

Water and wastewater management in mountain tourist shelters of Karkonosze National Park

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ABSTRACT

The increase in tourist traffic, related to the local and global development, as well as increased availability of tourist-attractive areas causes noticeable environmental changes. Mountain areas are tourist areas enjoying increasing popularity. The emergence of new tourist facilities such as mountain huts, hotels, tourist shelters is related to providing users staying in them with the access to technical infrastructure, mainly related to access to water. The increasing number of tourists using accommodation objects results in pollution discharged to the environment resulting from intensive use of local water intakes. One of the still unresolved problems is the formation and subsequent treatment of wastewater in mountain areas. This paper presented an attempt to characterize the impact of tourist traffic and related water as well as wastewater infrastructure on the direction of changes in the areas with intense tourist traffic. The research area included the objects located directly in the Karkonosze National Park included on the list of UNESCO biosphere reserves and in the protection area of Natura 2000, which is annually visited by over 3 million tourists. The solutions used for wastewater treatment were mostly local wastewater treatment plants (mechanically-biological) with discharge to the ground or to surface water receiver. The conducted research concerned an in-depth analysis of the functioning of mountain tourist shelters in the analyzed area. The studies concerned the analysis of legal conditions and applicable regulations, as well as the ownership structure of the analyzed objects, and the resulting problems, including the lack of investment in the modernization as well as renovation of outdated water and wastewater systems by tenants. The analyses carried out showed intensive water intake from own intakes in the protected area, along with the discharge of treated wastewater into watercourses with low flows in a source part of catchments. Intense tourist traffic generates unsteady wastewater inflows to the treatment plant and limits their proper functioning in the absence of constant monitoring of the inflow volume.

Keywords: Karkonosze National Park, tourism, wastewater, technical infrastructure, nature protected areas, UNESCO Biosphere reserves.

INTRODUCTION

The development of civilization and society is widely visible on a local, regional and global scales, one of the important factors that directly affect the development of areas is tourism (Zhao and Li, 2018). Through the development of tourist traffic as well as closely related development of technical and non-technical infrastructure, the access to valuable areas has greatly increased, in which the presence of human beings causes environmental changes. Therefore, it is important

to take pro-ecological measures (technical and non-technical) aimed at balancing of environmental resources and areas exploited by people (Ars and Bohanec, 2010; Gössling et al., 2012). Mountain areas are an attractive space for tourists, with high educational and scientific value, and high environmental importance. Mountains are a region in which the sources of many rivers are located, in addition, the areas are very sensitive for climate change, deforestation and environmental degradation (Myga-Piątek and Jankowski, 2009), which is why the uncontrolled

number of tourists in these places creates serious environmental implications. Achieving the maximum capacity of mountain ecosystems causes high ecological pressure and causes the introduction of pollutants supplied with the tourist traffic into the environment (Fayyaz et al., 2018). The main impact of tourism is noise and light pollution, waste, sewage outflow and toxic substances (e.g. oils, gasoline from the use of motor vehicles in protected areas), fire threat and destruction of valuable landscape sources (Joppe, 2018).

Increasing tourist traffic in mountain areas results in the creation of infrastructure facilities, such as mountain hostels, hotels and also tourist shelters. These objects are most often located in high landscape valuable areas and the areas under nature protection. The existence of such facilities is related to ensuring that people staying in them have access to technical infrastructure – primarily access to water, which involves the need to equip facilities in installations that take measures to manage the wastewater and generated waste (including sewage and sludge) (Rodel et al., 2016). Due to the widespread availability of tourist-attractive places, the number of people using tourist sanitary infrastructure is gradually increasing. Singh and Mishra (Singh and Mishra, 2004) indicate that in the case of the seasonal peak, the infrastructure of mountain facilities (tourist shelters/hostels) is insufficient, which could pose a significant threat to the environment. Human activities related to unregulated mountain tourism is one of the main factor with negative influence on protected area environment (Schmeller et al., 2018). Among others, this issue was raised in terms of research analysis for mountain regions of Europa – Alps (Boehler et al., 2007; Foladori et al., 2012), Carpathians (Iordache et al., 2015; Nikolaichuk, 2008), Australia – Australian Alps Protected Area (Pickering et al., 2003), Asia – Himalaya (Sanjay, 2002), Central America – Tilaran mountain range of northwest Costa Rica (Dallas, 2004), Japan – Fuji, Tanzania – Kilimanjaro (Apollo, 2016).

