selected sub-catchments.

MATERIALS AND METHODS

Assessed area falls within the territorial unit of the district demarcation Zlaté Moravce. Within the boundaries of the district will focus only on 3 sub-catchments own basin and stream flows Žitava and sub-catchments Drevenica and Čerešňový Creek. Data on settlements, percentage of drinking water for residents and connectivity sewer network and wastewater treatment plant were processed on the development plans of public water and sewer (Regional Environmental Office, Nitra). Demographic trends in the population of the villages we have identified for urban and community websites. Water consumption in the villages in the period 2005–2010 we reviewed the data provided of West Slovakia Water Company, Inc. Nitra. Municipalities where the wastewater treatment plant was built, we sent a questionnaire about the construction, suppliers and operators of wastewater treatment. Municipalities in the district showing the position of the originator of a document in Figure 1.

Demographic trends in the population of villages in the sub-catchments is elaborated in Table 1.

Description of areas with the characteristics of farming and land use in each sub-catchment is documented in Table 2. The water catchment Drevenica we watched municipality falling under the district Zlaté Moravce, Beladice, Kostoľany under Trábeč, Ladice and Neverice. Similarly in the sub-basin of Žitava, we evaluated the villages belonging to the district Zlaté Moravce – Jedľové Kostoľany, Machulince, Obyce, Tesárske Mlyňany, and Vieska over Žitava, Zlaté Moravce and Žitavany. Our contribution is related to only village located just near the stream, we have not dealt with the municipalities located on tributaries. Although a significant impact on water quality in Žitava can have its tributaries. In the Čerešňový Creek basin was evaluated community Choča, Sľažany, Slepčany and Velčice.



Fig. 1. Žitava catchment with waterbodies
Rys. 1. Zlewnia Žitava

Table 1. Population development in Žitava catchment
Tabela 1. Rozwój mieszkańców w zlewni Žitava

Villages forming Žitava catchment Miejscowości w zlewni Žitava	Population – Populacja									
	1900	1910	1921	1930	1940	1961	1970	2000	2010	
Beladice	299	290	258	270	291	854	871	1547	1519	
Choča	398	395	443	467	562	685	651	445	486	
Chrástňany	606	647	673	773	907	1 065	1 063	–	–	
Jedlové Kostelany	1127	1186	1534	1490	1433	1701	1580	1091	1011	
Kostolany pod Tribečom	485	573	612	623	635	696	723	395	349	
Ladice	776	855	865	897	1 003	1 148	1 107	794	800	
Machulince	510	559	593	624	666	846	931	999	1 037	
Neverice	586	585	588	740	898	795	774	654	675	
Obyce	851	1001	1031	1042	1254	1632	1708	1507	1557	
Sľažany	820	844	850	1019	1194	1669	1837	1691	1704	
Slepčany	759	815	871	960	974	1086	1090	859	847	
Tesárske Mlyňany	1364	1 430	1597	1789	1895	2081	1997	1691	1652	
Velčice	807	833	974	913	991	1097	1093	895	849	
Vieska nad Žitavou	352	377	395	382	430	545	564	487	442	
Zlaté Moravce	2786	3227	3 394	3636	4358	6915	9229	15 473	13 554	
Žitavany	1365	1518	1583	2607	1796	2177	2275	–	1818	
Total	13 891	15 135	16 261	18 232	19 287	24 992	27 493	28 528	28 300	

Table 2. The total cadaster areas and land types
Tabela 2. Użytkowanie obszarów

Villages forming catchment Žitava Miejscowości w zlewni Žitava	Total area Powierzchnia calkowita	The total area of land types, km ² Rodzaje użytkowania w całkowitej powierzchni, km ²							Forest Lasy	Other Inne
		Build Zabudowania	Arable land Użytek	Gardens Sady	Permanent grassland Użytki zielone	Agricultural land Grunty orne	Forest Lasy	Other Inne		
Drevenica catchment – Zlewnia Drevenica										
Beladice	4.9825	0.3958	4.0236	0.1647	0.0655	4.3910	0	0.1865		
Kostořany pod Tribeřom	22.1217	0.4267	1.0941	0.2265	3.1767	4.5662	17.1780	0.0656		
Ladice	11.6483	0.6582	7.0637	0.2441	0.6082	8.5186	2.0193	0.4620		
Neverice	5.9596	0.6454	5.0352	0.2962	0.0420	5.3790	0	0.0307		
Čerešňový Creek catchment – Zlewnia Čerešňový Potok										
Choča	4.3897									
Sl'ažany	16.2740	1.2295	13.4365	0.5419	0.7832	14.8171	0.0817	0.1344		
Slepčany	9.3519	0.7428	6.6985	0.2793	0.9290	8.0517	0.1250	0.1202		
Velčice	34.7047	0.7016	4.0856	0.3619	4.1601	9.1582	24.7942	0.0905		
Žitava catchment – Zlewnia Žitava										
Jedřové Kostořany	27.2939	1.1364	0.9763	0.4157	9.0226	10.4147	15.7541	0.1457		
Machulince	9.4212	0.5912	2.3270	0.2469	0.9269	3.5656	5.2197	0.2505		
Obyce	31.2697	1.2213	2.8270	0.3746	3.4581	6.7314	23.3250	0.4255		
Tesárske Mlyňany	18.0073	1.3635	13.7467	0.5798	0.2744	15.0294	0.5717	0.6641		
Vieska nad Žitavou	5.4650	0.4011	3.6852	0.1969	0.1940	4.2101	0.1663	0.5024		
Zlaté Moravce	19.2527	5.1302	10.3679	1.3763	1.8247	14.1259	0	2.1653		
Žitavany	18.2020	1.1126	4.0681	0.3852	0.5897	5.7085	11.6083	0.0753		

