Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2009, 6, 27–34

PROBLEMS OF WATER SUPPLY AND SEWAGE DISPOSAL MANAGEMENT ON LEGALLY PROTECTED AREAS ON THE EXAMPLE OF LUDWIN COMMUNE

Krzysztof Czernaś[*], Krzysztof Jóźwiakowski[**]

[*]Department of General Ecology, [**]Department of Land Reclamation and Agricultural Engineering,
University of Life Sciences in Lublin, Akademicka str. 15, 20–950 Lublin,
[*]krzysztof.czernas@up.lublin.pl, **krzysztof.jozwiakowski@up.lublin.pl

Summary. The problems of water supply and sewage disposal management on legally protected areas were studied using the example of Ludwin commune. The commune occupies an area of 12 207 ha, including 43% of legally protected areas. Waterworks supply water to about 80% of the commune's inhabitants, while other households use dug wells. Only 16.3% of water taken for household purposes was purified at the two commune sewage treatment plants in Ludwin and Kaniwola in 2008. The remaining quantity of waters were disposed directly to the natural environment with no purification. The excessive development of tourism, lack of a sewage system, and discharging untreated sewage are main reasons for worse quality of water in surface reservoirs located within the Ludwin commune.

Key words: water supply and sewage disposal management, protected areas, wastewater treatment plants, environment pollution

INTRODUCTION

An intensive development of tourism and recreation has been observed recently in Poland. It also refers to legally protected areas, where changes of habitat condition can be seen. Many recreational centres as well as private properties arise at the lakes and around, and they produce more and more sewage. In a majority, those areas have no sewage system and the sewage is accumulated in leaky cesspits. Improper water-sewage management leads to underground waters pollution and at the same time it accelerates the eutrophication processes and degradation of surface waters. The change of lakes trophy directing to eutrophy and sometimes even hypertrophy, is the effect. Inappropriate waste management, storage, and utilisation also contribute to natural environment degradation.

The study was aimed at learning the problems associated with water-sewage management system on legally protected areas using the example of Ludwin commune.

MATERIAL AND METHODS

Materials and information acquired from Ludwin commune [Environment Protection for Ludwin Commune 2004–2015, Local Development Strategy 2008–2020, Ludwin Commune], as well as results of own study performed in 2008 referring to the functioning of sewage treatment plants in Ludwin and Kaniwola, were used in the present study. Determinations of raw sewage and disposed by the treatment plants were carried out in February, May, August, and November. Analyses of collected sewage samples were performed in accordance with commonly applied procedures [Hermanowicz *et al.* 1999], which included BOD_5, COD_{Cr}, total sediments, total nitrogen, and total phosphorus contents. Effects of pollutants removal in studied treatment plant were calculated on the basis of achieved results and they were subsequently compared with requirements set by the Ministry of Environment [2006].

CHARACTERISATION OF LUDWIN COMMUNE

Ludwin commune occupies an area of 12 207 ha. It is inhabited by 5055 people. Mean population density within the commune is 42 persons per 1 km^2 [Local Development Strategy 2008–2020, Ludwin Commune]. The inhabitants are mainly involved in agriculture. The commune is characterised by original natural virtues, making it possible to develop for tourism and recreation. Legally protected areas cover about 43% of the commune area.

According to region division by Kondracki [2001], Ludwin commune is situated between two physico-geographical sub-provinces: Polesie and Lublin–Lvov Upland. Most of the commune area is located within Western Polesie, the Łęczyńsko-Włodawska Plain meso-region is a part of which. A small south-western fragment of the commune belongs to Świdnik Plateau meso-region as a part of the Lublin Upland. The area of the plain is a flat, sometimes slightly wavy surface at about 160 to 180 m above sea level, diversified by depressions filled with lakes, swamps, and peat-bogs. The subsoil of discussed area is formed by marls and chalks. The chalk sediments are covered with Quaternary sediments layer with varied thickness, present mostly in the form of river and lake-genesis water-glacier and morainic silts and sands. The area is abundant in surface karst forms (non-outflow depressions, karst sinks, boulders), mainly reproduced in Quaternary formations [Harasimiuk *et al.* 2002].