Water management of tourist facilities is based in most cases on own water intakes, sub-surface or surface, rarely centralized solutions (water supply systems). Increased water intake in accommodation facilities is related to the development of wastewater treatment systems, the main purpose of which is collecting and treating wastewater to a level that allows safe introduction to the environment (Pan et al., 2018) and

complies with applicable law. The systems used in mountain shelter/hostels mainly include local solutions based on the collection and treatment of wastewater at the place of their formation (Weissenbacher et al., 2008). Due to the size of the accommodation facilities and difficulties in access for specialist vehicles like slurry tankers, cess-pool should be the rarest solution.

The most common solution in mountain tourist shelter conditions are local wastewater treatment plants with sewage discharged to ground or surface waters (Kaczor et al., 2015; Schories, 2008; Weissenbacher et al., 2008). The applied technologies result from the location of facilities and access to technical infrastructure, which is a global situation in the mountains and extra-urban areas (Andreottola et al., 2003; Langergraber, 2011; Maunoir et al., 2007; Schories, 2008). The majority of original mountain facilities (tourist shelters) are dozen-year-old buildings (Kaczor et al., 2015; Potocki, 2005) equipped with the sanitary installations that require modernization. This is related to the use of outdated technologies and poor technical condition of the installation. One of the solutions that can be used in mountainous regions are constructed wetlands, which are characterized by high resistance to changes in the inflow of sewage and the ability to work even at low temperatures (Vymazal and Březinová, 2014). However, the recommended solutions should be those that will have the least impact on the state of the environment (which is a receiver of treated wastewater). Such a problem implies an urgent need for research to assess the extent of the impact of tourist traffic and activities directly related to it, causing the phenomenon of introduction and transport of pollutants in mountain areas, as well as indicating solutions to minimize the environmental impact of infrastructure, intensively used by tourism activity.

In Poland, mountain areas occupy about 10% of the total area of the country. These are the mountain range of the Sudetes and the Carpathian Mountains, and among them one of the most environmentally valuable mountain areas – the Karkonosze Mountains (also known as Giant Mountains), where the Karkonosze National Park is located, which is one of the most visited nature protected regions of the whole country (Rogowski, 2018). The annual number of tourists visiting the park is estimated at few million a year (Mazurski, 2010). Such intense tourist traffic as well as disproportionate infrastructure development

and the environmental risk resulting from these factors prompted the authors to undertake this research topic. The main aim of this work was to outline the scale of the phenomenon of the impact of tourist traffic and related tourist shelters as well as water and wastewater infrastructure on the direction of pollution transport in mountain, nature protected, valuable landscape areas.

OBJECT OF THE STUDY

The Karkonosze National Park (KNP) is located the mountain range of the Sudetes in the southwest of Poland (Figure 1). KNP was created in 1959 and is one of the oldest national parks in Poland. In the early years, the park was visited by 0.75–1.0 million tourists annually, and in subsequent years the number increased to 3–3.5 million people (Mazurski, 2010), while Park authorities and national statistics based on the tickets sold (counted entries, local residents are not included in the statistics because they enter without fees) indicate over 2 million tourists a year. The research by Knapik and Migoń (Knapik and Migoń, 2010) indicates that this trend seems quite disturbing due to the limited and variable ecological resilience of the Park environment. In the summer

season, KNP is visited by 600,000 tourists and in winter by 150,000, on average. Every year, this number increases by 7–8%. In the park, 120 km of hiking trails are available with an average density of 22 m per hectare.

The area of KNP is 60 km², and the buffer area (lagging) is 131 km². KNP is one of the smallest national parks in Poland. The area of KNP in 74% is covered with forests, 8% is high-mountain meadows, and 3% of the area is rock rubble. KNP is included on the list of UNESCO biosphere reserves as one of 9 of the 23 national parks in Poland (Karkonosze Biosphere Reserve 1992 – cross-border area with the Krkonoše Mountains National Park in the Czech Republic). The entire KNP area is in the Natura 2000 area: Special Protection Area (code PLB020007 – Karkonosze) and Special Area of Conservation (code PLH020006 – Karkonosze). KNP is also partly in the protection area of Ramsar Convention on Wetlands – subalpine peat bogs with area around 40 ha. Nature protection in this area is very complex, especially through protection in the form of a National Park, but also through Natura 2000 areas and other forms of environmental protection (Figure 2).

