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POTENTIALITIES OF WATER RETENTION IN THE LAKES OF THE MAŁA WEŁNA CATCHMENT MOŻNOSTI ZADRŻIAPANIA VODY V JAZERÁCH POVODIA MAŁEJ WEŁNY

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The paper presents preliminary results of estimating water storage capacity in lakes on the Mała Wełna river catchment. The estimation was based on amplitudes of natural pool elevation, elevation-storage curves and inventory of hydraulic structures along the river. At elevation differences (amplitudes) ranging within 0.3–1.0 m in the investigated lakes of maximum total area 393 ha, their usable storage capacity may reach approximately from 1.2 up to 2.8 mln m³.

Key words: low retention, lakes damming, amplitude of oscillations

The research over the detailed description of water management of fish ponds in the region of Wielkopolska proved that there are difficulties in covering the existing demands for water requirements. It brings about certain problems or even hinders fishing procedures in the ponds (Murat-Błażejewska, 1999). In order to increase the resources at disposal, i.e. to increase the certainty for covering pond water needs, retentional capability of the lakes can be utilized by their damming. The basic factor restricting lake water retention is the height of damming.

The process of damming for economic purposes should not cause radical unfavourable changes in the natural environment. The initial results of the investigations concerning the problem of potentialities of water retention in the lakes of the Mała Wełna river catchment in the periods of water abundance and increased flows at disposal during water shortage periods were presented in the study.

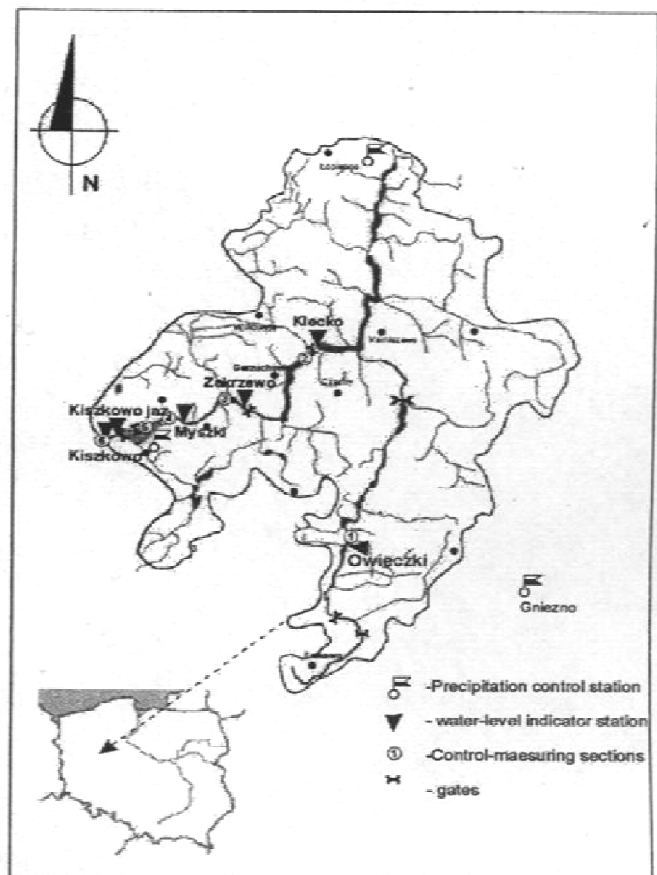
Material and methods

The research was based on the authors' own investigations and data taken from the Institute of Meteorology and Water Management, as well as cartographic materials. Complex field investigations carried out by the authors being the foundation of the study were conducted in the period from 1998 till 2000 in the catchment of the Mała Wełna river from its spring to the Kiszkowo section (Fig. 1). Regular observations and measurements were carried out during the research and they comprised: everyday atmospheric precipitation measurements at two stations (Kiszkowo, Łopienno); everyday water level measurements in the section closing the area of the investigated Mała Wełna catchment, monthly measurements of levels and flows of water in the other five sections of the Mała Wełna river in the periods of sample collecting, weekly water level measurements in two lakes (Owieczki and Kłecle); detailed listing of buildings and water appliances present in the catchment area.

