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SADŹIDE MURAT-BŁAŹEJEWSKA

STORAGE CAPACITY OF LAKES IN THE PRZEMEŃSKI LANDSCAPE PARK

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ABSTRACT. The paper presents preliminary results of estimation of storage capacity of lakes located in the Leszno Lake District in the River Obra catchment. The estimation is based on amplitudes of natural pool elevation-area and elevation-storage curves. By elevation differences (amplitudes) within range 0.2-0.5 m in the 17 investigated lakes of maximum total area 1528 ha their usable storage may reach approximately 7 mln m³.

Key words: small retention, storage of lakes, natural pool elevation

Introduction

Water storage in reservoirs created by damming lakes is one of priorities in development of so called small retention (Mioduszewski 1997). The most restricting factor of such lakes use is their maximum pool elevation which is limited by other purposes like fish and wildlife or recreation.

Investigations of elevation fluctuations in 32 Polish lakes, carried out by Borowiak (1997) for period 1961-1995, showed that the elevations had increased in time. That increasing trend was explained by an increase in precipitation. However six out of the 32 lakes showed an opposite trend, which was most probably caused by human activities.

This paper presents results of estimation of potential storage in the Przemeński Landscape Park.

Materials and methods

The paper is based on records collected and elaborated by IMGW (Institute of Meteorology and Water Management) as follows:

- yearly precipitations in the years 1976-1997 for weather station Leszno,
- daily elevations of the Osłonińskie Lake in period 1976-1983.

The following cartographic materials were utilized:

- topographic maps, 1:25 000,
- hydrographic maps, 1:50 000,
- Polish hydrographical division (**Podział...** 1980), 1:200 000,
- Polish hydrological atlas (**Atlas...** 1987), 1:500 000.

Hydrological and hydrographical characteristics

The lake system "Przemęt - Wielen" is located in the Leszno Lake District in the river Obra catchment, and more precisely in catchments of its main two tributaries: Inflow from the Dominickie Lake and the river Młynówka Kaszczorska. Both small-rivers are tributaries of the South Obra Canal (Fig. 1) and their catchment areas contribute 61% of catchment area of the last one. Table 1 depicts hydrological characteristics of the investigated catchments.

Catchment area of the Inflow from the Dominickie Lake down to section Przemęt is equal to 192.5 km². It includes as well the catchment of the North Przemęckie Lake with the following lakes: Olejnickie, Radomskie, Błotnickie and Przemęckie. These lakes bifurcate with the Górskie Lake and the Osłonińskie Lake which lie in the catchment of Młynówka Kaszczorska. The Dominickie Lake bifurcates with upper part of the river Młynówka Kaszczorska. In the Inflow catchment there are seven lakes of total area 724 ha, what equals 3.7% of the entire catchment area. Total volume of lakes is equal to 28.1 mln m³, what gives 146 mm of storage layer. Sources of the river Młynówka Kaszczorska are located to the west of Wschowa. Its catchment area down to section Mochy is equal to 243.5 km². The river basin consists of sands and sands overlying clays. The river flows to the South Obra Canal by two channels: an old natural below gauge station Mochy and a new one - the Kaszczor Channel. There are 10 lakes of total area 765 ha in the catchment. They cover 3.1% of the catchment area. Total storage volume is 20.7 mln m³ and storage layer equals 85 mm. Relative lake pool area is twice as large as medium for the Great Poland and Pommern Lake Districts equalled 1.8% (**Atlas...** 1996). All lakes are connected by a channel network, and their total catchment area is equal to 436 km². Almost all lakes lie in boundaries of the Przemęcki Landscape Park.