In the park, there are mainly podzols (68%) as well as cambisol soils. The soil fraction

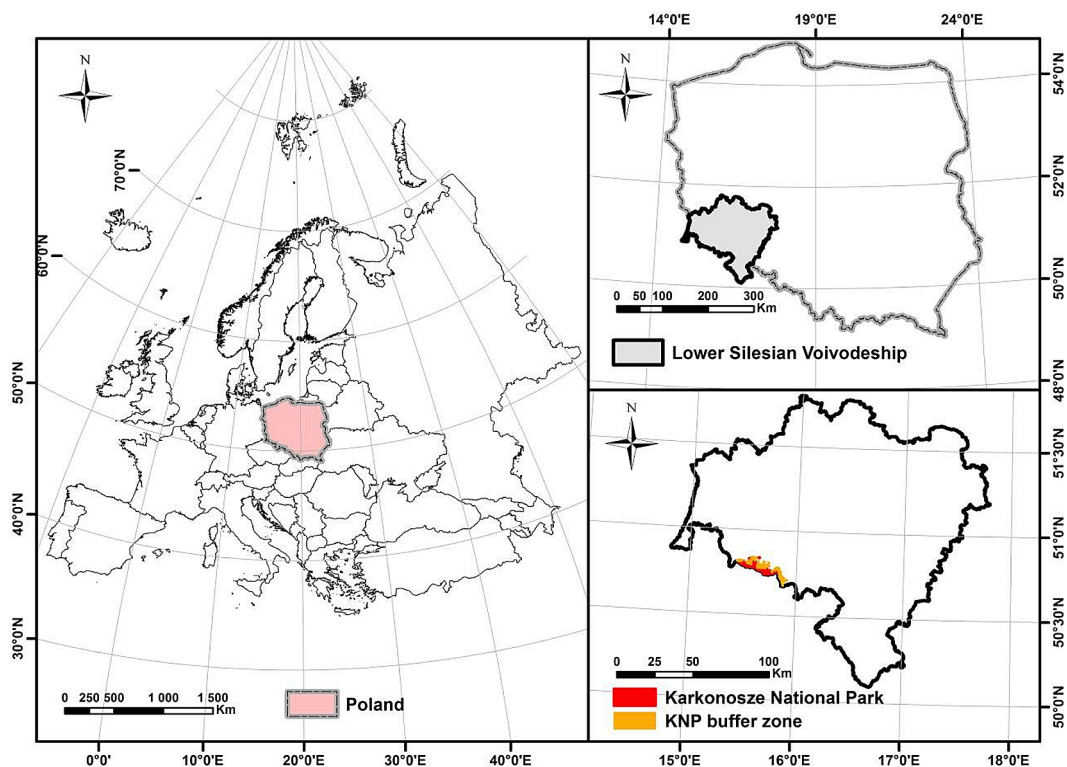


Figure 1. Location of the Karkonosze National Park

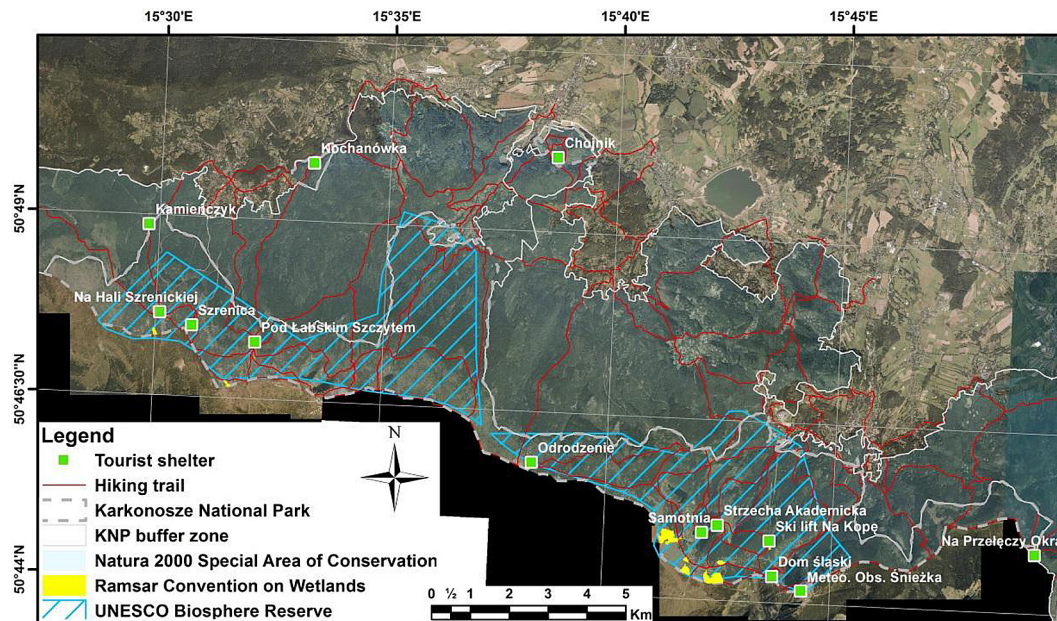


Figure 2. Location of the mountain tourist shelters in the Karkonosze National Park in relation to hiking trails and protected zones

distribution of soils formed on slates and gneisses is 30–40% of silt, which indicates sandy loams with a high content of silt fraction often turning into loam. In the places where granite is the bedrock, sandy loams with a less amount of the silt fraction (20–30%) occur. In addition, there are also loamy sands in the KNP area (Waroszewski et al., 2018). What connects all the soils of the Karkonosze Mountains is the low content of clay that reaches a maximum of 5%.

