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THE VALIDITY OF RESERVE PROTECTION REGARDING THE SEEPAGE SPRING AREAS OF THE ŁYNA RIVER FOR TOURISM DEVELOPMENT AND PRESERVATION OF ITS WATER QUALITY

*Katarzyna Parszuto**, *Renata Tandyrak***,
*Jolanta Grochowska****, *Urszula Deleżuch*****

Abstract

Purpose. The assessment of tourist attraction values of the landscape-morphological reserve “Roman Kobendza Springs of Łyna River”, and the quality of water springs reinforcing the river. The current condition of the environment and opportunities for development of tourism within the reserve area was determined.

Method. Field observation (attractiveness of the area, tourist management, educational values) and organic matter analyzes of water springs at selected points were performed. The dissolved (DOC) and suspended (POC) organic carbon content were determined. The quality of DOC was described based on changes in absorption ratios for different wavelengths (UV): 250/365 and 254/203. The Kruskal-Wallis test was used (season effect) and linear correlation coefficients (r) between chemical parameters were determined.

Findings. Landscaping and educational values, and the availability of the reserve throughout the year, are an asset for sightseeing in organized groups (school children), and leisure activities (different age groups, families with children). The morphology of the terrain enables the realization of leisure activities. The water in the area of the reserve is supplied organic material of natural origin (wooded areas). The good quality of water probably results from small number of tourists in this area and the possibilities for self-purification of water.

Research and conclusion limitations. The results of field observations were based on the opinion of a small number of persons.

Practical implications. Updating information about the tourist values, the natural areas and about the importance of monitoring in areas legally protected.

Originality. Quantitative and qualitative research of organic carbon forms in the spring's water of Łyna on the reserve area were never performed.

Type of paper. The article presents the results of empirical research.

Keywords: landscape-morphological reserve, spring, seepage spring areas, tourism, recreation, organic matter.

* Ph.D. Eng., University of Warmia and Mazury in Olsztyn, Faculty of Environmental Sciences, Department of Water Protection Engineering; e-mail: kasiapar@uwm.edu.pl

** Ph.D. Eng., University of Warmia and Mazury in Olsztyn, Faculty of Environmental Sciences Department of Water Protection Engineering; e-mail: renatat@uwm.edu.pl

*** Assoc. Prof., University of Warmia and Mazury in Olsztyn, Faculty of Environmental Sciences, Department of Water Protection Engineering; e-mail: jgroch@uwm.edu.pl

**** M.Sc. Eng., University of Warmia and Mazury in Olsztyn, Faculty of Environmental Sciences, Department of Water Protection Engineering; e-mail: uladelezuch@gmail.com

Introduction and literature review

A biosphere reserve – nature reserves, landscape parks and national parks are the forms of natural and landscape protection [Glińska-Lewczuk et al. 2014; Kistowski 2010; Lee 2013; Pawlaczyk 2010; Sender et al. 2014] and cultural values of the particular area [Kistowski 2008], but also fulfil tourist, recreational or medical functions [Górna 2013; Kulesza, Czocho 2007; Newsome 2013].

Protected landscape areas often have many conditions for local, regional and countrywide tourism development. The factors determining the development of regional tourism have been divided into four groups:

- 1) traditional elements of tourist attractions,
- 2) elements of territorial marketing,
- 3) elements of technical infrastructure,
- 4) socio-economic, cultural and political conditions (institutional infrastructure) and ecological conditions [Butowski 2010].

The seepage spring areas are the regions very valuable in terms of ecological and landscape aspects, and therefore, also as a tourist attraction [Girjatowicz 2013]. They are covered by various types of protection due to the presence of unique and often endangered species of fauna and flora. In addition, these areas are protected in order to preserve the geomorphological features of these regions [Mertzanis et al. 2016; Okoń, Rózkowski 2010], and their cognitive values [Baścik, Partyka 2011].

In Poland, the most important seepage spring areas belong to the Carpathians and the Sudetes, where the beginnings of the main rivers of our country are situated: the Vistula, Odra, Elbe, the middle tributaries of Danube. Another important seepage spring area is Minor Poland, where we may find the springs of Warta, Przemsza and Pilica rivers.

