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Sustainability between trees

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ABSTRACT

The article presents the implemented solution for the organization of a pioneer scouting camp located in Poland on Babinka Lake following the principles of sustainable development. The camp was not located on a camping site or in a scout cabin, but in a place that had to be adequately prepared for the 2-week stay of 50 participants. It was necessary to provide water for drinking and preparing meals, water for washing, sanitary facilities, and waste segregation. Scouts who wanted to act according to sustainable development goals decided to eliminate the use of water in plastic containers. Before the camp, a local inspection of the area was carried out, the possibility of drawing water from a nearby deep well was checked, pilot holes were made in other locations, and water samples were collected and tested for physicochemical and bacteriological parameters. A solution consisting of bringing safe drinking water and using lake water for washing was proposed, and a safe location of latrines and places to store segregated waste was also indicated. Our study proved that it is possible to abandon the use of single-use plastic water containers and other non-eco-friendly solutions during the scout camps and provide a water supply more sustainably. Following this study, organizers can reduce the negative impact on the environment on the campsite.

Keywords: Drinking water; Sustainability; Scout camp; Sanitation systems; Sustainable development goals

1. Introduction

In Poland, there are more than 120,000 scouts and the majority of them go camping every year. Some of the camps are located in forests, in specially prepared places, such as campsites or scout cabins. However, some scout teams prefer to camp in the forest far from civilization and without already existing sanitary facilities. Therefore, the guides organizing the camps must prepare water and sanitation systems even if they do not have experience with this matter. Since waste needs to be managed according to the local rules, this often means the segregation of basic waste fractions (organic, plastics and metals, glass, paper, residual waste) at the campsite and transporting it to the local collection point. When it comes to wastewater, the most common solutions are pit latrines or dry toilets built by the participants in the

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place recommended by the local forester. Thus, providing water supply is usually the most challenging and usually camp organizers decide to use easier but often less environmentally friendly solutions, for example, drinking water from plastic bottles.

Polish scouts are members of the movement that also acts for worldwide sustainability and supports efforts of the United Nations, an intergovernmental organization, in achieving 17 Sustainable Development Goals that are associated with 169 targets intended to ensure a sustainable way for human development [1,2]. This is especially important in the context of climate change when all people are required to adapt, protect existing water resources and look for alternative water sources [3]. One such water source can be, for example, rainwater. Recent studies indicate that its physicochemical quality, depending on the location of the collection, is comparable to the quality of water intended for human consumption, while microbiological quality is a problem [4]. One of the most important tasks of the new strategy for the development of economic growth adopted by the European Commission (EC) at the end of 2019, the so-called European Green Deal, is to work towards a clean circular economy (CE). The European Commission recommends actions to be taken in the coming years, with a strong emphasis on the implementation of the principles of sustainable development [5,6]. Sustainable development allows us to meet the needs of the present generations without limiting the possibilities of the future. This is a global issue, but acting locally is also important, and Polish scouts should be concerned. For example, they can reduce their negative impact on the environment by removing plastic bottles during their camps.

During this study, we applied engineering knowledge to the pilot scheme and provided water to the scout camp without harming nature. To achieve the goal in summer 2019 we performed an analysis of water in the forest of Nowa Brda and the nearby settlement. The quality of drinking water is the subject of interest of authorities at all levels [7]. The best-known and most credible organization making recommendations on water quality is the World Health Organization (WHO). The WHO, since 2000, has recommended a comprehensive approach to water quality management and the care of water safety. In the past, the ordinance on water quality was only about monitoring the endpoint of the water supply. Now, these recommendations are based on risk analysis at every stage of the water supply process [8]. To meet the guidelines of the WHO recommendations, in 2020, the European Union adopted a new directive on the quality of water intended for human consumption [9]. The purpose of the directive is to protect human health. This protection should be at the same level in every European country. It means that every country, a member of the EU, has to agree with this directive and follow the recommendations of the WHO as well. In Poland, there is a Regulation by the Minister of Health on the quality of water intended for human consumption. According to this document, water is safe to use if it is free from pathogenic microorganisms and parasites in number that pose a potential risk to human health and if any substances in its concentrations represent a potential risk to human health or show aggressive corrosive properties. Concentrations of these components should not be risky for humans.