The main aim of visiting Karkonosze as well as KNP is tourism combined with overnight stays. Therefore, 13 mountain tourist shelters (TS) are located in the area of KNP (Figure 2). Most of them (11 TS) are managed by Polish Tourist and Sightseeing Society (Polish acronym PTTK), 2 are private facilities. The most important objects should include the High-Mountain Meteorological Observatory (Meteo. Obs.) Śnieżka, the upper station of the ski lift Na Kope, and the Domek Myśliwski – the KNP educational facility (Figure 3). Vehicle traffic within KNP is forbidden, except for special cases such as Mountain Volunteer Search and Rescue (Polish acronym GOPR), National Park vehicles and others that have obtained seasonal or one-time permits.

Almost entire area of KNP is in the catchment of the Bóbr River, which is the left tributary of the Oder River, which is in the basin of the Baltic Sea. In the Polish part of the Karkonosze Mts., the left tributary of the Bóbr is a Kamienna and Łomnica

river (Table 1). Individual water intakes for economic purposes for mountain tourist shelters as well as places for discharging treated wastewater from accommodation places are located on catchment from IV to VI river order (level), which are direct or indirect tributary of Kamienna and Łomnica river.

RESEARCH METHODOLOGY

The conducted research had the initial character, consisting mainly in recognizing the scale and type of the problem of functioning of tourist facilities in mountainous areas of the protected environment. The research consisted in identifying the accommodation facilities in KNP as well as determining their structure, parameters, and technical infrastructure used (water intake and wastewater treatment method). The research was conducted by means of field reconnaissance in facilities, as well as studies of archives and current water permits. Water-legal permits, in accordance with the applicable Water Law (Ustawa Prawo Wodne, 2017), must be issued for water intake, irrespective of the type of intake, when the water intake is used for economic purposes, and always for discharging treated wastewater into the environment (when the receiver is a watercourse or ground). In order to obtain an appropriate permit for water intake and wastewater disposal, it is necessary



Figure 3. The mountain tourist shelters in the Karkonosze National Park: a) Strzecha Akademicka, b) Na Hali Szrenickiej, c) Pod Łabskim Szczytem, d) Dom Śląski (private hostel), e) Samotnia, f) Szrenica (private hostel), photo: Pawęska/Dąbek, 2018–2019

Table 1. Morphometric parameters of the most important catchments of the Karkonosze National Park

River level *			River name	Length [km]	Catchment area [km ²]	Part of the KNP in catchment area [%]	Tourist shelter
II			Bóbr	283.3	5885.2	99.5	**
	III		Kamienna	35.6	274.8	61.6	**
		IV	Wrzosówka	14.7	96.6	33.7	Chojnik
		V	Podgórna	12.6	71.0	12.2	**
		VI	Czerwień	7.8	13.8	3.2	Odrodzenie
		IV	Kamieńczyk	5.9	10.5	11.3	Na Hali Szrenickiej Kamieńczyk
		IV	Szklarka	7.0	18.9	14.9	Kochanówka
		V	Szrenicki Potok	5.3	10.4	9.0	Pod Łabskim Szczytem Szrenica
	III		Łomnica	20.9	116.5	37.9	Strzecha Akademicka Samotnia Domek Myśliwski
		IV	Jedlica	17.1	55.7	2.9	Na Przełęczy Okraj
		IV	Łomniczka	9.7	18.9	14.7	Dom Śląski Meteo. Obs. Śnieżka
		IV	Bystrzyk	3.5	2.2	3.5	Ski lift Na Kopę

Note: * – river level is determined according to the rule that the river that has an estuary to the sea has level I, the river which is its tributary has level II, etc., ** – location of tourist shelter in relation to the hydrographic division is determined from the highest river level possible to separate in this area (the smallest hydrographic unit), e.g. tourist shelter Chojnik, which is in the catchment of Wrzosówka river level IV, according to the hydrographic division, is also in the catchment area of river level III Kamienna and river level II Bóbr, and river level I Odra, which has an estuary to the Baltic Sea.

