Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2013, 10, 284–290

ROLES AND THREATS OF THE SMALL RETENTION RESERVOIR CZAJKI

Magdalena Patro

Departament of Environment Engineering and Geodesy, University of Life Sciences in Lublin
Leszczyńskiego str. 7, 20-069 Lublin, magdalenapatro@wp.pl

Co-financed by National Fund
for Environmental Protection
and Water Management

Summary. Function of the small water body in the village Czajki in Lublin province and dangers caused by land management around it were analyzed in the paper. Research object was built in 2012 on the Milutka stream for agriculture, to improve the landscape values and increase the recreation offer for population. The main risk arise from same location of the reservoir (surroundings is mostly arable land). It is important to protect it against intense inflow of biogens that may cause slow eutrophication.

Key words: small water reservoirs, small retention, agricultural landscape

INTRODUCTION

Small water reservoirs are an important component of the agricultural landscape, in which they play natural, hydrological and economic roles. Water bodies are also essential technical projects within the small retention program [Mioduszewki 1999, 2006b, Koc *et al*. 2001, Kowalewski 2003]. When designing reservoirs, it is important to determine its future impact on the surrounding area, as well as its vulnerability to anthropogenic transformation and degradation [Koc *et al*. 2001, Skwierawski 2005].

The importance of the small retention reservoir Czajki and the analysis of risks resulting, among others, from current managing the lands adjacent to the water body was presented in the paper.

MATERIALS AND METHODS

Object of the study was the reservoir built on the Milutka watercourse within the section 2 + 460–3 + 720 km, which is the left-side tributary of the Wojsławka river in the village Czajki in Lublin province in 2012 (Fig. 1). The object is located within Skierbieszowski Area of Protected Landscape. The reservoir has an area of 21.26 hectares and total capacity of approximately 342 thousand m^3 [Materials ... 2006]. It is supplied mainly from the current flow of the watercourse. The surface supply occurs during snow melting and heavy rains.

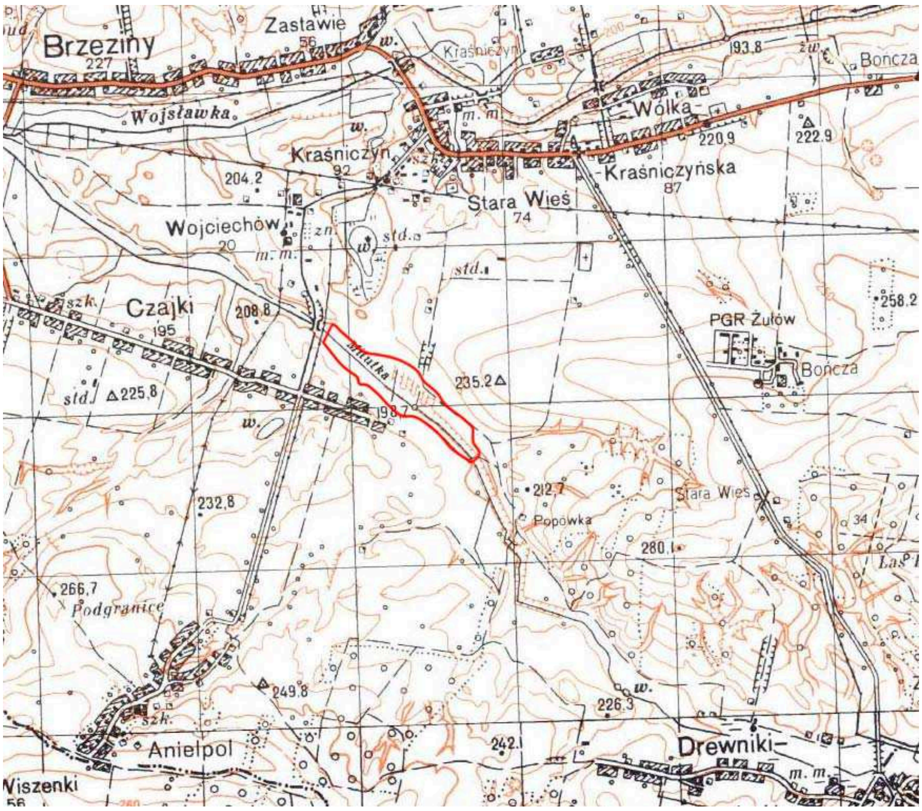

Fig. 1. Location of the small retention reservoir Czajki [mapy.geoportal.gov.pl/imap/]

The reservoir was created in the framework of the Regional Operational Program of the Lublin Voivodeship for the years 2007–2013. The main objective of the project was to improve the water management of Kraśniczyn municipalities. In addition to the impact on the water balance of the catchment, the reservoir Czajki is to be part of shaping the water resources for agriculture, has to influence on the development of agritourism by raising the landscape values of surrounding areas, as well as on creating conditions for recreation and relaxation for the local population. An important function of the reservoir is its impact on the diversity of the agricultural landscape and increasing the biodiversity of the area.

