

Mariusz Ptak *

**THE RECONSTRUCTION OF THE BATHYMETRY OF THE
NON-EXISTENT KROKOWO LAKE**

S u m m a r y

The intensive drainage works conducted a few centuries ago in Poland contributed to a significant depletion of the hydrographic network. Currently, there are more and more frequent problems with water stress and the introduction of a programme aiming at the retention development, i.e. through the construction of artificial reservoirs or damming up natural lakes. The paper presents the reconstruction of the morphometry of the non-existent Krokowo lake. It was found that the reservoir with the surface area of 58 ha and volume of 2.6 million m³ disappeared as a result of the anthropogenic impact. In the light of an increase in the retention possibilities in Poland, the restoration of natural lakes to their original condition seems to be an interesting approach. Renaturalisation of these environmental elements in the context of the balance components' improvement seems to be more justified than the creation of new (artificial) components.

Key words: anthropogenic impact, drainage, water resources, lakes

INTRODUCTION

Lakes constitute an important element of the natural environment, undoubtedly affecting the stabilisation of hydrological conditions in areas where they occur [Ptak, 2013]. This finding should be associated with high possibilities of water retention in lake basins. The lake's role is not limited strictly to hydrosphere, but in many cases it directly and significantly affects human life. Lakes are particularly important in regions where there is a large density of them, that in the belt of lake districts and it is where they decide on the economic development of

* Uniwersytet Adama Mickiewicza, Wydział Nauk Geograficznych i Geologicznych

these regions (tourism, leisure, fishing, etc.). As a result of the lake basins evolution which basically was initiated when they were formed, they are subjected to the permanent process of disappearance. It is estimated that at the moment there is only about 1/3 of lakes in comparison to the moment of their formation [Kaliniowska, 1961]. The process of disappearance in natural conditions is most frequently slow and successive in nature. It may take place as a result of overgrowing, shallowing and constant reduction of water level. Another time dimension to the process of lake disappearance (especially, with regard to the factors listed above) is provided by humans. Regulation of water conditions and vast, hydro-technical possibilities of the water cycle regulation, may contribute to the quick and drastic changes to the hydrographic network. In the case of Poland, significant regulations of water conditions took place in the 18th and 19th centuries [Kowalczyk, 2004; Grzywna, Mazur, 2014; Kaniecki, Ptak, 2016]. They concerned also lakes where the surface area of lakes significantly decreased [Wieczorek, et al. 2017] or lakes completely disappeared [Ptak, 2017] as a result of drainage works. Actions conducted then aimed at, among others, gaining new agricultural lands. Currently, that is at least for several decades, problems related to water stress are more frequently observed in Poland. Such a situation forced specific measures aiming at increasing retention and lakes are significant element to reach this goal [Nowak, Ptak, 2018].

The aim of this paper is to reconstruct the bathymetry of the drained Krokowo lake (the Masurian Lake District) and the theoretical evaluation of water resources lost as a result of human activities.

RESEARCH MATERIALS AND METHODS

In this paper, the cartographic method to examine environmental changes [Saliszczew, 2003], which consists in including a map into the research process, was used. A map plays then a double role: as a research tool and object in a form of the model replacing the actual phenomenon, whose direct examination is not possible. Such a situation concerns non-existent lakes for whom the determination of morphometric parameters based only on field works is unfeasible.

Based on the above assumption, the analysis was based on archive cartographic materials covering: a Schroetter's map from the beginning of the 19th century (1:150000, fig. 1), medium-scale topographic map from the beginning of the 20th century (Messtischblatt, 1:25000) as well as the current topographic map (1:10000). On the basis of the historic cartographic materials, the original lake coverage was determined. This allowed to determine the ordinate of the water surface level. The knowledge of this condition and the distribution of contour lines allowed to reconstruct the bathymetry plan of Krokowo lake which later

made the determination of the lake basin volume possible. This value was calculated on the basis of the mathematical method which equates the lake basin to a set of truncated pyramids closed by a cone. The volume of the lake basin can be determined by calculating the partial volume of each of these solids, and then by summing them up. Calculations were performed in the QGIS software.

a)



b)

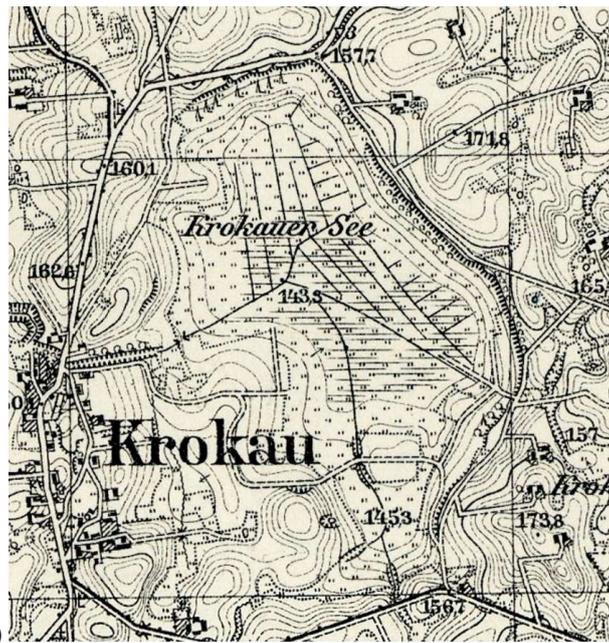
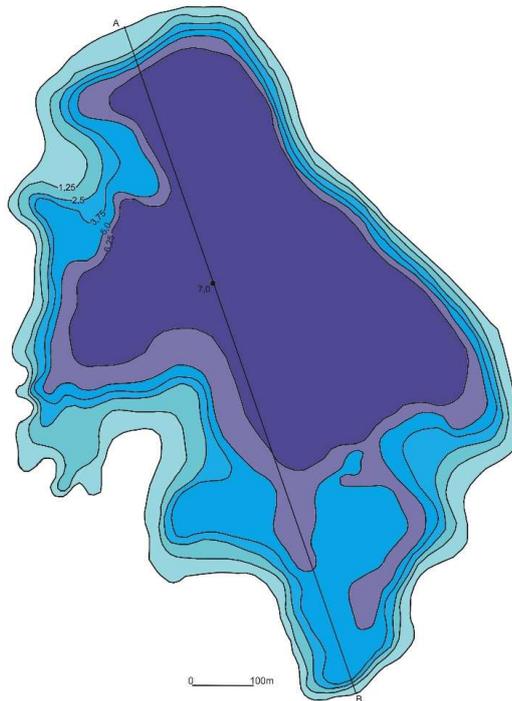