Deviations of yearly precipitation in years 1976-1997 from the whole-period mean calculated for the IMGW weather station Leszno showed (Fig. 2), that there

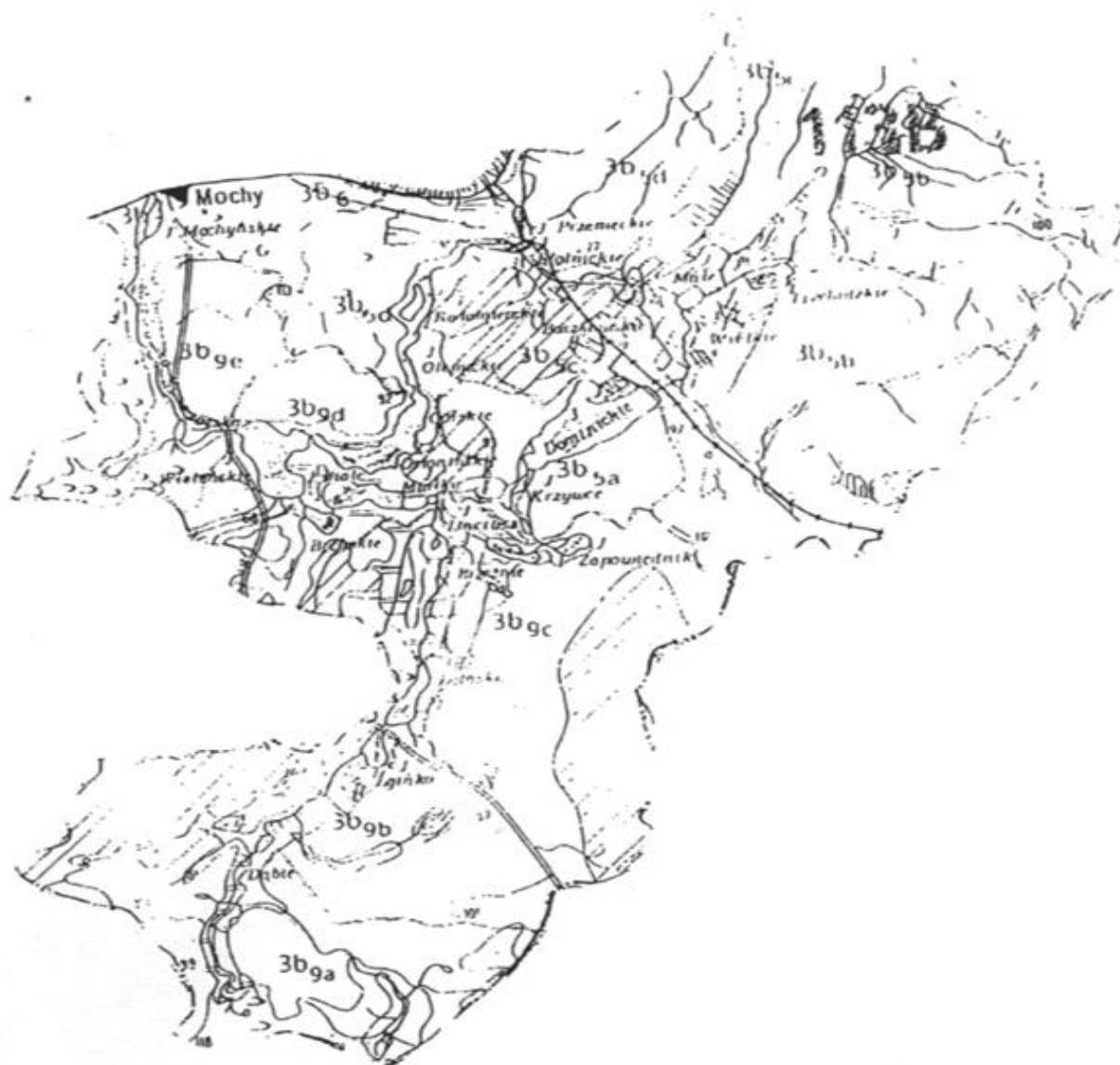


Fig. 1. Catchments of Inflow from the Dominickie Lake (fields 3b_{5a-5d}) and river Młynówka Kaszczorska (fields 3b_{9a-9e}) (Podział... 1980)

Ryc. 1. Struktura hydrograficzna zlewni Dopływu z Jeziora Dominickiego (pola 3b_{5a-5d}) i Młynówki Kaszczorskiej (pola 3b_{9a-9e}) (Podział... 1980)

were dry years (1982-1984, 1989 and 1992), wet (1977, 1993, 1997) and average years (1978, 1979, 1994-1996).