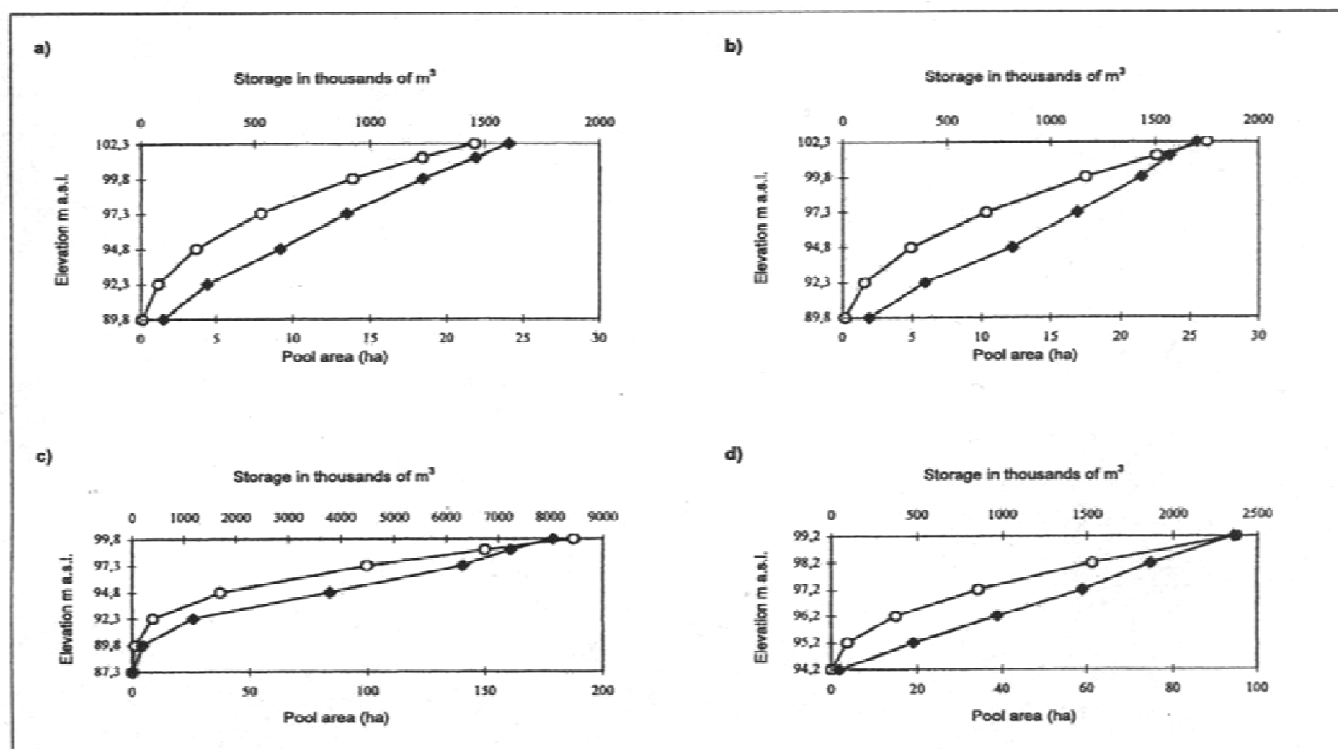
The investigated catchment is situated in the central part of the Wielkopolsko - Kujawska Plain in the Gnieźnieńska Upland. The area of the Mała Wełna catchment up to the Kiszkowo

section (44.6 km of the river course) covers 342 km² and the mean longitudinal acclivity of the river's bottom equals to 0.6‰. The Mała Wełna river rises in a peat valley situated at the height

Figure 1 Catchment of Mała Wełna river down to Kiszkowo (Map scale 1 : 200 000)
Obrázok 1 Povodie Malej Welny do prierezu Kiszkowo (Mierka 1 : 200 000)



Obrázok 2 Krivky povrchu a objemu jazier
 Figure 2 Elevation-area and elevation-storage lakes
 a) Biskupickie, b) Działyńskie, c) Kleckie, d) Gorzuchowskie



of about 120 m above sea level and next passes across nine lakes running along the klecko-lubawska gully; the Polish lakes atlas (Jańczak, 1996) mentions eight lakes since the Kleckie and Świniarskie lakes are connected into one called Kleckie. All the lakes are varied as far as their sizes (from 5.6 to 179 ha) and mean depth (from 2.5 to 6.9 m) are concerned. The total area of the lakes crossed by the Mała Wełna river reaches 392.8 ha while the stagnant water surface in the area amounts to 780.5 ha (including 235 ha of fish ponds). The lake coverage ratio reaches 2.3% in relation to the total catchment area. The joint lake capacity equals to 20.5 mln.m³ which presents the retentional catchment ratio amounting to 60 mm.