According to the Map of main reservoirs of underground water... [1998], Ludwin commune is situated within the main reservoir of underground water 407 – Lublin Basin (Chełm–Zamość). Karst and Quaternary formations being in general in hydraulic contact are the environment of underground waters of main utility layer. They are slot-pore and pore waters with free or strained surface. The wells take water mainly from karst formations. Exploitation of main water-carrying layer resources within the commune does not make any disturbances in the natural hydrological balance.

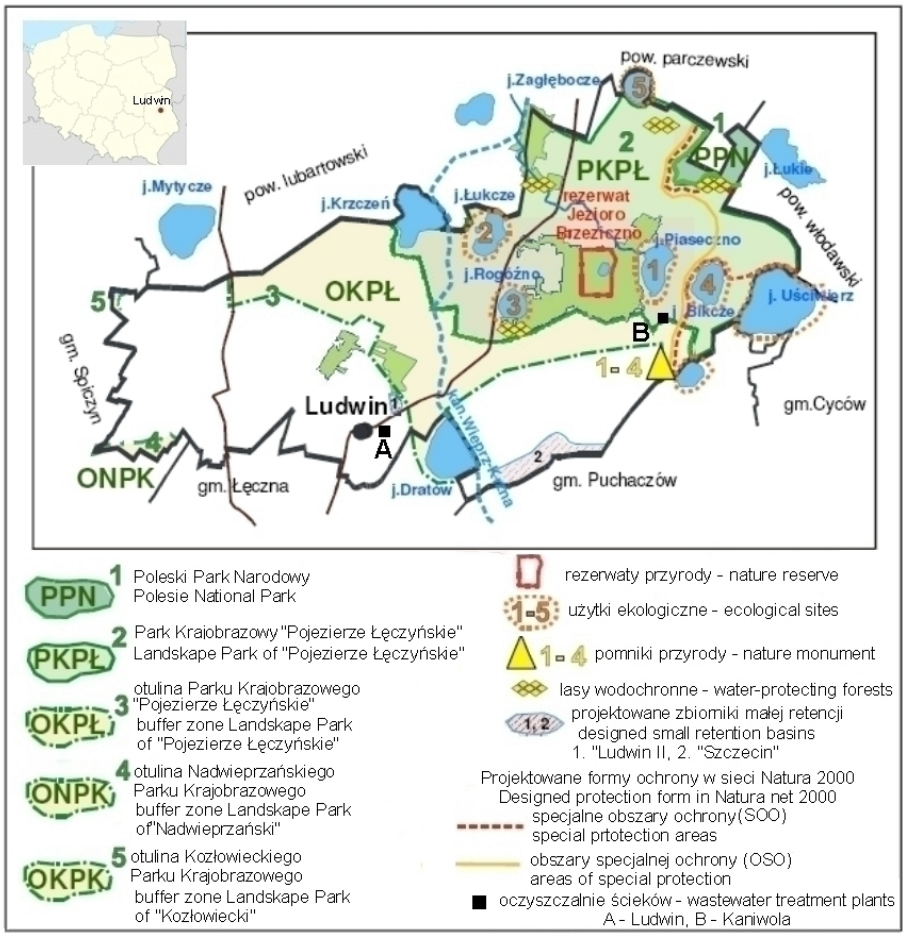

Fig. 1. Form of protection of nature in Ludwin commune [Environment Protection Program and Management Plan for Ludwin Commune in 2004–2015]

The Ludwin commune is situated completely within river Wieprz catchment. River Tyśmienica – as river Wieprz tributary flowing out of the commune – has its springs near lake Rogóźno (Uciekajka village). The presence of lakes of

the Łęczna-Włodawa Lakeland mainly determined the abundance of surface waters in the commune. Most of them have karst and thermo-karst origin. They are characterised by diverse size, depth, and eutrophication level. The largest lakes are Bikcze (area 85 ha, max depth 3.3 m), Piaseczno (84.7 ha, 38.8 m), Zagłębocze (59 ha, 25.0 m), Rogóźno (57.1 ha, 25.4 m), Łukcze (56.5 ha, 8.9 m), and a lake converted into a retention reservoir – Krzczeń (area 174 ha) [Harasimiuk *et al*. 1998].

Considering the biological abundance and diversity, the area within Ludwin commune boundaries is the most valuable in the Lublin region. Several principal natural ecosystems can be distinguished there – peat-bogs, meadows, and forests.