The microbiological requirements are presented in Table 1. The requirements for organoleptic and physicochemical parameters are stated in Table 2 [10].

According to the Polish Ministry of Health Regulation [9], a water sample (100 mL) should not contain any Escherichia coli or Enterococcus bacteria (Table 1) due to the risk of epidemy.

Table 1
Selected water microbiological requirements for water quality in Poland [10]

Parameter	Parametric value	
	Number of microorganisms (CFU)	Sample volume (mL)
Escherichia coli	0	100
Enterococcus	0	100

Table 2
Selected organoleptic and physico-chemical requirements for water quality in Poland [10]

Parameter	Parametric value
Ammonium ion, mg/L	0.50
Color, TCU	Acceptable for consumers and without abnormal changes
Chlorides, mg/L	250
Manganese, μg/L	50
Turbidity, recommended value range of up to 1.0 NTU	Acceptable for consumers and without abnormal changes
Concentration of hydrogen ions (pH)	6.5–9.5
Conductivity, μS/cm	2,500
Taste	Acceptable for consumers and without abnormal changes
Sodium, mg/L	200
COD ($KMnO_4$), mg·O_2/L	5.0
Odour	Acceptable for consumers and without abnormal changes
Iron, μg/L	200

A water sample should have color, turbidity, taste, and odour acceptable to consumers.

In this publication, based on the example of a summer scout camp in Nowa Brda on Babinka Lake, the solution will be presented on how to provide water to 50 people in a water-balanced manner. Babinka Lake is a small lake located near the town of Nowa Brda (Fig. 1). The intimate location among forests makes it possible to spend time there pleasantly, which is why the scouts chose it as the perfect place to organize a scout camp in accordance with the principles of sustainable development. The area of Babinka is only 2 ha, and the maximum depth does not exceed 3 m. The bottom is mostly covered with silt, creating an ideal environment for ropes and crucians [11].

2. Materials and methods

The water samples for analysis were collected on Babinka Lake and at the water intake point in the settlement close to the camp. Water samples were collected in 300 mL sterile bottles. Immediately after collection, the following water analysis was determined according to standard methods [13]: alkalinity, dissolved oxygen concentration, pH and temperature.

After the transport of the samples to the laboratory, the chemical oxygen demand (COD) with $KMnO_4$, total organic carbon (TOC), total hardness, turbidity, selected heavy metal concentrations and the total number of psychrophilic bacteria (22°C) and mesophilic bacteria (36°C) were determined. The number of psychrophilic bacteria was counted after their inoculation and growth on enriched agar (HPC Method). For TOC measurements, a TOC/TN multi-NC 3100 (Analytik Jena, Swiss) was used. The carbon content was determined by thermocatalytic decomposition of the water sample in the presence of an N/C catalyst at 800°C with synthetic air as carrier gas. The chemical oxygen demand (COD_{KMnO4}) was determined using the acid permanganate method according to the Polish standard PN-C-04578-02:1985. Heavy metal determination was performed with the use of the Shimadzu AA-7000 atomic absorption spectrophotometer equipped with the ASC-7000 autosampler. The samples were pre-prepared by acidifying with pure concentrated nitric acid in the proportion of 200 μL of acid per 100 mL of water sample. Each water analysis was repeated three times.

3. Results and discussion

The safety of drinking water is a major issue around the world. Groundwater is mainly contaminated by iron and manganese compounds, although other contaminants such as ammonium, nitrate compounds, as well as heavy metals and organic matter, are also noted [14]. In many regions of Poland and other countries, groundwater quality is very good. Often, tertiary water is suitable for direct human consumption. When organizing summer camps according to the principles of sustainable development, a good solution is to find your own groundwater intake. The chemical composition and the degree of mineralization of the water are influenced by the lithology, depth, and time of the water stay in the rock environment. It should be emphasized that groundwater is usually less polluted than surface water. Experience in the implementation of technological research and knowledge of the physicochemical and bacteriological composition of water allows the development of a simple technology for its purification under field conditions [15–18]. Standard treatment technology for this kind of water is based on aeration and filtration processes [19–21].