RESULTS

Based on Table 1, we can conclude that the evolution of the population from 1900 to 1930 in sub-catchments Drevenica, Čerešňový Creek and the Žitava grew slightly, then slowed. Another period of depression in the development of the population, the years 2000 to 2005 (in 2005, an increase of only 82 people). Since 1900, to the year 2010 we have seen an increase in population of 49.08%. In the studied communities is not expected on the basis of this assessment, and neither has been a significant increase in population, which can also be seen from Table 1. The last ten years, the population decreased, compared with 2000 in 2010, a marked decrease of 228 residents. The situation is similar throughout the regions of Slovakia, which is shown in Figure 2. The same results are expected in the forecast that was prepared for the demographic future of the districts of Slovakia (<http://www.infostat.sk/vdc/pdf/prognoza2008.pdf>). Said District Zlaté Moravce, of our case, selected from his municipality, is one of the districts, in which are not in the future (processing up to the year 2020) expected increase of the population.

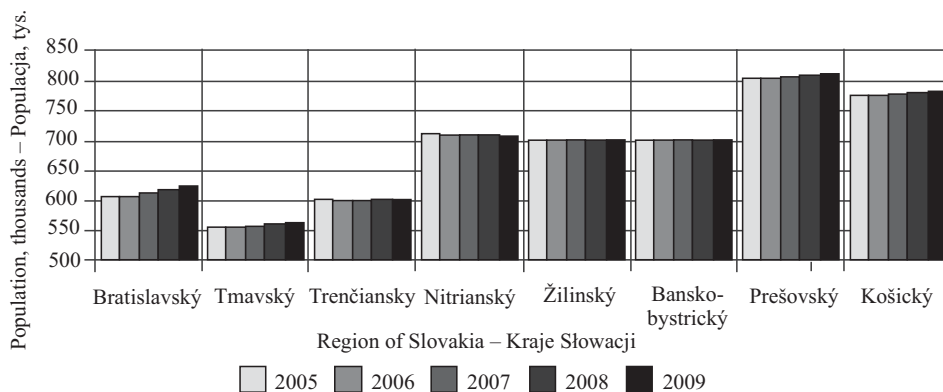


Fig. 2. Regions in Slovakia population development in last 5 years (in thousands)

Rys. 2. Rozwój mieszkańców przez ostatnie 5 lat – region Słowacji (w tys.)

In terms of land use in catchment Drevenica (sub-basin in the district of Zlaté Moravce) dominated by agricultural land, particularly of the total area of 44.7121 km², the percentage of 51.12% municipalities. Built-up area communities are 4.76%, with gardens and arable land and permanent grassland 49.29%. Forest lands are only in two communities, i.e. Kostol'any under Trábeč and Ladice of the total area studied municipalities with 42.94%.

In the Čerešňový Creek basin, the total area of settlements is 64.7203 km². Since the village Choča we don't obtained data on the acreage of land types, the percentage of land use was evaluated only in the remaining three villages Sľažany, and the Slepčany Velčice. Like Drevenica basin dominated by agricultural land (53.09%), of which the arable land, gardens and the permanent grassland is 51.84%. Built-up area of the municipality is 4.43% of total area. Forest lands of the villages are a total of 41.44% for most of the area municipalities have forest land in the village Velčice (71.44%).