No long-term trend in precipitation was observed. The impact of precipitation on elevations of lake storage can be stated on the basis of a course of characteristic lake elevations. The only IMGW station conducting continuous monitoring of elevation was located on the Oślonińskie Lake. The course of characteristic elevations of that lake is shown in Figure 3, where the highest (WW) and the lowest yearly elevations since 1984 had been calculated according to relationship between yearly

Table 1

Characteristics of the investigated catchments
Charakterystyka badanych zlewni

River Rzeka	Section Przekrój	Catching area Pow. zlewni (km ²)	Lake area Pow. jeziora (ha)	Number of lakes Liczba jezior	Lake area contribution Jeziorność (%)	Lake volume Poj. jeziora (mln m ³)	Storage Retencyjność (mm)	Runoff Odpływ (mm)	Runoff Współczynnik odpływu
1	2	3	4	5	6	7	7/3	8	9
Inflow from the Dominickie Lake Dopływ z jeziora Dominickiego	Przemęt	192.5	723.8	7	3.7	28.1	146	81.6	0.15
Młynówka Kaszczorska	Mochy	243.5	764.9	10	3.1	20.7	85	142.0	0.26
Total mean Razem średnia	Przemęt + Mochy	436.0	1 488.7	17	3.4	48.8	112	94	0.17

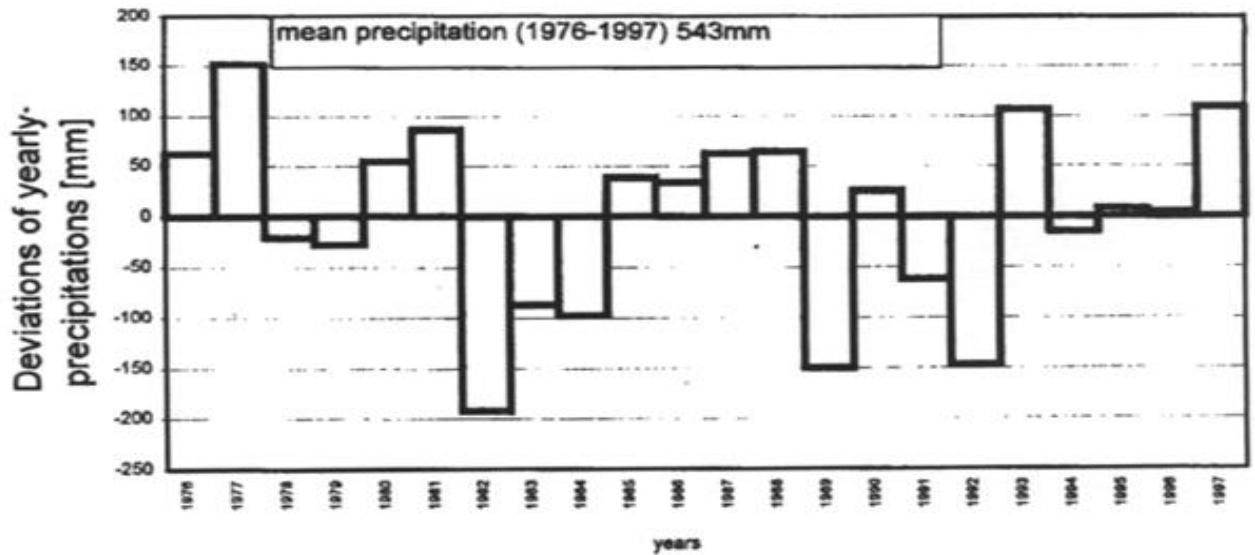


Fig. 2. Deviations of yearly precipitation from the mean 1976-1997 for the IMGW weather station Leszno

Ryc. 2. Odchylenia sum opadów rocznych od średniej z wielolecia 1976-1997 według stacji opadowej IMGW Leszno

elevation differences and precipitation. In period 1976-1995 the highest yearly elevation occurred in the wet year 1977 (WSW = 134 cm) and the lowest one in the very dry year 1992 (NSW = 83 cm). The elevation difference WSW - NSW equalled to 51 cm may be regarded as the maximum amplitude of natural water elevation in lakes under consideration.