to provide the conditions for using the environment, including a description of the technology, location of facilities, volume of water intake or discharges and others. Any change in the technology used, e.g. as a result of facility modernization, or a change in the volume of water intake or wastewater discharges, requires appropriate notification to the appropriate authority (currently the State Water Holding – Polish Waters) and obtaining the appropriate water-legal permit. Moreover,

based on the Map of Hydrological Division of Poland and a digital terrain model, the location of the tourist shelters in the aspect of the hydrography of the area was determined. TS (Tourist shelter) were grouped in terms of the method of water intake and sewage management. The measurement campaign was performed in the summer of 2018. Water samples from selected rivers that are the source of the water for TS (including the one with the largest and the lowest number

of beds) were collected (above the sewage discharge). In those samples, the determination of phosphates, nitrate, nitrite, ammonium and total organic carbon as well as pH, conductivity and turbidity were performed. Additionally, the out-flow samples (from wastewater treatment facilities) as well as samples of water at a distance of 3–5 meters below the wastewater discharge in to the rivers were collected. The measurements were conducted in accordance with the applicable standards (Bridgewater et al., 2012). For comparison, tap water samples from selected TS (used by tourists) were analyzed.

RESULTS AND DISCUSSION

The attractiveness of the mountain area is confirmed by the continuous increase of tourist number (Apollo, 2016). In each of the visited place, man has an impact on the environment (Singh and Mishra, 2004).

In the area of strict nature protection in KNP, there are 8 mountain TS (Figure 4), which means that they have direct impact on the environment in terms of water intake and wastewater management as well as waste generation. They are equipped with their own water intakes; however, the information about the actual amount of water consumed and the amount of wastewater produced is not yet fully available, only the information that is available is that specified in the water permits. Tourist shelters were originally intended as a place for refuge (equipped in minimal way) during mountain expeditions but then evolved

rather in hotel facilities in most cases without sufficient water and wastewater infrastructure (Kariel, 1992). The most common type of water intake for TS are surface water intakes (Table 2) located in the catchment areas of the Kamięńczyk, Łomnica and Łomniczka rivers. The highest daily intake of water, according to issued water-legal permit, have together the mountain TS Samotnia and Domek Myśliwski (total of 20 m³ per day), which is not one of the largest accommodation facilities in KNP; however, it is located on the most frequented tourist route in this region, what could cause system overloading during peak of the season (Singh and Mishra, 2004). The largest TS (Strzecha Akademicka and Na Hali Szrenickiej) have been equipped with water intakes of 18 m³ per day separately. The research conducted by Yang (Yang et al., 2011) indicates that water consumption by tourists significantly exceeds the specific water consumption for local residents.

In July 2018, the samples of tap water intended for consumption were taken from four selected mountain TS (Strzecha Akademicka, Dom Śląski, Na Hali Szrenickiej and Kamięńczyk). The selected contamination parameters such as concentrations of nitrates and nitrites, the concentration of total organic carbon as well as the physicochemical parameters of pH and conductivity were determined. In each case, the mountain TS was supplied with water from a surface intake, the same as in the research of Lebersorger (Lebersorger et al., 2010). The highest concentrations of nitrate nitrogen were characterized by the samples taken from the intake for the TS Strzecha Akademicka (0.56 mg N-NO₃·dm⁻³);

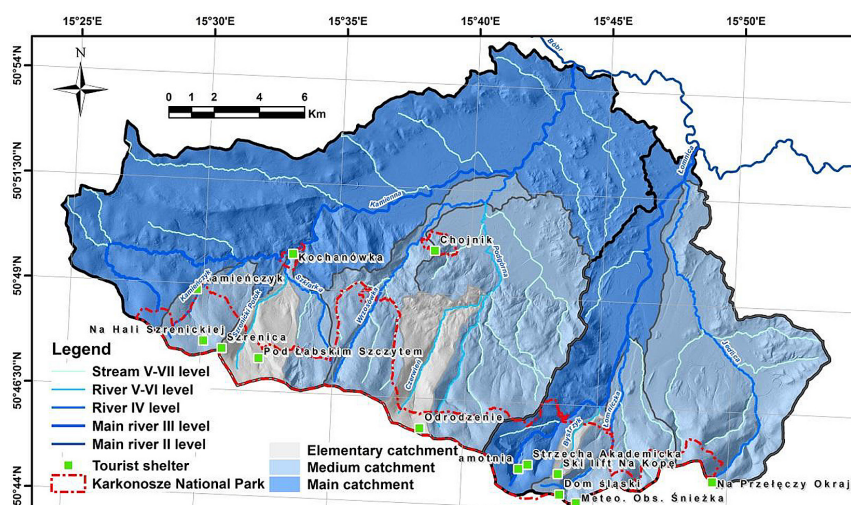


Figure 4. Location of the tourist shelters in the Karkonosze National Park in the hydrographic aspect