The springs in the lake regions are mainly located on the slopes of the river valleys [Puk 2005]. They may flow at the foot of the slopes, and then penetrate into the bottom of the valley and supply alluvial waters. One of the examples of reserve protection of springs in Poland is “The Reserve of the Springs of Tanew River” (186.54 ha) located in Lubaczów county, in Narol. It was created in 1998. This is a type of forest reserve, where in addition to the springs, the whole vegetation is also protected [Rechulicz et al. 2009]. Another reserve is located in Tuchola Forest District and is called “The Springs of Stążka River” (250.12 ha). The reserve has a high degree of naturalness. As in the previous cases, both springs of the river (spring niches) and the vegetation are under the protection. The springs of Stążka river were declared a monument of nature [Dysarz et al. 1999].

Changes of resources and water quality are associated with many factors. The most important should be associated with contamination related to the development of agriculture [Galas 2005], industry and tourism

[Lee 2013], climate changes [Bartosz et al. 2012; Frydel, Miler 2014; Jasik, Małek 2013], as well mismanagement of water resources [Sołtys-Lelek et al. 2010]. A major threat to the seepage spring areas is the contamination of soil and lowering the phreatic zone as a result of land transformation by humans [Baścik, Partyka 2011; Michalik 2008]. As a consequence of such actions, the changes occur in the degree of meteoric water infiltration. It may even result in cutting off the flow of the water supplying the springs. Thus, a seepage spring area is connected with the conservation of the resource quality and quantity of this type of water [Sołtys-Lelek et al. 2010]. This can be done through the creation of parks and nature reserves, one of the aims being preservation of biodiversity in the area of natural regions [Dysarz et al. 1999]. Natural values are also one of the elements attracting tourists [Bielinis et al. 2015; Mazurek et al. 2010; Mertzanis et al. 2016; Newsome 2013]. However, it is important to balance the objectives pursued in such areas where the development of tourism should go hand in hand with preserving natural values. Therefore, people who explore the protected areas should have high environmental awareness [Kistowski 2010; Kulesza, Czoch 2007; Niezgodą 2011].

Coordinated protection of such sites gives the chance to leave this unique environment in its natural state [Imran et al. 2014]. Therefore, an important task for the units managing the protected area with tourism potential is its monitoring [Chełmicki et al. 2010; Wiśnios et al. 2015]. Such areas include the “Roman Kobendza Springs of Łyna River” landscape-morphological reserve. This reserve is transformed by man for tourism. The authors subjected the values of the tourist attractions in this area and the quality of water springs located there to assessment. These are the springs which reinforce Łyna river. On this basis, the current environmental condition and opportunities for development of tourism in the reserve were specified.

Method

The research was performed three times: in summer (2 July), in early autumn (17 September) of 2015 and in the spring of 2016 (31 March). The observations and chemical tests of seepage spring water at selected points in the area are shown in Fig. 1 which were used as the area for research.

The observations concerned:

- attractiveness of the area (landscape and natural values, availability of the area),
- tourist management: provisions for visitors, trails, parking, viewpoints,
- educational values (cognitive).

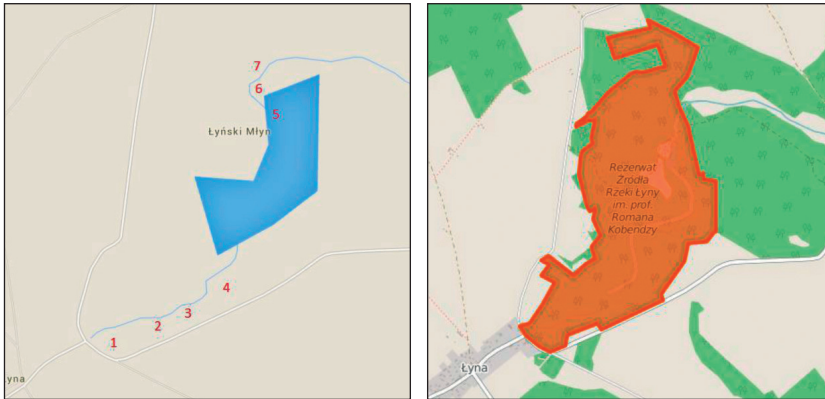


Fig. 1. The area of landscape-morphological reserve "Roman Kobendza Springs of Łyna River" and the sampling points (1-7)

Source: [<https://www.google.com/maps/> (date of access: 09.05.2016); <http://www.openstreetmap.org/> (date of access: 04.05.2016)].

The visual conclusions in the field were based on the perceptual assessment of 4 adults who conducted the research. In addition, the opinions of 30 people, including children and adolescents, who visited the reserve at different times of the year in last three years were considered.