The reservoir does not function as a controlled anti-flood device, but installed overflow device will automatically conduct increased water flows. Moreover, the irrigation functions will be implemented by removing stoplogs from the sluice construction [Irrigations ... 2006, Supplement ... 2006]. The first study (after the reservoir construction) upon the groundwater level (May 2013), indicates its increase, which is consistent with the conclusions of Kędziora and Juszczak [2005] and Mioduszewski [1997, 2006a] on the relationship of water levels in small reservoirs with level of groundwater.

In 2009–2011, monitoring of the Milutka stream was carried out before the reservoir construction, and it was aimed at determining, inter alia, physico-chemical properties of stream water and groundwater in the valley. Samples were collected seasonally (spring–autumn); samples of surface water – in 8 terms, and groundwater from 6 measurement wells located on both sides of the watercourse (3 sections) at the foot of the slopes mainly used as arable lands – 7 terms. Following indexes were determined: electrolytic conductivity (conductometry), pH (potentiometry), ammonia (NH_4^+), nitrates (NO_3^-), nitrites (NO_2^-), phosphates (PO_4^-), potassium (K^+), chlorides (Cl^-) (photometry), and furthermore in surface water dissolved oxygen, BOD_5 (diluting) i COD (dichromate). When assessing the water quality, the extreme and average values of researched indicators were determined for surface water and groundwater. Within the field research, the land use structure and water pollution sources were recorded in the spring of 2013 after filling the reservoir.

RESULTS AND DISCUSSION

Construction of the reservoir caused a radical change in the landscape of the valley of the Milutka stream (Photo 1), which enhanced the recreational opportunities of the area. Presence of the reservoir also contributes to the improvement of biodiversity in the monotonous agricultural landscape, creating a favorable habitat for aquatic flora and fauna. Aquatic ecosystems of rural areas are among the richest in terms of number of related plant and animal species [Ryszkowski *et al*. 2003, Williams *et al*. 2004, Ożgo 2010]. During the field research in spring 2013, the presence of wading and predatory birds was found. However, construction of the reservoir contributed to the elimination of an important element of agricultural landscape – meadows, which are also rich habitats of flora and fauna.

The reservoir Czajki, due to its small volume, will not significantly affect the water-soil environment, although because of its size is susceptible to degradation. The main source of threats is the land use around the reservoir. Almost its whole surroundings are arable fields or pastures (directly bordering with its shore), and only on the east there are grasslands. Ploughing fields to the very shore of the reservoir took place in a few cases (Photo 2). Such a method of cultivation and location of the arable fields on slopes favours rapid runoff of contaminated rain and snowmelt waters into the reservoir.

Photo 1. View of the valley of the Milutka stream before construction of the reservoir and after its completed (2009, 2013)

Photo 2. Lack of buffer zone between the shore of the reservoir and arable fields (2013)

Research conducted in 2009–2011 showed that groundwater was characterized mostly by poor quality. Indicators that lowered the water quality were mostly nitrogen compounds contributing to the eutrophication of surface waters. Maximum concentrations of ammonium ions, nitrates and nitrites amounted to: 5.26 mg · dm^{-3} (July 2009), 188 mg · dm^{-3} (April 2010), and 2.24 mg · dm^{-3} (July 2009), respectively (Tab. 1). The high phosphate content in groundwater was recorded only in 2009, as indicated by 4.5–10 times higher average value of this indicator as compared to average values in 2010 and 2011 (Tab. 1). Also elevated levels of iron in the first and second year of research were determined – average values of this component amounted to 1.74 and 2.03 mg · dm^{-3} (Tab. 1), respectively. Other indicators specified for the groundwater did not decrease their quality (Tab. 1).