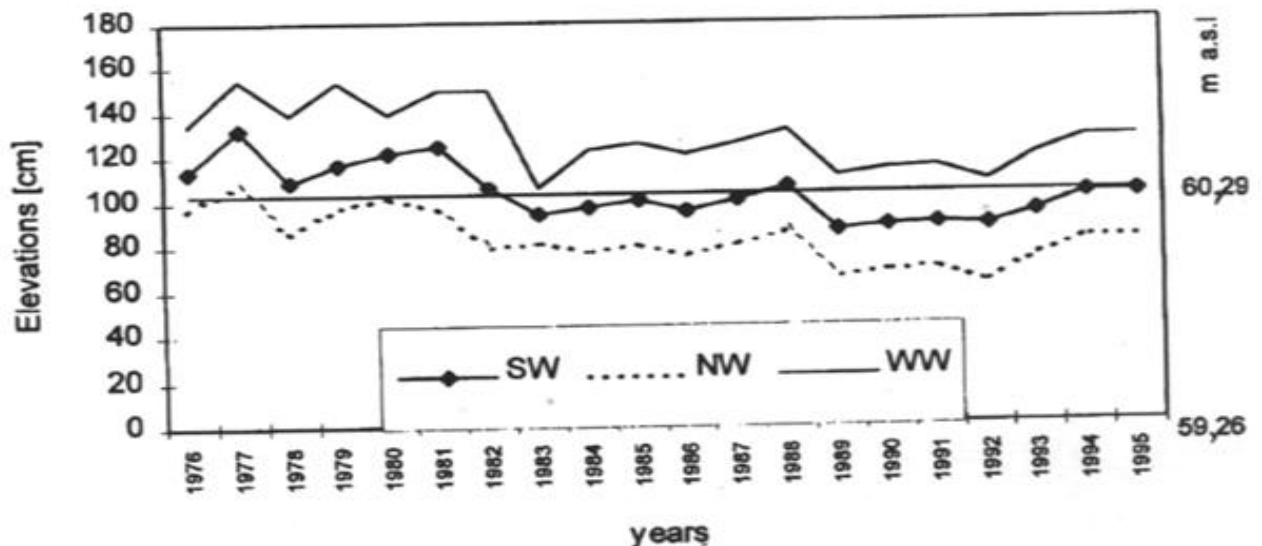


Fig. 3. Course of elevations in the Osłonińskie Lake in 1976-1995

Ryc. 3. Przebieg charakterystycznych stanów wody w Jeziorze Osłonińskim w latach 1976-1995