During the on-site visit, a well drilled and used by fishermen was found and launched in the field. Unfortunately, its efficiency and water quality were not sufficient to

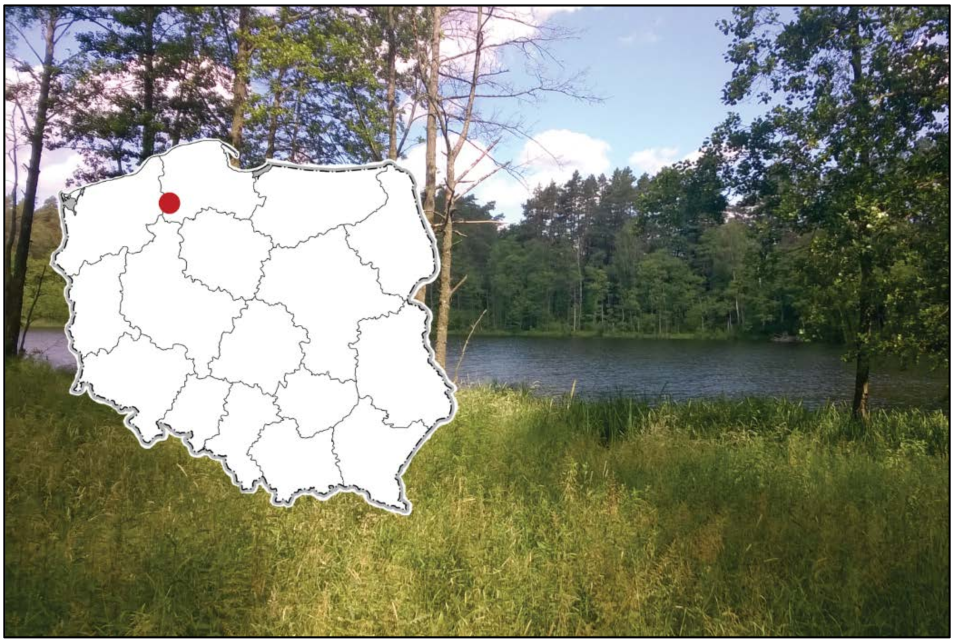

Fig. 1. Location of the scout camp in Kaszuby, Poland (map from (12), photo by A. Pruss).

provide drinking water for 50 participants of the scout camp (Fig. 2). Therefore, several new wells were made, however, no drinking water was found in either of them.

To provide water during the scout camp, we built a water supply system. The system consisted of a water tank (Fig. 3), a water withdrawal point (Fig. 4), and showers (Fig. 5). Water was taken to a drinking water tank (300 l, approved for food purposes) from a water intake point located about 2 km from the camp (Forest District with its own underground water intake). Table 3 presents the physicochemical and bacteriological results of the quality of water taken from a well located approximately 2 km from the site of the planned scout camp. Table 3 presents the results of all performed analyses, even those for which there are no legal regulations in Poland. The water was then disinfected with 1 mL of sodium hypochlorite and transported to the campsite. One tank was sufficient for 2–3 d of consumption.

The quality of the water from the intake point was within the recommendations of the Regulation by the Minister of Health from the 7th of December 2017 [10] on the quality of water intended for human consumption. Some parameters are more important to the health of the water consumer