Within the administration limits of Ludwin commune, there are many natural valuable areas and objects being under different types of legal protection on the basis of the nature protection decree of 16 April 2004. They are the Poleski National Park, the Landscape Park „Pojezierze Łęczyńskie", its surroundings, a fragment of the Nadwiślański Landscape Park surroundings, or the nature reserve „Lake Brzeziczno". Other forms of nature protection also can be found in Ludwin commune: ecological lands (5) and nature monuments (4). Protective forests are also present as a nature protection form. Total areas of protective forests amount to about 56 hectares in Ludwin commune.

In 2002, a motion for creating the „West Polesie" Biosphere Reserve received positive opinions. The central and eastern part of Ludwin commune is situated within the buffer zone of the projected reserve. A group of Uściwierz Lakes in the commune is under that form of protection. Valuable and often little transformed plant communities as well as rare and protected plant and animal species can be found there. That area is a mainstay for birds of local and international importance CORINE, as well as a key area in the international system ECONET. The most valuable fragments are under the NATURA 2000 network as mainstays for birds and habitats (Fig. 1).

RESULTS AND DISCUSSION

About 80% of the inhabitants of Ludwin commune are supplied with water through the municipal waterworks. Water is collected from 5 points, within which there are 8 drilled wells. The water originates from Quaternary and karst water-carrying layer. The total underground water intake for household purposes amounted to 254 489 m^3 in 2008. The length of the waterworks network is 136.5 km. Moreover, 196 households in Ludwin commune use individual dug wells [Local Development Strategy 2008–2020, Ludwin Commune].

Total length of the sewage system within the Ludwin commune is 19.8 km. Connection with the sewage system is made in 225 households, while others (608) use nearby cesspits. Sewage from Ludwin commune is received by two treatment plants – in Ludwin and Kaniwola. The sewage treatment plant in Ludwin has a daily maximum capacity of about 300 m^3, whereas that in Kani-

wola about 160 m^3. In 2008, the average daily amount of sewage supplied to the above treatment plants was 96.1 m^3 d^{-1} and 17.9 m^3 d^{-1}, respectively (Tab. 1), i.e.

Table 1. Profile of wastewater treatment plants in Ludwin commune [Local Development Strategy 2008–2020. Ludwin commune]

Location	The type and the kind of wastewater treatment plant	Maximum capacity m^3 d^{-1}	Average quantity of sewages on one day, m^3 d^{-1}, in 2008		
			together	in this	
				brought sewages	inflow of sewage system
Ludwin	mechanical--biological 3 ponds	300	96.1	29.3	66.8
Kaniwola	mechanical--biological BIO-PAK	160	17.9	3.9	14.0

much lower than planned. The sewage treatment plant in Ludwin purifies 69.5% of the sewage supplied through the sewage system, while the remaining 30.5% is transported from recreational centres all over the Łęczna-Włodawa Lakeland by vehicles. The sewage system delivers 78.2% of sewage treated in Kaniwola, while the remaining 17.8% is transported by sanitation trucks. Melioration ditches are the receivers of purified sewage, and then it flows to river Świnka (in Ludwin) or river Piwonia (in Kaniwola).

According to data of the Ludwin Commune Office from 2008, the sewage treatment plants in Ludwin and Kaniwola purified 41 636 m^3 of total sewage quantity, making up 16.3% of water amount taken for household purposes that year. Such a result indicates that a lot of used water never came back to the treatment plant, instead it was probably disposed to the natural environment in unpurified form. Therefore, it is an alarming information which should be a stimulus to undertake activity aimed at reducing the illegal sewage discharge to the environment within the commune that contains up to 43% of legally protected areas.

Excessive development of tourism, the lack of a proper sewage system, and discharging unpurified sewage to the environment are the main reasons for the worsening of the water quality in lakes within the Ludwin commune. Increasing levels of primary production and chlorophyll in 2001–2002 indicate gradual eutrophication of lake Piaseczno waters [Serafin and Czernaś 2003].