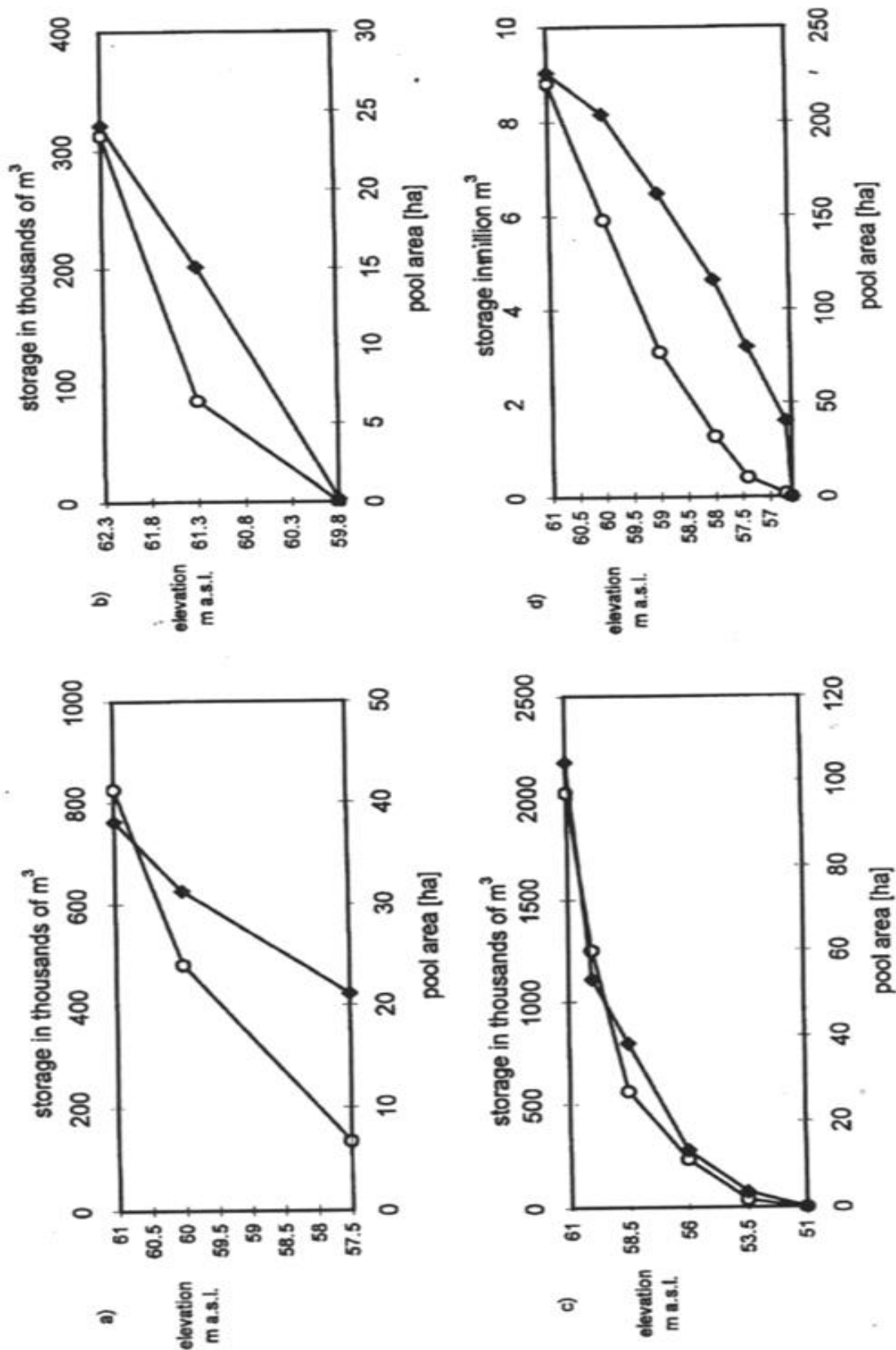


Fig. 4. Elevation-area —●— and elevation-storage —○— curves for Lakes: a) Breńskie, b) Zapowiednik, c) Białe + Miałkie, d) Ostonińskie and Górskie

Ryc. 4. Krzywe powierzchni —●— i pojemności —○— jezior: a) Breńskiego, b) Zapowiednika, c) Białego + Miałkiego, d) Ostonińskiego i Górskiego