Table 3. Connection of inhabitants to water supply and sewers in Žitava catchment
 Tabla 3. Ilość mieszkańców przyłączonych do wodociągu i kanalizacji w zlewni Žitava

Villages forming catchment Žitava Miejscowości tworzące zlewnię Žitava	Drinking water and wastewater treatment, % Wodociągi i oczyszczalnie ścieków, %						Construction WWTP Termin budowy	
	Population Ludność	Water supply Wodociągi	% supplied % wyposażenia	Sewerage Kanalizacja	WWTP Oczyszczalnia ścieków	Conetion sewerage Łączna kanalizacja		Connection WWTP Podłączone oczyszczalnie ścieków
Drevenica catchment – Zlewnia Drevenica								
Beladice	1 519	yes	49.90	yes	yes	69.12	69.12	2004
Kostořany pod Tribeřom	349	no	0	no	no	0	0	
Ladice	800	no	0	no	no	0	0	
Neverice	675	no	0	no	no	0	0	
Čereřovský Creek catchment – Zlewnia Čereřovský Potok								
Choča	486	yes	69.10	yes	yes	79.42	79.42	1997
Sřařany	1 704	yes		yes	yes	25.65	25.65	2005
Slepčany	847	yes	86.10	no	no			
Velčice	849	no	0	yes	yes	37.69	37.69	2005
Žitava catchment – Zlewnia Žitava								
Jedřové Kostořany	1 011	yes	92.50	no	no	0	0	
Machulince	1 037	yes	80.90	yes	yes	50.14	50.14	2000
Obyce	1 557	yes	91.80	no	no	0	0	
Tesárske Mlyňany	1 652	yes	88.30	yes	yes	49.82	49.82	2000
Vieska nad Žitavou	442	yes	92.10	no	no	0	0	
Zlaté Moravce	13 554	yes	92.40	yes	yes			
Žitavany	1 818	yes		no	in construction	0	0	

yes – tak, no – nie, in construction – w budowie

The sub-basin Žitava we evaluated a total six municipalities and the one city. The total area is 128.9 km². Again here the predominant agricultural land, namely 46.38%, but compared with the previous representation of the catchment forest land is almost comparable with agricultural land (43.94%). Built-up area municipalities a total area of 8.50% and the arable land, gardens and the permanent grassland together 44.89%.

Dominant influence on water quality in streams, it is for agricultural activity. In three sub-catchments an area of agricultural land is 64.36% of the total area. Another important influence on water quality in stream outside of agriculture, waste water produced in the settlements. Status of the population with drinking water supply and the abstraction and the wastewater treatment shows the Table 3.

The situation of the population drinking water supply and the drainage and wastewater treatment in sub-catchments are similar to those in Slovakia. The development of sewerage and sewage treatment plants lags behind the development of water supply. Only in villages and Choča and Beladice we noted that the majority of the population is connected to a sewerage network and the wastewater treatment, and the less to drinking water from public water supply.

In the basin Drevenica from four municipalities have only one community WWTP, and in three villages is not built public water supply. Kostol'any under Tríbeč, Ladice and Neverice shall be linked on the Zlaté Moravce group water supply (Vráble).



Fig. 3. Selected sub-catchments: Drevenica, Čerešňový Creek and Žitava
Rys. 3. Wybrane zlewnie: Drevenica, Čerešňový Potok i Žitava

In the Čerešňový Creek basin of four villages are built in three wastewater treatment plant. In the village Velčice is no public water supply, data on the percentage of population supplied with drinking water from municipality Sřažany we do not have available, we were only given information on water consumption.

In Žitava basins are in three villages (one city) built sewage treatment plants. Residents in villages in the basin of Žitava (district Zlaté Moravce) are supplied with drinking water from public water supply. Like Čerešňový Creek basin, in the village Žitavany we have a figure only the consumption of water, not a percentage of the population supplied. Details on Zlaté Moravce not given, as in our paper we are dealing with municipalities to 2,000 the population.

In addition to traditional municipal mechanical-biological wastewater treatment people can use a home wastewater treatment plant. Here but now face a problem in the Slovak legislation, and that waste water discharged from a house cleaning must meet the limit values of pollution rather than by the population connected to it, but the municipal size category, where it is located. Therefore, the very district office people such variant of wastewater treatment is not recommended. Marking selected cadastral municipalities in Žitava region is illustrated in Figure 3.

An important element in determining the recipients of sewage pollution is the consumption of water in the village and its development. Therefore, the last part of the contribution we devote water consumption in the villages for the last six years (Table 4).