A survey carried out in 2008 revealed that raw sewage supplied to treatment plants in Ludwin and Kaniwola contained very high levels of pollutants (Tab. 2). In order to remove them, it is necessary to apply very efficient sewage purification methods. Studies on the functioning of the treatment plants in Ludwin and Kaniwola indicate that the plants remove a majority of contaminants with high efficiency (Tab. 2, Fig. 2). Average efficiency of BOD_5 decrease in

Table 2. Composition of raw sewages and cleaned sewages in studied wastewater treatment plants

Parameters	Wastewater treatment plant in Ludwin								Wastewater treatment plant in Kaniwola							
	raw sewages				cleaned sewages				raw sewages				cleaned sewages			
	min	max	x	σ	min	max	x	σ	min	max	x	σ	min	max	x	σ
Temperature of sewages, ^{o}C	12.0	24.3	17.5	5.2	10.9	24.4	17.1	5.8	15.5	22.5	18.4	3.6	15.9	23.6	18.9	4.1
Reaction pH	7.35	7.64	7.51	0.12	7.96	8.20	8.12	0.11	7.25	7.73	7.42	0.27	6.2	7.7	6.7	0.9
Dissolved oxygen, mg O_2 dm^{-3}	0.18	1.04	0.59	0.43	2.56	11.7	7.16	3.82	0.21	0.31	0.26	0.05	4.6	5.3	5.0	0.3
Total suspended solids, mg dm^{-3}	133	200	165	27.8	27.6	48.7	37.5	9.7	141	615	399	240	37.2	58.6	49.5	11.1
BOD_5, mg O_2 dm^{-3}	128	212	170	42.5	4.7	34.0	15.6	12.7	603	694	659	49.2	4.7	34.0	20.8	14.9
COD, mg O_2 dm^{-3}	350	440	388	45.0	91.0	140	108	22.7	1120	1400	1257	140	74.0	170	110	52.3
Total nitrogen, Mg dm^{-3}	83.0	128	97.0	21.0	40.0	68.0	53.5	12.2	120	141.0	133	11.6	107	128	119	10.8
Total phosphorus, mg P dm^{-3}	28.1	37.4	33.0	4.0	6.3	15.7	10.6	4.5	63.9	90.5	76.8	13.3	17.7	26.3	21.1	4.6

min – minimum value, max – maximum value, x – average value, σ – standard deviation

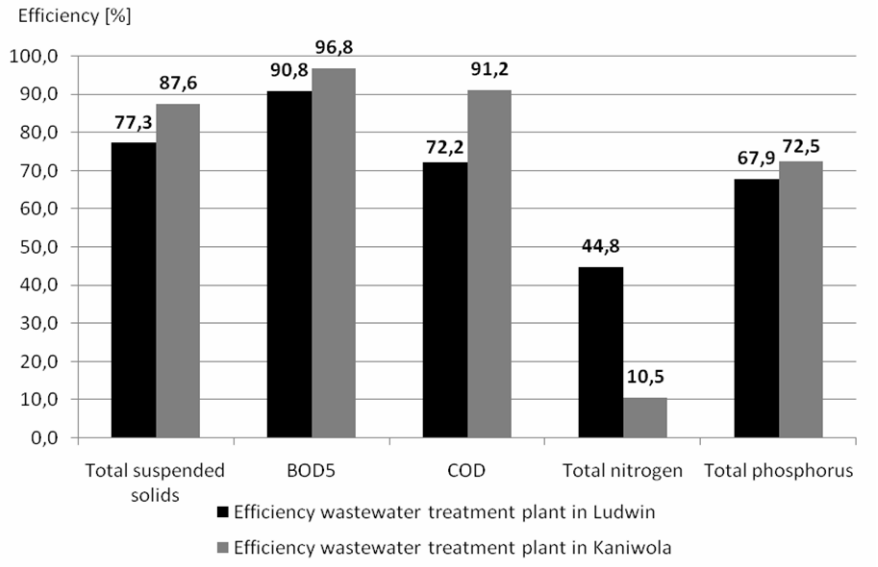

Fig. 2. Average efficiency of pollutions removal in wastewater treatment plants in Ludwin commune in 2008

discussed sewage treatment plants in 2008 was 90.8% in Ludwin and 96.8% in Kaniwola, while COD decrease – 72.2% in Ludwin and 91.2% in Kaniwola. Also the removal of total sediments was quite efficient – 77.3% in Ludwin and 87.6% in Kaniwola (Fig. 2). Achieved effects of contamination removal make that the mean values of these indicators in sewage flowing out of the treatment plants do not exceed permissible levels set by the Ministry of Environment [2006].