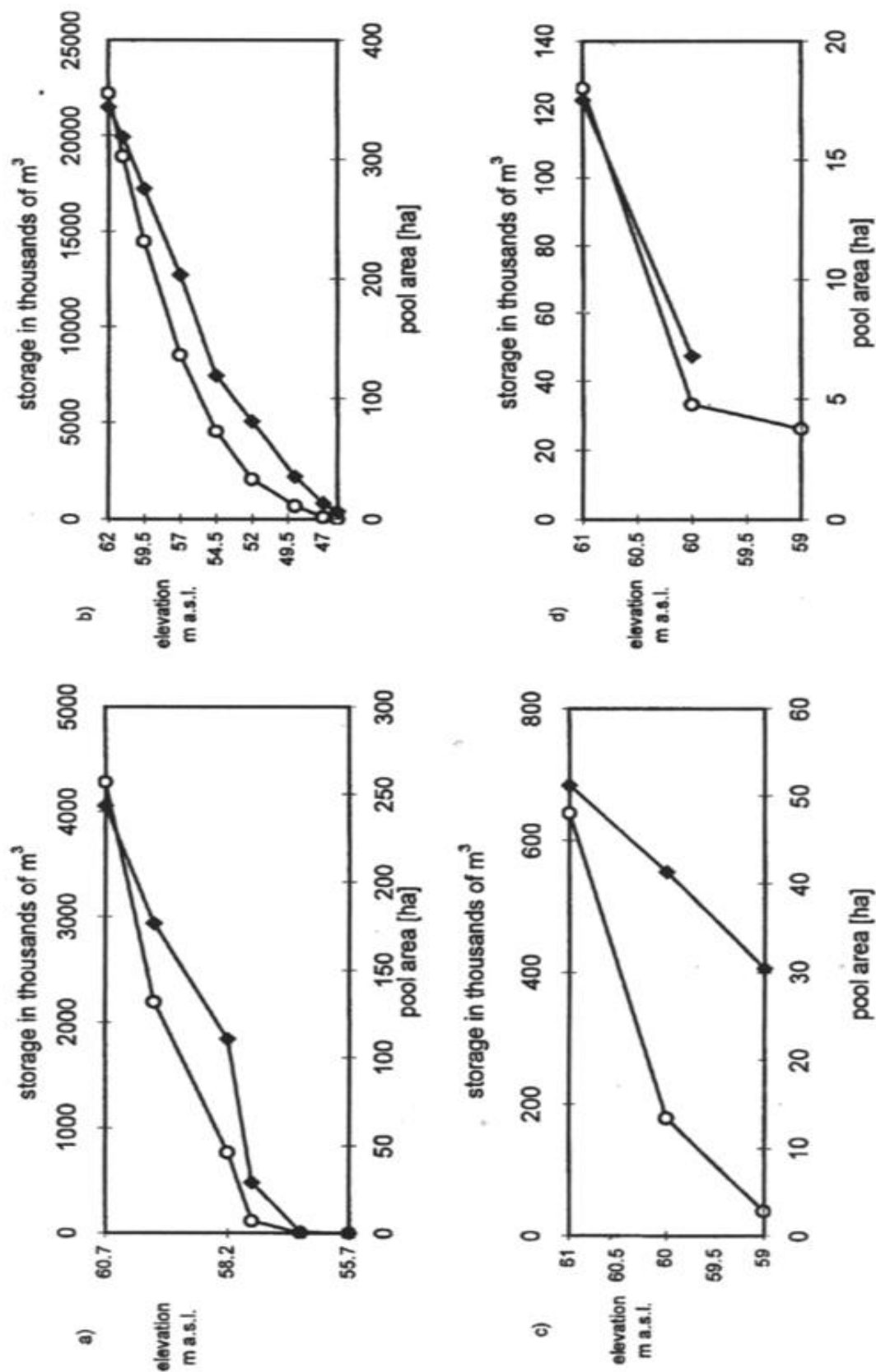


Fig. 5. Elevation-area —●— and elevation-storage —○— curves for Lakes: a) Przemęckie, b) Dominickie, c) Wielkie, d) Małe
 Ryc. 5. Krzywe powierzchni —●— i pojemności —○— jezior: a) Przemęckiego, b) Dominickiego, c) Wielkiego, d) Małego

Tabela 2

Morphometric data on lakes in investigated catchments (Atlas... 1996)
Dane morfometryczne jezior w badanych zlewniach (Atlas... 1996)