Fig. 1. The original coverage of Krokowo lake - the beginning of the 19th century (a) and the condition after the drainage from the beginning of the 20th century (b)

RESULTS AND DISCUSSION

On the basis of the condition from the beginning of the 20th century (Fig. 2), it can be said that the area of the former lake was drained by means of a dense network of ditches. Such a system guarantees drainage of water flowing to the lowering of the ground after the former lake. Fig. 3 presents the reconstructed bathymetric plan of Krokowo lake. The surface area of the drained reservoir was equal to 58.0 ha, the maximum depth - 7 m, the average depth - 4.5 m, and the volume of the lake basin - 2.6 million m³.

a)



b)

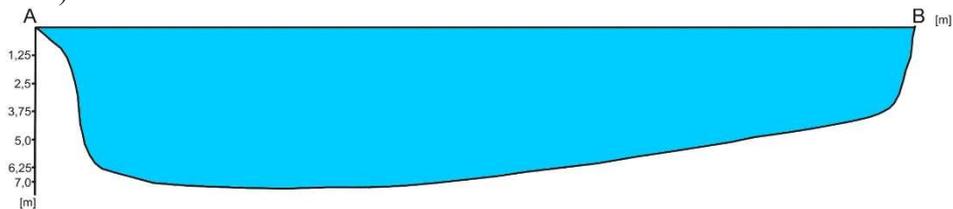


Fig. 2. The reconstructed bathymetric plan (a) and profile of the non-existent Krokowo lake (b)

The example of drainage of Krokowo lake presented in the paper demonstrates radical changes to the natural environment which occurred as a result of the strong anthropogenic impact. As indicated in the introduction, the adaptation of the environment aiming at its optimisation for human life causes that some processes lasting in a natural way for thousands years, can sometimes be drastically shortened. In the context of water problems in Poland observed for several decades, the great drainage works undertaken centuries ago should be regarded as exceptionally unfavourable. It must be underlined here how difficult to predict are the long-term effects of the expansive interference into the natural environment. This means that drainage conducted in the 18th or 19th century was one of the most optimum solutions - especially if we take the dynamic civilization development (among others the need to satisfy nutritional and residential needs) into account. Currently, the effects of these decisions and a drain on the water resources resulting from them can hinder the functioning of some economic areas. As it was noted in the introduction, the development of the retention elements is to slow down the water outflow. The construction of dam reservoirs radically changes the natural environment - "suddenly", an element affecting all other components in its neighbourhood is formed in the place of a previously dry or periodically flooded river valley. Each decision to construct such an object must therefore take a range of consequences resulting from the existence of the open water reservoir into account. These consequences, especially considered in the long term, are frequently difficult or impossible to predict. Therefore, apart from the construction of new reservoirs and damming up the existing lakes, we should look for other possibilities to increase retention. Considering the above mentioned facts, the possibility of restoring the original condition of lakes which were eliminated in the last several hundred years seems to be interesting, and as numerous papers on the matter [Choiński et al. 2012; Ptak et al. 2013; Ptak, 2015] present it, the scale of such actions was significant. The restoration of natural but non-existent in the environment lakes should be more justified from the economic perspective (high costs of the construction of artificial retention reservoirs) and at the same time less invasive for the environment. The example of renaturalisation of water reservoirs is Bartnickie lake (near Bartniki) or Lodygowo lake (near Lodygowo).

CONCLUSIONS

At a time of the observed climatic changes, water balance components are becoming significantly disrupted. It is already estimated that the significant increase in air temperature [Ptak et al., 2018] and as a consequence an increase in vaporisation is a significant element affecting water resources of lakes in Poland

[Choinski et al., 2016]. This will force to look for wider and newer solutions reducing this unfavourable situation and renaturalisation of drained lakes can be one of many alternatives.

The obtained results may be a basis for further analyses of this type, in the light of the planned increase in the retention possibilities of Poland. At the moment, the question of surveying the terrain and checking whether, in a given area, there was a natural lake which ceased to exist as a result of human interference becomes very important. As in the case of the lake described in the paper (as all other situations of this type), the initial investigation of the potential water resources is only theoretical in nature. If at any time in the future actions of this type will be undertaken, the presented method can be a backbone for more detailed studies (legal, geodesic, etc.).

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