Biogens – nitrogen and phosphorus – were much less efficiently removed in discussed sewage treatment plants. Mean efficiency of nitrogen and phosphorus removal in 2008 amounted to 44.8% and 67.9% (Ludwin), and 10.5% and 72% (Kaniwola), respectively, hence biogens concentrations in purified sewage were very high – especially in the treatment plant in Kaniwola. Average concentration of total nitrogen in purified sewage in 2008 was 53.5 mg dm^{-3} (Ludwin) vs. 119 mg dm^{-3} (Kaniwola), while average levels of total phosphorus amounted to 10.6 mg dm^{-3} (Ludwin) and 21.1 mg dm^{-3} (Kaniwola) (Tab. 2). Although current legislation does not require nitrogen and phosphorus to be removed with high efficiency, 43% of Ludwin commune area is taken up by protected areas and that site is considered as particularly exposed to agricultural-origin nitrates [Ministry of Environment 2003], thus functioning of these objects should be soon improved referring to biogens removal.

REFERENCES

Czernaś K., Serafin A., 2007. Changes in phytoplankton productivity in the pelagic zone of the mesotrophic Piaseczno Lake in 1987–1989 and 2001–2003. Oceanol. Hydrobiol. Stud. V. XXXVI, 210–212.

Environment Protection Program and Management Plan for Ludwin Commune in 2004–2015. Part 1. Environment Protection Program.

Decree on Nature Protection from 16.04.2004. Dz. U. from 2004 No 92 pos. 880.

Decree of Ministry of Environment of 24 July 2006 on conditions to be met at discharging sewage to waters or soils as well as on substances extremely harmful for aqueous environments. Dz. U. No 137, pos. 984.

Harasimiuk M., Michalczyk Z., Turczyński M., 1998. Łęczyńsko-Włodawskie Lakes. Natural Monograph. UMCS, Library of Environmental Monitoring. Lublin.

Harasimiuk M., Dobrowolski R., Rodzik J., 2002. Poleski National Park. S. Radwan (ed.). MORPOL, Lublin.

Hermanowicz W., Dojlido W., Dożańska W. Koziorowski B., Zerbe J., 1999. Physicochemical determination of water and sewage. Arkady, Warszawa, pp. 556.

Kondracki J., 2001. Regional geography of Poland. PWN, Warszawa.

Local Development Strategy 2008–2020, 2008, Ludwin Commune.

Map of main reservoirs of underground waters in Poland. A.S. Kleczkowski (ed.), 1988.

Ministry of Environment – Department of Water Resources, 2003. Information on designation of Polish areas extremely exposed to agricultural-origin nitrates and necessary activities.

Smyłła A., Piotrowska-Seget Z., Tyflewska A., 2003. Pathogenic bacteria hazard in surface waters. AUMC Limnol. Pap. (Toruń), XIII, 110, 159–169.

PROBLEMY GOSPODARKI WODNO-ŚCIEKOWEJ NA TERENACH PRAWNIE CHRONIONYCH NA PRZYKŁADZIE GMINY LUDWIN

Streszczenie. Badano problemy gospodarki wodno-ściekowej na terenach prawnie chronionych na przykładzie gminy Ludwin. Gmina zajmuje obszar 12 207 ha, w tym 43% to obszary prawnie chronione. Wodociągi zaopatrują w wodę około 80% ogółu ludności gminy, a pozostałe gospodarstwa korzystają ze studni kopanych. W 2008 r. w dwóch gminnych oczyszczalniach w Ludwinie i Kaniwoli oczyszczano zaledwie 16,3% ilości wód pobranych na cele komunalne. Pozostałe wody odprowadzano do środowiska przyrodniczego w stanie nieoczyszczonym. Nadmierny rozwój turystyki, brak kanalizacji i odprowadzanie nieoczyszczonych ścieków są głównymi przyczynami pogarszania się jakości wód w zbiornikach powierzchniowych zlokalizowanych na terenie gminy Ludwin. Zastosowanie skutecznych technologii w oczyszczalniach w najbliższych latach przyczyni się do ich zdecydowanej poprawy.

Słowa kluczowe: gospodarka wodno-ściekowa, obszary chronione, oczyszczalnie, zanieczyszczenie środowiska