The chemical research was connected with the determination of the organic content in the form of dissolved (DOC) and particulate (POC) organic carbon. The level of DOC (dissolved organic carbon) indicates contamination of organic matter of anthropogenic origin [Piiroo et al. 2012].

In order to separate the particulate and dissolved organic carbon, a membrane filter with a pore size of $0.45 \mu\text{m}$ (rinsed with 250 ml of deionized water) was used. The content of POC (particulate organic carbon) was calculated from the difference between the concentration of the total (TOC) and dissolved (DOC) organic carbon. The concentration of DOC and TOC ($\text{mg C}/\text{dm}^3$) was determined using the IL 550 TOC-TN by HACH company analyser [Polska Norma: PN-EN 1484:1999].

In addition, the evaluation of qualitative changes of organic matter was performed, and on this basis, its origins in the waters of the springs were investigated. Qualitative studies were based on absorption spectra analysis of the compounds of DOC within the range of UV radiation (spectrophotometer SHIMADZU UV-1601PC). Absorption coefficients were determined for selected wavelengths: 250/365 and 254/203. By observing the dynamics of these coefficients, one can determine the structure of DOC molecule compounds and describe their properties [Barreto et al. 2003; Głazewski, Parszuto 2002; Głazewski, Wiśniewski 2008].

Water chemistry data was statistically analysed. Analysis of variance (program Statistica 12.5) using the Kruskal-Wallis test (distribution of test

value is not normal distribution) was performed in order to check whether there are differences between the mean values of parameters of qualitative and quantitative analysis in the subsequent samplings (summer, fall, spring). In order to explain the reasons for the variability of parameters, the relationships between them were checked – linear correlation coefficients (r) (Excel) were determined.

Area of research

Łyna river has its course in the following counties: Nidzica, Olsztyn, Bartoszyce and Lidzbark Warmiński and flows into Pregel in Kaliningrad Oblast [Kondracki 1994]. Mainly it flows through the ribbon lakes, and the biggest of them has an area of 10.5 km². Łyna basin has an area of approximately 7,126 km². This river is very volatile. Fragmentarily, it flows very slowly, while sometimes flowing like a mountain stream. The width of Łyna valley varies from a few meters to even up to 5 km. In Olsztyn, the river flows through the Las Warmiński reserve. Also, the „Łyna” power plant is located by it in Olsztyn. Łyna river is a major attraction because of canoeing, which is organized on it.

In order to protect backward erosion (retreating slope), which is a very rare phenomenon in the lowlands and to keep the seepage spring area of the Łyna river, the landscape and morphological reserve was established and is under the name of Prof. Roman Kobendza. Underground water leaking in the form of a spring leaches rock material. This results in regression of the land, forming semicircular niches while the river extends [Nawrot 2009].

The reserve covers an area of 121 hectares [Zarządzenie Ministra Leśnictwa i Przemysłu Drzewnego z dnia 20 października 1959 r. w sprawie uznania za rezerwat przyrody, M.P. 1959 nr 90 poz. 489 – Ordinance of the Minister of Forestry and Wood Industry of October 20, 1959 regarding recognition as a nature reserve MN 1959 No. 90 Item 489: <http://isap.sejm.gov.pl/DetailsServlet?id=WMP19590900489>; Rejestr rezerwatów przyrody województwa warmińsko-mazurskiego – Registry of warmińsko-mazurskie voivodeship nature reserve: http://bip.uw.olsztyn.pl/pl/bip/urzed_wojewodzki/wydzialy_i_delegatury/wydzialy/wydzial_srodowiska_i_rolnictwa/wykazy_i_rejestry_dostepne_w_wydziale/px_rejestr_rezerwaty_przyrody.pdf]. It is located near the villages Łyna and Orłowo in Nidzica county.

The area of the reserve is covered by mixed forest. According to information received from the forest district Nidzica, there is pedunculate oak, Norway maple, common hornbeam, silver birch, aspen, Scots pine and Norway spruce. The soils in the area of the reserve are podzoluvisols, arenosols and brown earth. They are situated on the post-glacial layers, which consist of dumping and fluvioglacial parts. They are placed on a layer of tertiary loams.

The streams penetrating the sandy material of the glacial moraines run down the impermeable loams, creating exudative springs. The reserve is situated in the broad valley with many slopes, gullies and valleys with steep and high slopes. The springs flow out of the slope closing the main valley.