Table 1. Extreme and average values of water quality indexes in the stream waters and groundwaters in 2009–2011

Indicator	2009		2010		2011	
	Stream	Wells	Stream	Wells	Stream	Wells
Conductivity, μS · cm^{-1})	506–588 (553)	90–523 (259.50)	530–576 (553)	196–1629 (413.13)	599–608 (604)	109–1603 (347)
pH	7.62–7.83 (7.74)	6.26–8.2 (7.16)	7.39–7.63 (7.51)	5.94–7.21 (6.55)	7.54–8.11 (7.77)	6.35–7.81 (7.01)
O_2, mg · dm^{-3}	7.47–8.54 (8.07)	-	5.99–8.59 (7.29)	-	10.34–15.11 (12.16)	-
BOD_5 mg · dm^{-3}	0.83–2.39 (1.41)	-	1.14–2.05 (1.60)	-	2.22–8.03 (4.5)	-
COD_{Cr}, mg · dm^{-3}	9–18 (12.33)	-	12–37 (24.50)	-	4–12 (7.33)	-
NH_4^+, mg · dm^{-3}	0.03–0.09 (0.07)	0.19–5.26 (1.89)	0.28–0.40 (0.34)	0.53–2.36 (1.11)	0.07–0.29 (0.18)	0.21–1.70 (0.47)
NO_3^-, mg · dm^{-3}	0.47–2.67 (1.26)	0.10–17.72 (5.06)	0.1–0.28 (0.19)	0.1–188 (53.47)	0.3–1.07 (0.69)	0.95–115.6 (31.21)
NO_2^-, mg · dm^{-3}	0.06–0.27 (0.13)	0.08–2.24 (0.65)	0.03–0.05 (0.04)	0.06–1.37 (0.45)	0.02–0.07 (0.05)	0.11–0.57 (0.33)
PO_4^-, mg · dm^{-3}	0.095–0.608 (0.3)	0.351–3.925 (1.93)	0.017–5.5 (6.00)	0.10–1.32 (0.38)	0.048–0.756 (0.29)	0.031–0.401 (0.20)
Fe^+, mg · dm^{-3}	0.14–1.1 (0.55)	0.11–5.49 (1.74)	0.25–0.29 (0.27)	0.14–10 (2.03)	0.32–0.81 (0.53)	0.12–1.28 (0.50)
K^+, mg · dm^{-3}	1.42–2.5 (2.12)	1.34–11.76 (4.80)	-	1.9–9.25 (4.62)	1.77–24.72 (9.89)	1.12–11.78 (2.98)
Cl^-, mg · dm^{-3}	9.2–16.5 (12.33)	1.65–34.33 (11.57)	8–34 (21.0)	0–101.8 (16.03)	18.2–23.2 (20.37)	1.2–34.8 (9.63)

Despite high content of biogenic compounds in groundwater, water from the stream was characterized by relatively good quality. Electrolytic conductivity and pH were at relatively constant level and amounted to 553–604 μS · cm^{-1} and 7.51–7.77 (Tab. 1). The average BOD_5 value in 2009 and 2010 was at a low level, while in the last year it has risen almost three-fold (Tab. 1). In contrast, the average COD values considerably varied during the 3-year study period, but did not indicate any major water pollution in the watercourse (Tab. 1). Among the mineral forms of nitrogen, nitrite concentration was the least preferred. The average concentration of this component in 2009 was 0.13 mg · dm^{-3} (Tab. 1). Throughout the study period, an increased iron content was recorded: the mean level was 0.27–0.55 mg · dm^{-3} (Tab. 1). In November 2011, high potassium content – as compared to previous studies – was found: 24.72 mg · dm^{-3} (Tab. 1). Very high concentration of phosphate (5.5 mg · dm^{-3}) recorded in July 2010 was the factor reducing the water quality in the stream (Tab. 1), which may indicate an intense surface runoff from arable lands to the stream.

Grasslands situated in the valley bottom, which were the effective biogeochemical barrier separating the watercourse from the arable fields had a high impact on water quality in the Milutka stream, despite high content of biogenic compounds in groundwater [Koc and Szyperek 2001, Zubala *et al*. 2006]. Currently, the lack of an effective buffer zone separating the reservoir from the arable fields is a major problem. Shores of the reservoir are mostly directly adjacent to farmlands. In order to maintain the reservoir in a satisfactory state, it should ensure an adequate protection of the reservoir before the runoff of surface waters from arable lands.