No. Nr	Lake name Nazwa jeziora	Catch. area Powierzchnia zlewni (km ²)	Altitude a.s.l. Wyso- kość n.p.m. (m)	Pool area Po- wierzchnia (ha)	Volume (th. m ³) Obję- tość (tys. m ³)	Max. depth Głębokość maks. (m)	Mean depth Głębokość śr. (m)	Max. length Długość maks. (m)	Max. width Szerokość maks. (m)	Length of shoreline Długość brzegowa (m)	Circle peri- meter to shoreline Rozwinię- cie linii brzegowej
Catchment of Inflow from the Dominickie Lake - Zlewnia Dopływu z Jeziora Dominickiego											
1	Krzywce		61.9	11.8	236.3	3.4	2.0	650	250	1 530	1.3
2	Dominickie	20.0	61.7	343.9	22 230.0	17.1	6.4	3 830	1 660	10 575	1.6
3	Wielkie		61.0	51.2	641.0	2.3	1.2	1 295	645	3 250	1.3
4	Małe		61.2	17.5	126.2	1.4	0.7	720	370	1 650	1.1
5	Trzebieckie	86.2	61.0	26.8	245.7	1.7	0.9	835	485	2 275	1.2
6	Boszkowskie	43.6	61.1	29.4	352.8	2.2	1.2	1 010	510	2 800	1.5
7	Przemęckie	42.7	60.7	243.4	4 280.0	5.0	1.6	6 500	595	17 525	3.0
Catchment of Młynówka Kaszczorska - Zlewnia Młynówki Kaszczorskiej											
1	Dąbie (Wygnańcyce)	33.1	65.0	10.7	224.7	4.3	2.1	540	270	1 400	1.2
2	Lgńko		60.0	39.1	1 422.1	7.2	3.6	1 050	585	2 725	1.2
3	Lgńsko	71.0	62.0	68.6	4 778.3	16.9	7.0	1 825	613	4 550	1.6
4	Lincjusz		61.6	37.5	492.6	2.9	1.3	1 037	455	2 600	1.2
5	Zapowiednik		62.3	24.1	301.0	2.7	1.2	765	415	1 880	1.1
6	Brzeźnie	39.5	61.8	43.2	685.0	4.5	1.6	1 380	450	3 370	1.4
7	Białe (+ Miałkie)		61.1	104.4	2 024.7	10.2	1.9	2 020	890	5 625	1.6
8	Breńskie		61.0	38.1	825.2	4.4	2.2	1 020	600	2 700	1.2
9	Wieleńskie (+ Trzytoniowe)	33.4	60.8	220.2	7 055.4	5.6	3.2	1 850	1 790	7 250	1.3
10	Ostonińskie (+ Górskie)		60.8	182.0	2 858.0	3.0	1.6	4 170	750	9 765	2.1

Tabela 3

Storage volume of lakes for 0.5 m elevation difference
Objętość wody zretencjonowanej w wyniku podpiętrzenia jezior o 0,5 m

No. Nr	Lake name Nazwa jeziora	Elevation a.s.l. Rzędna zw. wody n.p.m. (m)		Pool area Powierzchnia jeziora (ha)		Area difference Różnica powierzchni (ha)	Volume (thous. m ³) Objętość (tys. m ³)		Volume difference (thous. m ³) Różnica objętości (tys. m ³)	
		max. maks.	min.	max. maks.	min.		max. maks.	min.		
Catchment of Inflow from the Dominickie Lake - Zlewnia Dopływu z Jeziora Dominickiego										
1	Krzywe	61.9	61.4	11.8	—	—	236.3	177.3	59.0	
2	Dominickie	62.0	61.5	343.9	330.9	13.0	22 230.0	20 574.0	1 656.0	
3	Wielkie	61.0	60.5	51.2	46.2	5.0	641.0	412.0	229.0	
4	Małe	61.0	60.5	17.5	12.2	5.3	126.2	80.0	46.2	
5	Trzebieckie	61.0	60.8	26.5	—	—	245.7	192.1	53.6	
6	Boszkowskie	61.1	60.9	29.4	—	—	352.8	294.0	58.8	
7	Przemęckie	60.7	60.2	243.4	210.4	33.0	4 280.0	3 236.0	1 044.0	
Total - Suma				724.0			28 112.0	24 965.4	3 146.6	
Catchment of Młynówka Kaszczorska - Zlewnia Młynówki Kaszczorskiej										
1	Dąbie (Wygnańczyce)	65.0	64.8	10.7	—	—	224.7	203.3	21.4	
2	Lginko	60.0	59.8	39.1	—	—	1 422.1	1 344.9	77.2	
3	Lgüńsko	62.0	61.8	68.6	—	—	4 778.3	4 435.3	343.0	
4	Lincjusz	61.6	61.1	37.5	—	—	492.6	417.6	75.0	
5	Zapowiednik	62.3	61.8	24.1	20.3	3.8	313.0	202.5	110.5	
6	Brzeźnie	61.8	61.3	43.2	—	—	685.0	469.0	216.0	
7	Białe (+ Miałkie)	61.1	60.6	104.4	78.4	26.0	2 024.7	1 628.7	396.0	
8	Breńskie	61.0	60.5	38.1	35.7	2.4	825.2	643.4	181.8	
9	Wieleńskie (+ Trzytoniowe)	60.8	60.3	220.2	—	—	7 055.4	5 954.4	1 101.0	
10	Ostonińskie (+ Górskie)	60.6	60.1	218.0	206	12.0	7 600.0	6 200.0	1 400.0	
Total - Suma				803.9			25 421.0	21 499.1	3 922.9	
Both catchments total Obie zlewnie razem				1 527.9			53 533.0	46 464.5	7 068.5	