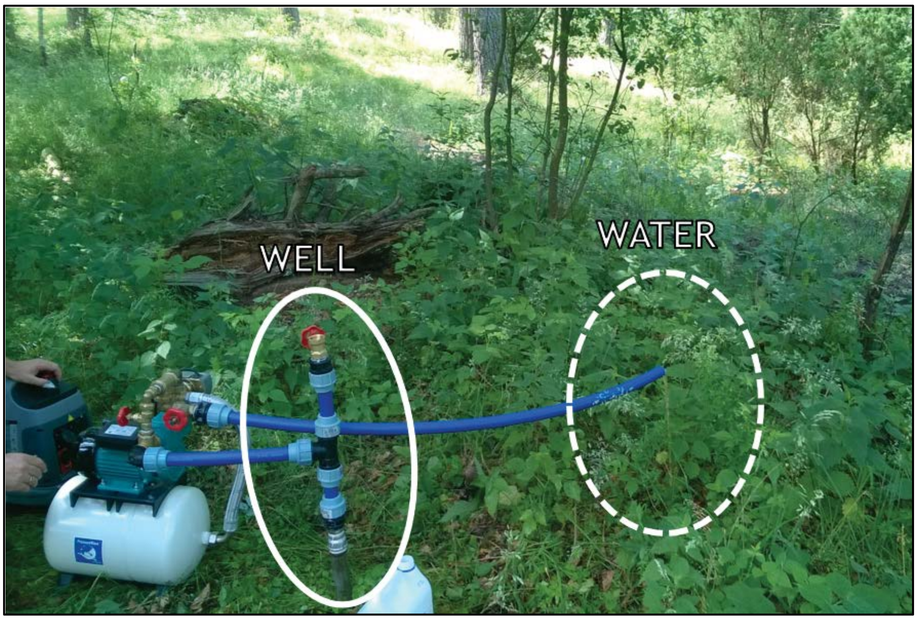

Fig. 2. Pumping of water from the well (photo author A. Pruss).

Fig. 3. Drinking water tank (photo author J. Karolczak).

Fig. 4. Water withdrawal point (photo author J. Karolczak).

Fig. 5. Shower cabin (photo author J. Karolczak).

than others. In this category, we can include calcium and magnesium. Unfortunately, in the water analysed, there is a lack of these components. It can be dangerous to health to drink this water for a long time without calcium and magnesium supplementation. It may cause, for example, weakness of the bone structure [22]. In the case of drinking water during the 2-week scout camp, it would not be a problem.

Bacteriology must be carefully examined during water storage and disinfection should be applied if necessary. It is also worth noting that attention should be paid to the mineralization of water intended for human consumption. For short-term use, the low concentration of calcium and magnesium ions would not harm the participant's health. However, that water came from the intake of local residents who drank it every day. Drinking water with a low mineral concentration for a longer period can have a harmful effect on human health. Calcium and magnesium are essential for the proper development of the organism. These elements are far more easily absorbed from water than from food, and soft water can be much more dangerous to the body than hard water. Research on the effects of demineralised water on the human body has been carried out since

Table 3
Quality of water from the water intake point in settlement

Parameter	Result	Parametric value*
pH	7.91	6.5–9.5
Conductivity, µS/cm	334	2,500
Turbidity, NTU	0.19	<1.0
Alkalinity, mval/L	3.0	–
Total hardness, °n	10.0	
Total hardness, mval/L	3.57	
Total hardness, mg·$CaCO_3$/L	178.5	60–500
Carbonate hardness, °n	8.4	
Carbonate hardness, mval/L	3.0	
Carbonate hardness, mg·$CaCO_3$/L	150	
Calcium, mg·Ca/L	66.3	
Magnesium, mg·Mg/L	3.1	Recommended 7–125
Sodium, mg·Na/L	8.5	200
Potassium, mg·K/L	3.72	
Chlorides, mg·Cl/L	18.0	250
Ammonia, mg·NH_4/L	0.427	0.5
Nitrite, mg·NO_2/L	0.013	
Nitrate, mg·NO_3/L	6.0	50
Iron, mg·Fe/L	0.00	0.2
Manganese, mg·Mn/L	0.011	0.05
COD ($KMnO_4$), mg·O_2/L	2.11	5.0
Bacteriology		
CFU/100 mL	0	0
Mesophilic bacteria (36°C), CFU/1 mL	1	–
Psychrophilic bacteria (22°C), CFU/1 mL	40	It is recommended that the total number of microorganisms do not exceed. - 100 CFU/1 mL of water introduced into the water supply system; - 200 CFU/1 mL on the consumer's tap.

*Regulation by the Minister of Health from the 7th of December 2017 (Journal of Laws of 2017. item 2294) on the quality of water intended for human consumption [10].