Table 2. Tourist shelters water intake type specification in the Karkonosze National Park

No.	Tourist shelter	Altitude [m ASL]	Number of beds [no.]	Water intake type	Average intake [m ³ per day] *
1	Strzecha Akademicka	1 258	140	Surface	18.0
2	Dom Śląski	1 400	59	Surface	8.0
3	Na Hali Szrenickiej	1 200	100	Subsurface and surface	18.0
4	Samotnia	1 195	50	Surface	20.0
5	Domek Myśliwski	1 158	14		
6	Pod Łabskim Szczytem	1 168	38	Subsurface and surface	5.0
7	Kamieńczyk	840	19	Surface	5.0
8	Odrodzenie	1 236	100	Subsurface	No data

Note: * – information in accordance with the consent given in the water-legal permit.

in this case, one of the higher concentrations of total organic carbon (7.24 ppm) was also measured. The water samples were characterized by a similar pH value (6.0–6.7) and low electrolytic conductivity values (34.3–57.5 $\mu\text{S}\cdot\text{cm}^{-1}$). Nitrite nitrogen (N-NO₂) forms were not found in any of the analyzed samples. For each of the objects, water intended for economic purposes did not exceed the admissible values specified in the Regulation (Rozporządzenie Ministra Zdrowia, 2017). No exceedance of pollutant parameters were found either in river water samples collected above TS location (Table 3). Such water is used for the own needs of mountain TS, and after use it is discharged to individual wastewater treatment installations constructed in most cases as two-stage systems.

Wastewater treatment in one of the most energy consuming process (Goymann et al., 2008). The first stage of treatment is carried out in a settling tank, and then after biological treatment, the treated wastewater is discharged to the receiver, which in most cases is surface water (Table 3).

The largest amount of wastewater is generated in the TS Na Hali Szrenickiej, the second largest object in the analyzed area. The maximum permissible concentrations of pollutants in treated wastewater discharged into the environment, according to issued water-legal permit, should be consistent with the values indicated in the Regulation regarding the conditions to be met when introducing treated wastewater into water or soil, and on substances particularly harmful to the aquatic environment (Rozporządzenie Ministra Gospodarki Morskiej i Żeglugi Śródlądowej, 2019). The amount of wastewater generated in TS is characterized by seasonal fluctuation (even

up to 6 times), which could cause problem related to achieving high effluent quality. The quality of treated wastewater can also change significantly during the season (Singh and Mishra, 2004; Kaczor, 2015). Mountain TS, according to issued water-legal permits, should report to the State Water Holding – Polish Waters only twice a year on the quantity and quality of wastewater discharged to the environment. In the case of the highest daily values of wastewater outflows, it is a BOD₅ load of 4.2 kg O₂ per day introduced into surface waters (for the TS Na Hali Szrenickiej). Due to the age of the tourist shelters and the lack of modernization works, wastewater treatment installations are very often outdated and do not function properly (Figure 5). Similar problems are mentioned in the research of Lebersorger (Lebersorger et al., 2010) and Rodel (Rodel et al., 2016). The issue related to TS and water and wastewater management may pose a threat to the environment, because along with insufficiently wastewater treated entering the receiver, substances harmful for both human and animal organisms (products for personal care, chemicals such as plastic or flame retardants, pharmaceuticals, and their metabolites (Kumar et al., 2020) may be introduced (Zakoutska et al., 2013).

In accordance with the permits for the discharge of sewage outflows should only guarantee quality in relation to BOD, COD and suspension (Table 4). Research campaign conducted in 2018 pointed at extremely high concentration of ammonium nitrogen in wastewater discharge in to the mountain's rivers (Table 3). High values were observed also for turbidity, oxidizability and phosphates. Such issues are caused by high intensity of tourist traffic and failure of wastewater treatment systems. During the research campaign,

Table 3. Water quality in river below and above the wastewater discharge, quality of outflows from wastewater treatment plants for selected TS