The objects of chemistry research were the springs and water of Łyna in a nature reserve. Dozens of springs located in this area are exudative. They flow out from semicircular spring niches (valley circuses). They connect to a common outflow giving rise to the biggest river in the Warmian-Masurian Voivodeship. J.P. Girjatowicz [2013] reports that the water flows out from the outwash sands on the ground of impermeable Miocene loams at the foot of the terminal moraine at the height of 155 m above sea level. The helocrenes are among the most common springs of Łyna. They are characterized by an extensive erosion cirque. The heloreocrene and boggy springs are less common. The most common are rapidly flowing streams with sandy or stony bottoms.

The water samples were taken from seven points in the reserve area, into polyethylene bottles.

At the first position [Fig. 2] in spring, due to the small amount of water, there was no possibility of its sampling. Its terrain is covered with a small number of trees, which for unknown reasons, had broken branches and some were overturned. The area was poor in vegetation.



Fig. 2. The first sampling position – March 2016 (photo: Deleżuch)

The second position in summer was varied by growing grasses and other vegetation [Fig. 3]. Although the area was not dry, the vegetation could be seen only at the spring. In early spring, it was completely dry and damaged.



Fig. 3. The second sampling position – July 2015 (photo: Tandyrak)

The third position [Fig. 4] was an area transformed by humans. A small bridge for tourist purposes was built there. The area was very wet. The bottom of the spring was constituted by sand, water flows down a number of stones, which are already visibly overgrown in early spring.



Fig. 4. The third sampling position – March 2016 (photo: Parszuto)

At the fourth position, closer to the point of sampling, both in summer and spring the water flowed down a narrow stream, it was very muddy,

making it difficult to obtain a representative sample. The area was erected by numerous pebbles and it was possible to find large quantities of fragments of branches [Fig. 5].

The fifth position [Fig. 6] was characterized by a large number of fallen trees and fragments of broken branches, as well as rotten vegetation. The area was very vast.



Fig. 5. The fourth sampling position – March 2016 (photo: Deleżuch)



Fig. 6. The fifth sampling position – March 2016 (photo: Parszuto)

The sixth position [Fig. 7] was a marsh of the river in which the water is collected by backpressure located in front of the mill. It was surrounded by overgrown with trees, so when the leaves fall, it is polluted by them. Nearby, there were a few buildings and a road for cars.

The last – seventh point of sampling, was located by the former mill, below the marsh. Water flows with powerful current, due to the difference in height and slope of the land and change the shape of a river bed. It was, therefore, well oxygenated [Fig. 8].



Fig. 7. The sixth sampling position – March 2016 (photo: Parszuto)



Fig. 8. A view of the seventh position, and the area between positions 6 and 7 – March 2016 (photo: Parszuto)

Results of field observation

The area covered by the study was characterized by a great diversity of morphology of the terrain. Overcoming differences in height forced more intensive effort. Along the sampling points, a yellow tourist trail was marked. The springs, for their protection, were separated by railings made of tree trunks, which was also a facilitation for visitors while also increasing their safety. In order to get closer, wooden walkways and bridges were placed [Fig. 9].

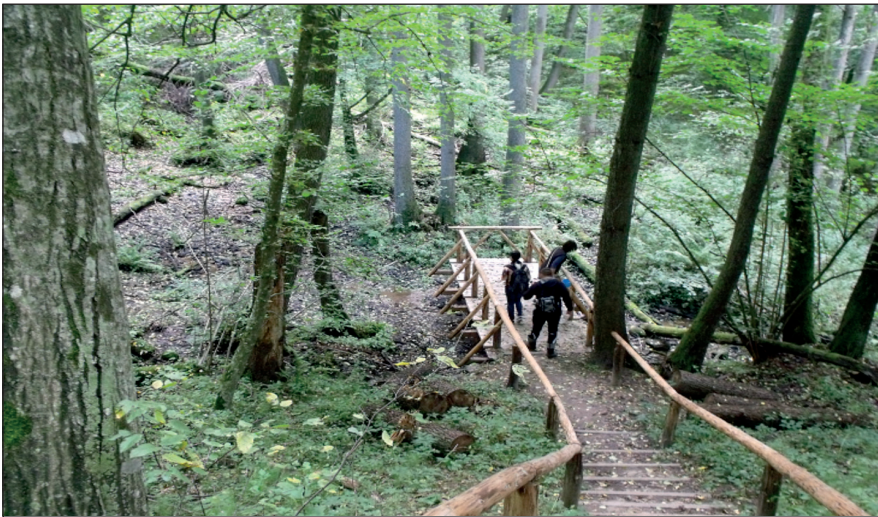


Fig. 9. The wooden walkways and bridge (photo: Parszuto)