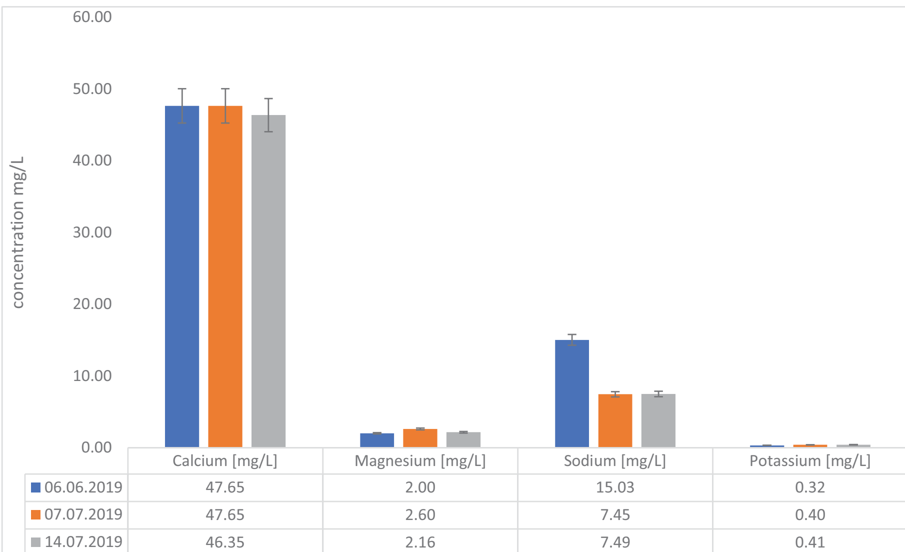

Fig. 6. Average concentration of calcium, magnesium, sodium and potassium in the water from Babinka Lake (mg/L), before the camp started (6.06.2019), after 7 d of camp duration (14.07.2019).

the 1960s, however, advanced filtering techniques have never been as widespread as they are today. Already in the 1970s [23], it was found that the mortality rate from heart disease is 20% higher for people who drink soft water, and the electrolyte-free water intake leads to changes in the composition of the electrolyte stability of the extracellular fluid [24–26]. The relationship between calcium and magnesium content and the risk of cardiovascular disease has been demonstrated by Rylander [22].

Hard water may be healthier than soft water as was confirmed by the example of Georgian residents, who drank hard water and suffered from atherosclerotic disease to a lesser extent and lived to a ripe old age. It was different in Finland, where citizens who drank soft glacial water often became sick and died of heart disease even at a young age. Research conducted in the Netherlands also confirmed the influence of calcium and magnesium in drinking water on cardiovascular disease [27,28]. The minerals contained in the water are absorbed by the body to a considerably greater extent because they are easily absorbed into the digestive tract. Micronutrients in the diet generally occur as poorly soluble and poorly absorbable complexes. The magnesium contained in the water is absorbed 30 times better than that provided in the diet, in addition to food processing, causing a loss of 30%–75% of this element. Significant loss of magnesium and other elements is also related to cooking with soft water [29].

The water for the showers was supplied from Babinka Lake with a pump (Fig. 4). The end of the hose was separated from the platform and the shore so that no dirt could enter the water. When attached to the buoys and bricks, the end of the hose was stable. The shower pump hose was covered with a layer of soil to protect it from damage.

The shower stand was located on the edge of the camping area in the immediate vicinity of the fire lane. Reusable tourist shower cabins were placed on compact pallets, through which water flowed to soak into the ground (Fig. 5).

In Poland, the Regulation by the Minister of Health from the 17th of January 2019 on the supervision of the quality of bathing water and places occasionally used for bathing (Journal of Laws of 2019, item 255) [30] is in force. This legal act takes into account microbiological requirements, additionally, it is recommended to visually monitor the water in terms of the appearance of cyanobacteria bloom or

Table 4
Quality of the water from Babinka Lake

Parameter	Result
pH	8.0
Conductivity, µS/cm	160
Turbidity, NTU	0.82
Alkalinity, mval/L	1.70
Total hardness, °n	4.9
Total hardness, mval/L	1.75
Total hardness, mg·$CaCO_3$/L	87.5
Carbonate hardness, °n	4.76
Carbonate hardness, mval/L	1.70
Carbonate hardness, mg·$CaCO_3$/L	85.0
Calcium, mg·Ca/L	47.646
Magnesium, mg·Mg/L	1.997
Sodium, mg·Na/L	15.030
Potassium, mg·K/L	0.320
Ammonia, mg·NH_4/L	0.392
Nitrite, mg·NO_2/L	0.000
Nitrate, mg·NO_3/L	0.040
Iron, mg·Fe/L	0.299
Manganese, mg Mn/L	0.000
COD ($KMnO_4$), mg·O_2/L	8.02
Nickel, mg·Ni/L	<0.0020
Copper, mg·Cu/L	<0.0030
Cadmium, mg·Cd/L	<0.0002
Lead, mg·Pb/L	<0.0010
Chrome, mg·Cr/L	<0.0010
Bacteriology	
Coliform bacteria, CFU/100 mL	3,720
Mesophilic bacteria (36°C), CFU/1 mL	268
Psychrophilic bacteria (22°C), CFU/1 mL	396