CONCLUSIONS

1. The small retention reservoir Czajki is an important part of shaping the water resources in the area. The researched reservoir, apart from economic and recreational functions, significantly improved the landscape values and contributed to increasing its biodiversity, creating a favourable habitat for flora and fauna.

2. The study carried out before the construction of the reservoir showed contamination of groundwater with biogenic compounds on the slopes with arable lands. However, isolated cases of elevated levels of these substances in waters of the Milutka stream were found. It is the result of effective buffer zone in a form of a meadow in the valley bottom.

3. Supply of biogenic compounds from the arable lands is a major threat to the water quality in the reservoir. In order to protect the reservoir, their migration should be halted primarily by shifting the field boundaries from its shores by means of efficient biogeochemical barriers.

REFERENCES

Irrigations and flood protection – the small retention reservoir Czajki (in Polish), 2006, typescript.

Kędziora A., Juszczak R., 2005. Aquatic ecosystems in rural areas (in Polish). Post. Nauk Roln., 3, 87–105.

Koc J., Cymes I., Skwierawski A., Szyperek U., 2001. Importance of protecting small water reservoirs in the agricultural landscape (in Polish). Zesz. Probl. Post. Nauk Roln., 476, 397–407.

Koc J., Szyperek U., 2001. Role of bank vegetation zones in the protection of mid-field ponds (in Polish). Zesz. Probl. Post. Nauk Rol. 477, 65–72.

Kowalewski Z., 2003. Influence of surface water retention on the water balance of small agricultural catchment (in Polish). Woda-Środowisko-Obszary Wiejskie, 6, 126.

mapy.geoportal.gov.pl/imap/

Materials to obtain a decision on the location of a public investment – the small retention reservoir Czajki (in Polish), 2006, typescript.

Mioduszewski W., 1997. Role of small reservoirs in the natural environment (in Polish), in: Water reservoirs. Role in agricultural landscape. Wyd. IMUZ, Falenty, Mat. Sem., 40, p. 7–17.

Mioduszewski W., 1999. Protection and shaping of water resources in the agricultural landscape (in Polish). Wyd. IMUZ, Falenty, 165 pp.

Mioduszewski W., 2006a. Influence of small water reservoirs on groundwater level. Teka Kom. Ochr. Kszt. Środ. Przyr., 3, 136–140.

Mioduszewski W., 2006b. Small water reservoirs (in Polish). Wyd. IMUZ, Falenty.

Ożgo M., 2010. The role of small water bodies in the conservation of biodiversity. Parki Nar. Rez. Przyr. 29(3), 117–124.

Ryszkowski L., Karg J., Bernacki Z., 2003. Biocenotic function of the mid-field woodlots in West Poland: study area and research assumptions. Pol. J. Ecol., 51(3), 269–281.

Skwierawski A., 2005. Transformation of small water bodies since the early twentieth century in the selected area Olsztyn Lakeland (in Polish). Zesz. Probl. Post. Nauk Rol., 506, 413–423.

Supplement to manual of water management – the small water reservoir Czajki (in Polish), 2006, typescript.

Williams P., Whitfield M., Biggs J., Bray S., Fox G., Nicolet P., Sear D., 2004. Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England. Biol. Conserv., 115 (2), 329–341.

Zubala T., Marzec M., Patro M., 2006. Impact of land use on groud water quality in agricultural microbasins (in Polish). Rocz. AR w Poznaniu, 375, Rolnictwo 65, 265–272.

FUNKCJE I ZAGROŻENIA ZBIORNIKA MAŁEJ RETENCJI CZAJKI

Streszczenie. W pracy przeprowadzono analizę funkcji małego zbiornika wodnego we wsi Czajki w woj. lubelskim oraz zagrożeń wynikających z zagospodarowania terenu wokół niego. Obiekt badań został wybudowany w 2012 roku na cieku Milutka, m.in. na potrzeby rolnictwa, dla poprawy walorów krajobrazowych oraz poszerzenia oferty rekreacyjnej dla mieszkańców. Główne zagrożenia wynikają z samego położenia zbiornika (otoczenie stanowią w większości grunty orne). Istotne jest zabezpieczenie go przed intensywnym dopływem substancji biogennych, które mogą spowodować jego powolną eutrofizację.

Słowa kluczowe: małe zbiorniki wodne, mała retencja, krajobraz rolniczy