No.	Parameter	Tourist shelter (TS)							
		Na Hali Szrenickiej		Pod Łabskim Szczytem		Domek Myśliwski		Strzecha Akademicka, Samotnia	
		Outflow from WWTP	B/A*	Outflow from WWTP	B/A*	Outflow from WWTP	B/A*	Outflow from WWTP	B/A*
1	pH	7.4	$\frac{7.2}{7.4}$	8.3	$\frac{6.0}{6.9}$	-	$\frac{7.50}{7.50}$	8.2	$\frac{5.7}{7.57}$
2	Turbidity NTU	102.0	$\frac{0.26}{61.20}$	73.2	$\frac{0.99}{1.66}$	-	$\frac{0.50}{0.30}$	46.1	$\frac{0.63}{1.32}$
3	Electrolytic conductivity, $\mu\text{S}\cdot\text{cm}^{-1}$	889.7	$\frac{19.6}{552.3}$	1705.2	$\frac{21.0}{36.6}$	-	$\frac{20.85}{17.62}$	1296.2	$\frac{14.0}{60.2}$
4	Temperature °C	14.3	$\frac{11.4}{13.5}$	15.9	$\frac{15.0}{13.1}$	-	$\frac{12.70}{11.73}$	13.7	$\frac{16.6}{11.9}$
5	Oxidability, $\text{g}\cdot\text{m}^{-3}$	34.4	$\frac{14.0}{26.8}$	48.8	$\frac{1.3}{3.95}$	-	$\frac{2.87}{2.97}$	35.2	$\frac{4.2}{4.4}$
6	Ammonium nitrogen, $\text{g}\cdot\text{m}^{-3}$	107.7	$\frac{0.0}{62.5}$	289.2	$\frac{0.01}{2.46}$	-	$\frac{0.14}{3.12}$	156.3	$\frac{0.07}{3.85}$
7	Nitrate nitrogen, $\text{g}\cdot\text{m}^{-3}$	1.0	$\frac{1.77}{1.03}$	1.37	$\frac{2.35}{1.98}$	-	$\frac{1.25}{0.96}$	7.61	$\frac{0.27}{1.62}$
8	Nitrite nitrogen, $\text{g}\cdot\text{m}^{-3}$	0.13	$\frac{0.0}{0.07}$	0.005	$\frac{0.0}{0.0}$	-	$\frac{0.006}{0.005}$	2.77	$\frac{0.0}{0.04}$
9	Phosphates, $\text{g}\cdot\text{m}^{-3}$	6.80	$\frac{0.04}{3.9}$	13.32	$\frac{0.02}{0.22}$	-	$\frac{0.015}{0.042}$	0.30	$\frac{0.01}{0.3}$

Note: * – below, above the sewage discharge.

only basic parameters of outflows quality were observed but one should be aware that substances harmful to human are introduced into environment with insufficiently treated wastewater.

The water and wastewater management of TS is not fully regulated. This involves legal and social problems. Tourism is inseparably associated with the economic development of the region, is a result of its attractiveness; however, more often problems of the water and wastewater management of TS are mentioned in local newspapers, radio stations, and TV news in the context of tourists' reactions to the effects of the facility malfunctioning. The actions taken to regulate mountain tourism and, consequently, an impact on the environment should be strictly regulated and implemented over a long time horizon (Muller, 1996; Nepal, 2002) and in cooperation with both public administration as well as facility managers.

The legal regulations (Ustawa Prawo Wodne, 2017) effect from the need of permission for water intake and wastewater discharging in terms of standards and scale of impact on environmental (e.g. quantity and quality of discharged

wastewater). Wastewater treatment plant management is related to keeping facility operating book, in which amount of generated wastewater, quality of treated wastewater, and time of sewage sludge removal are reported. At present, there is no legal obligation to monitoring the volume of water intake from surface and subsurface intakes as well as the volume of wastewater discharge to receiver. The fee is charged based on user statements, which is usually consistent with the value contained in the water-legal permit. Currently, control of wastewater quality discharged into the environment is carried out twice a year related to average daily sample, which completely omitted the increased intensity of tourist traffic during day or season.

The number of guests visiting TS every day, as well as the specification of overnight guests, would be an ideal reference for the load on the water and wastewater systems of these facilities. Unfortunately, it is difficult to determine the actual number of guests using TS. In case of one-stay day, facility managers are not obliged to register overnight visitors, in case of a longer stay (longer than one day), the regional tourist tax is charged which has to be

Table 4. Characteristics of wastewater management solutions for the selected mountain tourist shelters in the Karkonosze National Park

No.	Tourist shelter	Wastewater treatment method	Discharge [m ³ per day]*	Receiver	Permissible concentrations [g·m ⁻³]*
1	Strzecha Akademicka	Two stage (mechanical-biological)	24.0	Surface water	BOD ₅ =< 40 COD =< 150 TSS =< 50
3	Na Hali Szrenickiej		16.1		
4	Samotnia		3.0		
5	Domek Myśliwski		10.3		
6	Pod Łabskim Szczytem		2.6	Ground	BOD ₅ =< 25 COD =< 125 TSS =< 35
7	Kamieńczyk		16.5		
8	Odrodzenie				

Note: * – information in accordance with the consent given in the water-legal permit.