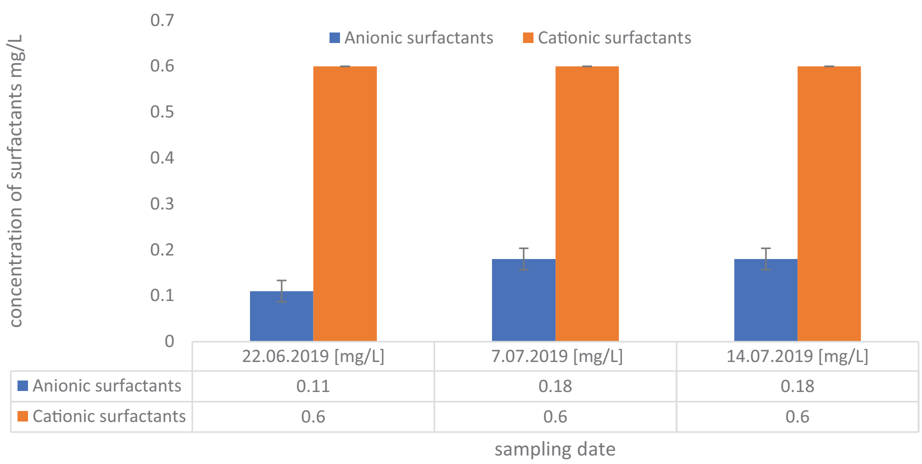

Fig. 7. Average concentration of anionic and cationic surfactants in the water from Babinka Lake (mg/L).

incidental water contamination, for example, tarry materials, glass, plastics, etc.

Table 4 presents the results of the physicochemical and bacteriological analyses of the water taken from Babinka Lake. The water analysis of Babinka Lake indicated a very low concentration of all measured parameters. According to the regulations in force in Poland [30] and Europe [31]), the water from the analysed lake could be used for bathing.

During the scout camp, participants did not bathe in the lake and when taking a shower in a shower cabin everyone used biodegradable personal cleaners. Greywater from showers was discharged into the fire lane where they were soaked into the ground. Fig. 6 shows the concentrations of calcium, magnesium, sodium, and potassium in the water collected from Babinka Lake before and during the camp. The results show no significant differences in the concentrations of sodium and potassium, which are the main components of soaps.

Fig. 7 shows the changes in the content of anionic and cationic surfactants in Babinka Lake water before and during the scout camp. No change in the concentration of cationic surfactants was observed, but a slight increase in the concentration of anionic surfactants occurred.

4. Conclusions

Our study proved that it is possible to abandon the use of single-use plastic water containers and other non-eco-friendly solutions during the scout camps and provide a water supply in a more sustainable way. Following this study, organizers can reduce the negative impact on the environment on the campsite. Scouts do not have to use described solutions but also create their own based on the analysis and available resources.

Setting up scout camps close to the lake enables the use of this water body as a source of water like it was performed on Babinka Lake. Its physicochemical and bacteriological quality was sufficient for this purpose, but its preparation for human consumption would require a lot of work related to its treatment. In this case, due to the relatively short period of water consumption (2 weeks), much more profitable was to bring drinking water from the nearest settlement and take care of its microbiological safety. This universal solution has the potential for application to scout camps with various conditions. Assuming the daily demand for water was 1.5 L per participant, 700 bottles of water were not purchased, which significantly decreased the use of plastics during the camp.

Undoubtedly, when organizing subsequent events of this type, the organizer should consider the possibility of reusing water from showers. In the case of traditional campsites or scout cabins, such water could be used, for example, to flush the toilets. In the case of scout camps in the forest, when participants use pit latrines or dry toilets, it would be necessary to come up with another economic application for greywater.

Acknowledgments

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