On the trail, there were benches, as well as the designated points of rest with a place where people could dine (table and wooden benches). The place was secured by garbage waste bins. On the way, information boards on the protection of the area were placed. The route of the trail enabled admiration of a variety of the landscape and nature values. These are wetlands with fallen trees and slopes of valleys in the upper parts covered with trees and low vegetation in the lower parts, depending on the season. In addition, an amazing impression was created by the slopes of the valleys with leaking seepage springs and the streams, which were formed by merging of leaking water (with the noise of the streams). Clean water encouraged to drink it (water can be easily taken being on the bridges). The peace and quiet was special, and in the afternoon during the off-season – there was lack of visitors. Hence, there was an opportunity to observe the fauna: woodpeckers, deer or rodents. The air was crisp due to the presence of forest areas and the lack of pollutants from vehicle exhaust. The reserve is

located about 1 km from the local road. Parking was about approx. 0.5 km away from the last of the sampling points (10 minutes walking distance). On the parking lot's information board, there was a description of the reservation's area as well as designated trails on the map (blue and yellow).

Results of chemical research

In the spring, the highest values of DOC were found at position 5 (Tab. 1). During the summer, the highest content of this fraction was observed at position 6, and in fall, at position 7. The lowest concentration of DOC occurred at position 2 (spring, summer) and 3 (autumn). The obtained data show that the highest mean concentration of dissolved organic carbon occurred at the 6th position (Tab. 1).

In most cases, higher concentrations of POC fractions were observed in the summer. At 7th position, there was no occurrence of suspension $>0.45 \mu\text{m}$. The average POC content was highest for the 1st and 6th positions (Tab. 1).

Tab. 1. The content of DOC and POC, taking into account the seasons in the tested waters in the landscape-morphological reserve "Roman Kobendza Springs of Łyna River"

Position	DOC [mg C/dm ³]			POC [mg C/dm ³]		
	Spring	Summer	Autumn	Spring	Summer	Autumn
Position 1	lack	1.33	1.19	lack	0.70	0.24
Position 2	1.36	1.10	1.59	not found	0.58	not found
Position 3	1.92	1.17	1.04	0.08	not found	0.31
Position 4	1.46	1.49	1.59	not found	0.69	not found
Position 5	2.22	1.52	1.65	0.41	not found	not found
Position 6	1.72	2.23	2.29	not found	0.60	0.49
Position 7	1.54	1.74	2.55	not found	not found	not found
Average:	1.70	1.51	1.70	0.25	0.64	0.35

Source: Authors' own research.

The highest quotient of 254/203 absorption occurred in autumn at station 4, the lowest – in the summer at position 1 (Tab. 2). In the case of the 250/365 ratio, the highest value obtained in spring was at position 3, and the lowest – in summer at position 2 (Tab. 2).

The highest average 254/203 absorption ratio occurred at the 4th position, and the largest quotient of 250/365 at the 3rd. At the other sites, values for both parameters were lower and did not change over a wide range (Tab. 2).

Tab. 2. The values of 254/203 and 250/365 ratio, taking into account the seasons in the tested waters in the landscape-morphological reserve “Roman Kobendza Springs of Łyna River”

Position	254/203			250/365		
	Spring	Summer	Autumn	Spring	Summer	Autumn
Position 1	lack	0.0073	0.0097	lack	4.72	8.53
Position 2	0.0121	0.0082	0,0118	7.87	3.37	9.79
Position 3	0.0093	0.0091	0,0099	41.14	4.30	12.15
Position 4	0.1574	0.1809	0.1926	11.18	3.80	5.99
Position 5	0.0180	0.0153	0.0342	9.87	4.53	3.66
Position 6	0.0188	0.0196	0.0281	10.46	4.83	5.56
Position 7	0.1760	0.0167	0.0290	11.09	4.50	5.07
Average:	0.0653	0.0367	0.0450	15.27	4.29	7.25

Source: Authors' own research.

Analysis of correlation coefficients (Tab. 3) showed that changes in the concentration of DOC and POC are not significantly dependent on each other. The 254/203 quotient decreased, while the value of the absorbance measured at a wavelength of 203 nm increased. Similarly, the absorbance value measured at a wavelength of 365 nm increased while the ratio of 250/365 decreased.