A decreasing trend in lake elevations can be alleviated by damming up to a maximum natural level. Elevation-area and elevation-storage curves for chosen lakes are shown in Figures 4 and 5. On that basis changes in storage volume were calculated for recent years. Elevations in all lakes were determined from the *Atlas...* (1996) and they as a rule were in agreement with long-term mean values. The same values were depicted in a topographical map in the scale of 1:25 000 (1982). The only significant discrepancy between the above mentioned two sources was observed in cases of lakes Lgińsko, Lincjusz and Brzeźnie: 1.2-1.4 m of difference between maximum elevations and 0.7-1.2 m between minimum ones. Finally data from the Górskie Lake. According to instructive materials of Biuro of Reclamation Design in Poznań (*Synteza...* 1979) the total area of these two lakes were 226 ha at elevation 60,28 m and from the *Atlas...* (1996) 182 ha only at higher elevation equalled to 60.80 m. As a result of own measurement made on a map in the scale 1:10 000 area of 218 ha was determined at elevation 60.60 m and 206 ha at elevation 60.10 m. The last values are intermediate between the former ones.

On the basis of the above described estimation a calculation of usable volumes of 0.5 m depth (or 0.2 m only for lakes with shallow shores) was accomplished. In cases of no data on minimum pool area, the increment of storage was computed by multiplying the maximum area by the elevation difference. As shown in Table 3, in lakes lying in the Inflow from the Dominickie Lake catchment one may obtain storage of about 3.1 mln m³, and in lakes located in the second catchment – approximately 3.9 mln m³. Total storage volume is thus equal to 7.0 mln m³. It is worth mentioning that because of no reliable information on long-term water budget; the estimated values are approximate only.

Conclusions

Lake system "Przemęt – Wieleń" is an important, natural reservoir of usable volume 7 mln m³ at elevation differences 0.2-0.5 m, controlled by sluice gates and weirs. Water can be stored in spring and utilized for augmentation of the Obra Canals.

A more detailed feasibility study of storage in dry years and estimation of elevation probability before summer season needs additional investigations on water budget of the lakes.

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MOŻLIWOŚCI RETENCJONOWANIA WODY W JEZIORACH PRZEMĘCKIEGO PARKU KRAJOBRAZOWEGO

S t r e s z c z e n i e

W pracy przedstawiono wstępne wyniki oceny możliwości retencjonowania wody w jeziorach położonych na Pojezierzu Leszczyńskim w dorzeczu Obry. Podstawą oceny były amplitudy naturalnych zmian poziomu wód w jeziorach obserwowanych w latach 1976-1997, a także krzywe powierzchni i pojemności jezior przy różnych rzędnych zwierciadła wody. Przy zmianach stanów wody w zakresie 0,2-0,5 m w poszczególnych jeziorach Przemęckiego Parku Krajobrazowego całkowita pojemność retencyjna tych jezior może wynieść ok. 7,0 mln m³.