Figure 5. Components of the mountain water and wastewater management system in the Karkonosze National Park: a-d) unprotected sediment tank, e-f) unprotected element of water supplying system, g-h) unprotected wastewater treatment plant building, i) discharge untreated wastewater to receiver, j) unprotected subsurface leaching system, photo: Pawęska/Dąbek, 2018–2019

recorded to the commune authorities. Such collected personal data are sensitive (include: name and surname, address), through what additionally it is difficult to obtain their for scientific research purpose. The terms for reporting this information to relevant commune institutions is no law regulated.

At the same time, it should be emphasized that the permits issued for surface water intake (licensing is e.g. 10 years, often longer) are issued taking into account keeping of biological flow in the watercourse, but it does not take into account, for example, climate change and its consequences, in the form of rainfall deficiency and drought. Unfortunately, this also applies to the discharge of wastewater into watercourses, apart from the possibility of their improper treatment, in the face of climate change and reduction of flows, it will be dangerous to discharge the treated wastewater into watercourses with negligible flows, which will not ensure adequate

dilution. This can result in a significant impact on the quality of the environment and the threat of its pollution, especially taking into account the water intakes below for larger cities.

The issue of TS ownership is also extremely important. In the analyzed case, most of the facilities are owned by Polish Tourist and Sightseeing Society (PTSS), and the persons managing the facilities are their tenants on a time-based lease basis. For the possibility of making commercial use of the facilities, providing accommodation and catering services, they pay an appropriate fee to PTSS. Unfortunately, apart from minor repairs resulting from the use of the facilities, tenants do not invest in them. This results from the fact that objects are not their property. All investments in TS, including modernization or renovation, are within the facilities owner, PTSS. Unfortunately, this organization owns many similar facilities throughout Poland, which hinders and

limits investing in facilities. There are about 100 mountainous TS in Poland, which are recognized by tourists, including 72 belonging to PTSS, 24 in the Sudetes and 48 in the Carpathian Mountains. Mountain tourist shelters in this arrangement of properties constitute the majority of accommodation facilities in the Polish mountains, approx. 75%, not including large hotels and guesthouses.

CONCLUSIONS

The water and wastewater management of the mountain tourist shelters in the area of Karkonosze National Park is not fully regulated. This creates a huge threat to the environment. Mountain tourist shelters are located mostly in areas under nature protection, National Park area, UNESCO Biosphere Reserve, Natura 2000 zones, with difficult water and ground conditions (shallow soils and impermeable layers of rocks, source area of important catchments). The most common way to neutralize wastewater generated in these facilities, due to lack of access to central wastewater system, are local wastewater treatment plants with discharge to the ground or to surface waters receivers. Those are mostly obsolete objects that require modernization and adaptation of technologies to binding standards. A significant problem in the matter of modernization of water and wastewater systems in mountain accommodation facilities is the issue of ownership of these facilities and their lease. This, as a result, leads to reduced investment in improving these facilities. Another important problem is the issue of the legal obligation to constantly monitor the amount of water intake as well as the quantity and quality of discharged treated wastewater. Fortunately, with time, the awareness and responsibility of tourists increases, who increasingly pay attention not only to the issue of convenience and relatively cheap accommodation, but also to the hygiene, sanitary and general functioning of such facilities.

The tourism sector, due to its continuous development, should place greater emphasis on changing the way water resources are used in accommodation places (such activities should be one of the key strategies of tourism traffic management and development of local communes). Unsustainable use of water manifested most often by obsolete sanitary installations, the lack of water-saving equipment and outdated technologies of wastewater treatment affects the environment

components. With increasing tourist activity, the amount of water collected as well as the amount of wastewater produced in the environment are increasing, which is also of great importance in the aspect of climate change and adaptation to them. The specificity of mountainous areas poses difficult challenges that should be met by the methods of wastewater disposal proposed for tourist facilities. A solution that provides greater control over both the amount of water collected and the wastewater generated is central sewer systems. It is a costly solution at the investment stage, as well as with a high environmental impact in the initial stages, but beneficial for each sides (environment, economy, society) and in accordance with the principles of sustainable development at the stages of use. In the future, this may allow reducing the impact of local solutions applied to wastewater treatment on the quality of surface waters constituting the target receivers. It is also extremely important to thoroughly and intentionally explore the size as well as type of environmental impact of mountain tourist hostels and their water and wastewater management system, through specialized field research and constant monitoring, which unfortunately is not currently legally required.

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