Tab. 3. The linear correlation coefficients (r)

DOC and POC (n=9)	254/203 and 254 (n=20)	254/20 and 203 (n=20)	250/365 and 250 (n=20)	250/365 and 365 (n=20)
-0.02009	0.193063	-0.93475	-0.21897	-0.53604
insignificant	insignificant	p=0.01	insignificant	p=0.02

Source: Authors' own research.

Analysis of variance (the Kruskal-Wallis test) did not confirm the differences between mean concentrations of DOC and POC depending on the season (Tab. 4). Average values of the 254/203 ratio did not differ significantly in subsequent samplings as well. In contrast, there were significant differences in the mean values of the 250/365 ratio between samples in spring and summer.

Tab. 4. Analysis of variance (the Kruskal-Wallis test) for parameters: DOC, POC, and 254/203 and 250/365 absorption quotients

	Kruskal-Wallis test: H (2, n=20)=1.150525, p=0.5626		
DOC	July	September	March
July		1.000000	1.000000
September	1.000000		1.000000
March	1.000000	1.000000	
POC	Kruskal-Wallis test: H (2, n=9)=6.111111, p=0.0471		
July		1.992048	2.108185
September	1.992048		0.333333
March	2.108185	0.333333	
254/203	Kruskal-Wallis test: H (2, n=20)=0.4884593, p=0.7833		
July		1.000000	1.000000
September	1.000000		1.000000
March	1.000000	1.000000	
250/365	Kruskal-Wallis test: H (2, n=20)=12.28435, p=0.0022		
July		0.140529	0.001467
September	0.140529		0.344400
March	0.001467	0.344400	

Source: Author's work based on the survey report.

Discussion

The “Roman Kobendza Springs of Łyna River” reserve is part of two areas of Natura 2000. This is a Special Protection Area (SPA) for birds and Special Area of Habitat Conservation (Napiwodzko-Ramucka Forest). Dilemma: to protect or to share places of outstanding natural beauty and landscape? – this is a problem frequently encountered in other attractive tourist protected areas [Kulesza, Czoch 2007].

Major landscape values of “Roman Kobendza Springs of Łyna River” reserve encourage recreation and leisure, both individually and in the groups. There is sufficient information on the trail allowing to extend the knowledge on the importance of protecting birds and reverse erosion occurring in the area. Reverse erosion is rare in lowland areas. Therefore, a person exploring the reserve can also take advantage of staying for educational purpose. Particularly great cognitive values of the reserve should attract groups of children and young people who, through the course of nature, biology or geography, could use such a trip for educational purposes. Similar projects are

implemented in the case of such areas as Wigry National Landscape in the vicinity of Wigry Lake [http://www.wigry.org.pl/jeziora/jeziora_pl.htm].

Cognitive values of the reserve and landscape invite you to visit this place at any time of the year [Kosiński et al. 2013]. Research by L. Bielinis et al. [2015] on the tourist, recreational and nature attractiveness of Olsztyn and its surroundings demonstrated that “Roman Kobendza Springs of Łyna River” reserve stood out among the natural values in the so-called “other” group. The fact that relatively few parks and reserves were distinguished as natural attractions may indicate insufficient promotion of such areas among residents and tourists [Butowski 2010; Głąbiński 2015; Karbowski 2008]. This may also arise from the fact that getting to the reserve requires one’s own transportation. The main road Olsztyn-Warszawa did not contain information about the possibility to visit the surroundings of the protected area, it included only information about the location of the Łyna river springs. Hence, people living far away are forced to obtain information on the subject from other sources, such as thematic websites [<http://www.museo.pl/content/view/1337/461/>] or guidebooks.

The great advantage of the studied reserve, when it comes to using it for tourism or recreation, apart from contact with nature, is the possibility of implementing active recreation. Such a trip could be interesting for people of all ages. This kind of attraction in the area of the reserve can be used for families with children [Kowalczyk-Anioł, Włodarczyk 2011], school trips [Sadoń-Osowiecka 2010], conference participants in the vicinity of Olsztyn, and seniors. In addition, supplying steeper climbs with barriers makes it easier to explore for those who are less physically fit and need time and places to stop and rest during the hike. Other attractions for tourists could be: cycling, Nordic walking, trekking, and possibly backpacking.

However, the increase in the number of the pedestrian tourists is associated with an increase in noise, littering, destroying the structure and soil pollution [Mertzanis et al. 2016], destruction of vegetation, pollution and a biodiversity decline of water [Baścik et al. 2011; Sołtys-Lelek et al. 2010]. The vision in the field and chemical testing of water springs did not reveal the severity of these adverse events in the area of the tested reserve. Only during the summer, an increased amount of waste in a place designated for rest (near the tables and wooden benches) was observed. Unfortunately, there were also glass bottles lying next to the garbage bins, which were dangerous for those trekking on the trail.