According to the climatic regionalization (Woś, 1994), the catchment in focus is situated in Region XV – Środkow Wielkopolski characterized by the lowest annual precipitation sums in Poland – usually not higher than 550 mm. The data from the Department's own precipitation measurement stations in Łopienno and Kiszkowo, as well as from the Gniezno station belonging to the Institute of Meteorology and Water Management were used to describe meteorological conditions at the time of the research. Departure of periodic precipitation sums from the many – year – mean for the Gniezno station in the investigation period 1998–2000 indicates that the winter half – year of 1998 and the summer half – year of 1999 can be described as average while the remaining half – years in the period were damp; especially the 1998 summer half – year and 1999 winter one when the declension from the mean precipitation reached 120 and 110 mm respectively.

Results and discussion

The measured water flows in the investigated sections of the Mała Wełna river present low intensity – mean single outflow reached 1.4 dm³·s⁻¹·km⁻² in the period 1998–2000. Numerous water buildings (four weirs and three sluice gates), situated in the upper river course, apart from atmospheric and physiographical conditions, influenced the observed low flows intensity in the discussed sections. Deficiencies of flows at disposal in the period of spring water abundance of the ponds situated in the Mała Wełna catchment (Murat – Błażejewska and Kujawa, 2000) were observed even in the wet year 1998, as a result of unreasonable water damming with weirs and sluice gates in the upper river course in the Myszki section. The results of the research on the potentiality of covering the fish ponds water demands showed that the coverage of the needs at the time of ponds filling in Kiszkowo oscillates between 53 to 68% in the average year and from 60% to 75% in a wet year.

The river system structure, as well as damming constructions on the river and its tributaries hinder a proper hydrological valuation. Rational exploitation of the existing damming structures situated below the lakes would increase the catchment water resources. Making use of the retentional potentiality of the lakes would facilitate - by damming them - obtaining meaningful quantities of water at disposal, which in turn would increase certainty of water demand coverage for the ponds.

The amplitudes of maximum annual water levels oscillations in the Owieczki and Kłeckie lakes measured from 0.3 to 0.7 m in the period of the research. Due to lack of systematic observations of water levels in the lakes till 1998, maximum and minimum water levels in the lakes in the last decade were estimated on the basis of natural traces in the area and interviews with local fishermen. Differences from 0.3 to 1.3 m can be regarded as amplitudes of natural lake water level oscillations for the area. Surface and capacity curves of four lakes (Działyńskie, Biskupickie, Kłeckie and Gorzuchowskie) crossed by the Mała Wełna river (Fig. 2) were plotted on the basis of the bathymetric data received from the Institute of Inland Fish Culture in Olsztyn.

The curves and topographic maps, as well as the information collected locally facilitated evaluating the changes of retentional capability of the lakes in recent years. Water capacities in the usable retentional layer from 1.2 mln.m³ to 2.8 mln.m³ can be gained by damming the lake water up to the height of maximum levels (from 0.3-1.0 m in respective lakes). Detailed investigations of water balance components of the lakes in focus will create a possibility of defining the degree of guarantee of a potentiality of damming the lakes in dry years.

Conclusions

The results of the three - year - research of hydrological conditions of the Mała Wełna river catchment indicate that the lakes which are crossed by the river form a significant natural retentional reservoir. Damming of the river up to the maximum levels (from 0.3 to 1.0 m in respective lakes) will enable obtaining water capacities in the usable retentional layer from 1.2 to 2.8 mln.m³. Such a procedure will improve fish ponds water management without a negative impact on the natural environment.

Súhrn

V príspevku sú výsledky hodnotenia možnosti zadržávania vody v jazerách, cez ktoré rieka Mała Wełna preteká do prierezu Kiszkowo. Základom hodnotenia boli výkyvy zmien úrovne hladiny vôd v jazerách (Owieczki, Kłecké, Działyńskie, Biskupické, Gorzuchovské) pozorované v rokoch 1998-2000. Sledovali sa krivky povrchu a objemu týchto jazier a tiež výsledky podrobnej inventarizácie stavu budov a vodných zariadení pozdĺž brehu rieky. Zvyšujúc hladinu vody v jazerách do výšky maximálnych úrovní (od 0,3-1,0 m v jednotlivých jazerách) možno zadržať od 1,2 do 2,8 mln.m³ objemu vody.

Kľúčové slová: malá retencia, zvyšovanie hladiny jazier, amplitúda výkyvov

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