Table 4. Water consumption in villages
Tabela 4. Zużycie wody w miejscowościach

	Water consumption in villages, thousand · m ³ · year ⁻¹ · community ⁻¹ Zużycie wody na wsi tys m ³ · rok ⁻¹ · wspólnotę ⁻¹							per capita · l. day ⁻¹ na mieszkańca na jeden dzień
	2005	2006	2007	2008	2009	2010	average średnia	
Drevenica catchment – Zlewnia Drevenica								
Beladice	23	22	33	29	32	31	28.33	51.10
Čerešňový Creek catchment – Zlewnia Čerešňový Potok								
Choča	6	7	8	7	8	8	7.33	41.34
Sřažany	2	5	8	10	13	14	8.66	13.93
Slepčany	10	10	11	10	14	11	11	35.58
Žitava catchment – Zlewnia Žitava								
Jedřové Kostořany	28	22	28	25	25	32	26.66	72.26
Machulince	21	16	22	29	21	28	22.83	60.33
Obyce	42	39	43	43	41	38	41	72.14
Tesárske Mlyňany	33	31	37	35	36	35	34.5	57.22
Vieska nad Žitavou	7	6	7	7	7	9	7.17	44.42
Zlaté Moravce	551	603	633	614	556	578	589.17	119.09
Žitavany	45	41	45	46	47	47	45.17	68.07

Average water consumption in sub-catchments for the period is 821.83 thousand $\text{m}^3 \cdot \text{rok}^{-1} \cdot \text{community}^{-1}$, which represents 84.59% of supplied inhabitants in the villages. This low consumption of water in some villages even below the minimum hygiene, can be caused by a number of houses have their own wells. During the period of water consumption in the villages in the three sub-catchments by 2007 has risen on average (the average water consumption of 72.48 liters per capita $\cdot \text{day}^{-1}$). This was followed by a slight decrease by 2009 (average consumption of 66.27 liters per capita $\cdot \text{day}^{-1}$) and 2010 water consumption to a rate of 68.84 liters $\cdot \text{day}^{-1}$.

DISCUSSION

The nature and structure of the country have an important impact on the quality of surface water in rivers at the basin level [Gergel et al. 2002]. Land uses to agriculture and urban settlements, as well as coastal areas and forests are key sources of surface water pollution [Moreno-Mateos et al. 2008]. At what show and our findings in this paper. Protection of water courses is primarily aimed at ensuring the required water quality discharge from sewage treatment plants. Typically, formerly known signs of sewage in rivers in European proportions were cleaning in mechanical-biological sewage treatment plants virtually eliminated [Krejčí and Hlavínek 2002]. Extent influenced by the flow of waste water flow is enhanced in the flow of treated water, weather conditions, the nature of the flow (natural flow, artificial concreted riverbed, the presence of cascades) and the like [Mlejnská et al. 2009].

Nutrients with organic substances discharged into surface waters are causing the risk of not achieving the objectives of the Water Framework Directive in 2015 to 35% of water bodies of the SR [Čerešňák and Bujnová 2011]. Drevenica and Čerešňový Creek are in the water plan for Slovakia as flows in which the term of achieving at least a second class of environmental quality postponed until 2021. One reason for the failure to achieve good ecological status are just not built up sewage treatment plants.

The field survey sub-catchments, we noticed that some flows are significantly changing the view, the water quality deteriorates (turbidity, vegetation change, the recovery of flow, etc.). The wooden cottage and cherry creek (small tributaries Žitava) from the source flow is negatively affected by the environment, through which flows. Agricultural activity reflected badly on the quality of water at the time of fertilization and tillage machines near the stream, municipality will affect the water quality of their wastewater. Many municipalities have built sewage waste water discharge of black discharges, which impair the quality of water in the stream. Therefore, the consequences of human activities that reflect the quality and quantity of water flows, require mutual respect in the top users, respectively, lower parts of the flow. Excessive water abstraction or pollution intensive on top of the stream water users can be on the bottom of the stream to prepare for their legitimate right to use water flow [Integrated protection... 2001]. E.g. in the basin, we observed extensive Drevenica flow recovery, but only in that place, until they reach the vicinity of villages, which flows through. There is a visual change (turbidity, odor and foam levels), riparian vegetation has changed, and that it has a higher nutrient content in water.

CONCLUSION

In conclusion we can say that in the study area (sub-catchments Drevenica, Čerešňový Creek and Žitava), we have seen a similar trend as in Slovakia. Not meet expectations regarding the expected consumption of drinking water and subsequent wastewater production in view of demographic developments in the basin of Žitava (district Zlaté Moravce) and its tributaries, Drevenica a Čerešňový creek. There is no apparent increase in the population, even the mere consumption of water in the villages below the minimum hygiene (80 liters per capita · day⁻¹) and therefore is not expected to increase the amount of wastewater. Waste water containing a cleaning after many substances that affect water quality in stream, but the situation in the area of drainage and wastewater treatment in the study area at a sufficient level. It is therefore expected that the construction of additional municipal wastewater (assuming the implementation of the year 2021, respectively 2027), water quality will not deteriorate in the flow. The biggest impact to waste water when the flow is equal to the flow in Q355 (two periods during the year, i.e. the summer months and early). The actual quality of water in the sub-basin Žitava depends on natural pollution and pollution that gets into the flow of human impact. The proper management of land treatment of sewage and suitable industrial activity can keep the quality of a good quality level, or even we can influence in a positive direction.

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