The authors subjected the water of the Łyna river springs in the area of the reserve to content and the quality of organic matter testing. In this way, it was possible to determine the condition of the aquatic environment and to evaluate the possible pressure of tourism in the area.

Quantitative and qualitative research on organic matter of the reserve water confirmed that the anthropogenic influence is small. Typically, in

the groundwater, concentrations of organic matter ranges from 0.2 to 20 mg C/dm³. Higher concentrations may result either from natural causes, such as water contact with coal seams or the impact of peatlands and anthropogenic influence [Kiryluk 2006]. High concentrations of DOC are usually associated with an increase in the share of so-called humic substances (HS), which are a fraction not easily degradable [Filip, Demnerova 2007; Purmalis, Klavins 2013]. In the tested water of seepage spring areas of the reserve, DOC concentrations were low. A similar and low variability of DOC was noted by E. Jekatierynczyk-Rudczyk, P. Zieliński and A. Górniak [2006] in the forest seepage spring area of Krzemianka river. A similar level of DOC was recorded in springs (seepage type) in north Poland surroundings of Lębork [Górniak, Pietryczuk 2015]. TOC export was calculated in the catchment for Szeszupa River covering the Natura 2000 area [Górniak 2016]. On this basis, it was found that the higher export occurs in the catchment with agricultural management. Low concentrations of DOC (as well as POC) in the investigated reserve of Łyna river indicate that organic matter does not constitute a pollution threat to this water. Since there were no differences in average concentrations of POC and DOC in the subsequent samplings, it is believed that in the studied aquatic ecosystem, no mechanisms of recycling organic matter were violated.

In the springs of Łyna river, the qualitative changes in DOC related to the season were verified. This means that changes in the quality of water springs depend on the biological activity of the basin [Wolanin 2014]. As a result of changes in the pace of mineralization of both POC and DOC, the participation of compounds which are more or less easily biodegradable changed [Dunalska et al. 2006; Sebestyen et al. 2009].

Testing changes in absorption coefficient 250/365 allows checking the variability of molecular weight of organic compounds among DOC. When the values increase, this means that the share of the compounds of lower molecular weight, which are usually less easily degradable, also increase [Piiroo et al. 2012]. In water testing within the area of the Łyna river reserve, it was shown that a significant increase in the share of such compounds in DOC took place in the spring [Kothawala et al. 2015].

In turn, the coefficient of 254/203 absorption expresses the ratio of the aromaticities to aliphatic carbon atoms in the molecule of the organic compound [Głazewski, Wiśniewski 2008]. This parameter did not change significantly in subsequent samplings. Its values indicate that the aromaticities have the largest share of the DOC fraction in the water within the area of the reserve.

Determination of absorption coefficients 250/365 and 254/203 confirmed that the water in the reserve is supplied by organic matter of natural origin. This is related to afforestation of the area. The fact that falling

leaves and branches as well as limbs had contact with the tested water can be a source of both DOC and POC [Allan 1998].

It was not researched whether the water quality of Łyna springs was correlated with the number of visitors. However, it can be assumed that the naturalness of the water springs was connected with both the possibility of self-purification of water, and with low tourist loading. In the case of increasing the number of tourists, such research should be conducted, i.e. tourist absorbency [Butowski 2014].

J. Karczmarek, A. Stasiak and B. Włodarczyk [2002] give examples of features for tourist products, which are the natural areas of reserves and landscape parks (type of tourist product – the place or tourist track): tourist valour, tourist infrastructure, tourist equipment, new experiences, impressions, emotions, weather. In the case of the investigated “Roman Kobendza Springs of Łyna River” landscape-morphological reserve, we can observe a few features for such tourist products. Many elements conducive to the development of this area as a potential tourism product were given above. The first and most important are the surroundings’ characteristics and tourist qualities – naturalness [Mitura 2010]. Lewandowski [2010] threads that spring areas are important for ecotourism development due to terms of sound (rustling of the grass and trees, birds, insects, water). The development of the “Springs of Łyna River” reserve as tourist product can have several effects. On the one hand, it can improve local economy [Butowski 2010]. However, for this reason, gastronomy, accommodation facilities, car parks and other facilities connected with service for many people should be developed. In addition, the promotion of this area should be expanded (popular-science publications, brochures, maps, guides, organization of trips for journalists and teachers, educational and promotional events – tourist fairs, TV commercials – targeted at different age groups). This requires action in many scopes and close cooperation with the local community. The lack of promotion is the most significant weakness for local tourism. It was confirmed – pro-ecological actions make influence on the formation of tourist product [Niezgoda 2011]. An increase in the number of visitors would incur additional costs associated with the continuous monitoring of the biosphere. Actually, the investigated area of the “Roman Kobendza Springs of Łyna River” reserve is not set to receive a large number of tourists for logistical reasons. The tourist capacity that would not be detrimental to the environment of this area should be determined.

Conclusions

The authors put forward the following observations. It was demonstrated that the tested water springs of Łyna show no anthropogenic changes.

Field observation and chemical testing of the water indicated that the area of the “Roman Kobendza Springs of Łyna River” reserve is not greatly altered by man, despite the adaptation of the area to be used for tourism and recreational purposes. Tourism use does not threaten the protection of Natura 2000 areas. Preserving good quality of water mainly results from the small number of tourists in this area. The problem: to protect or to share?, currently, this is not the case. These are valuable natural areas with high cognitive and educational value, which also provide aesthetic experience for visitors. Therefore, forms of ecotourism can be successfully implemented - that is environmentally friendly visiting [Beaumont 2011; Kulesza, Czoch 2007; Mertzanis et al. 2016; Niezgodna 2011].

The presented preliminary case study on the springs of the Łyna river is confirmation of the validity of reserve protection of such areas. The development of tourism connected with this area is moderate and in line with the principles of sustainable development [Jaremen, Turakiewicz 2009]. Therefore, the projects related to the promotion and increase in number of visitors to the landscape park must go hand in hand with public education concerning the principles of behaviour regarding the use of this type of natural values and their protection.

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ZASADNOŚĆ OCHRONY REZERWATOWEJ OBSZARU ŹRÓDLISKOWEGO RZEKI ŁYNY DLA ROZWOJU TURYSTYKI I ZACHOWANIA JAKOŚCI JEJ WÓD

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Abstrakt

Cel. Ocena walorów turystycznych rezerwatu krajobrazowo-morfologicznego „Źródła Rzeki Łyny” im. prof. Romana Kobendzy oraz jakości wód źródlisk zasilających rzekę. Określenie aktualnego stanu środowiska i możliwości rozwoju turystyki na terenie rezerwatu.

Metoda. Wykonano obserwacje terenowe (atrakcyjność terenu, zagospodarowanie turystyczne, wartości edukacyjne) oraz badania materii organicznej wód źródlisk w wybranych punktach. Określono zawartość rozpuszczonego (DOC) i zawiesinowego (POC) węgla organicznego. Jakość DOC opisano na podstawie zmian ilorazów absorpcji dla różnych długości fal (UV): 250/365 oraz 254/203. Wyznaczono test Kruskala-Wallisa (wpływ pory roku) i współczynniki korelacji liniowej (r) między parametrami chemicznymi.

Wyniki. Walory krajobrazowe i edukacyjne oraz dostępność rezerwatu w ciągu całego roku są atutem dla zwiedzania w grupach zorganizowanych (młodzież szkolna), a także spędzania czasu wolnego (różne grupy wiekowe, rodziny z dziećmi). Morfologia terenu umożliwia realizację form aktywnego wypoczynku. Do wód na obszarze rezerwatu dostarczana jest materia organiczna pochodzenia naturalnego (obszary zalesione). Zachowanie dobrej jakości wody wynika prawdopodobnie z niezbyt dużego obciążenia turystycznego tego obszaru i ze zdolności wód do samooczyszczania.

Ograniczenia badań i wnioski. Wyniki obserwacji terenowych oparto na opinii niewielkiej liczby osób.

Implikacje praktyczne. Aktualizacja informacji o walorach turystycznych obszarów cennych przyrodniczo i znaczeniu monitoringu na obszarach prawnie chronionych.

Oryginalność. Badania ilościowe i jakościowe form węgla organicznego w wodach źródeł Łyny na obszarze rezerwatu nie były nigdy wykonywane.

Rodzaj pracy. Artykuł prezentuje wyniki badań empirycznych.

Słowa kluczowe: rezerwat krajobrazowo-morfologiczny, źródło, obszary źródliskowe, turystyka, rekreacja, materia organiczna.

