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Potential Renaturalisation of Lakes as An Element Building Up Water Resources: An Example of Mosina Lake, Poland

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Abstract: Water deficits observed in many regions of the world make it necessary to implement measures intended to improve this situation. Poland is one of the countries with the poorest water resources in Europe due to its natural conditions and human impact. As a result of land reclamation carried out over decades, many elements of its hydrographic system have been changed, and some of them, like lakes, have disappeared altogether. In the days of the socio-economic transformation and more frequent extreme events, what seems worth considering is the renaturalisation of non-existing lakes, an idea presented in this paper on a selected example.
Keywords: environment transformation; drainage; water resources; human activity; Mosina Lake, Poland

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1 Introduction

Poland′s water resources are one of the poorest in Europe (Kowalczak *et al*., 1997), comparable with those of desert countries like Egypt. The causes of this situation should be sought in anthropogenic activities which have led to water deficits in both a direct way (land reclamation) and an indirect way (through changes in the land-use pattern, and hence in the individual components of the water balance). Human impact is a key element responsible for water deficits in many parts of the world (Ismaiylov *et al*., 2007; Demin, 2014). Poland is no exception here, intensive reclamation going back here to the 17th century with the start of so-called Dutch colonisation. It involved expanding cultivable land by removing excess water from it (Kaniecki, 1991). The most extensive work was carried out in river valleys, attractive to agriculture because of the flood loams lining their bottoms. Examples of such great reclamation schemes include the rivers Obra (Hildebrandt-Radke and Przybycin, 2011) and Noteć (Jamorska, 2013). Water conditions were also regulated with settlement goals in mind, as exemplified by Fajerek Lake in Olsztyn, which has disappeared because of the city′s steady expansion. It is worth devoting more attention to those elements of the hydrosphere that have stopped functioning in the environment over a relatively short time as a result of precise works.

Today, there are over 7000 lakes in Poland with an area of 1 ha and more. They are located mostly in the north of the country, which was covered by the last Scandinavian ice sheet. This is a mere one-third of their initial number (Kalinowska, 1961). The role of lakes in the natural environment is highly significant from both, a natural point of view (a high retentive capacity and hence the ability to soften extreme hydrological events: floods, droughts) and an economic one (the development of tourism, fishing, *etc*.). The aim of this paper is to assess water resources that could theoretically come into existence as a result of a reconstruction of Mosina Lake situated in Central Europe, and more accurately in North Poland (Pomeranian Lakeland, Fig. 1).

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Fig. 1 Location of study object

2 Materials and Methods

The implementation of the assumed objective involved the application of the cartographic method of examining changes in the environment (Saliszczew, 2003), i.e., a map was used in the research process. The map performs a double role: as a research tool and a model replacing an actual event the direct examination of which is not possible. This is the case of non-existent lakes for which it is impossible to determine morphometric parameters on the basis of fieldwork only.

Acting on the above assumption, the analysis of the issue in question was based on archival cartographic material embracing medium-scale topographic and geological maps from the end of the 19th century as well as current topographic maps at a scale of 1 ∶ 10 000 and an orthophotomap. On the basis of the distribution of peats (Fig. 2), the original extent of the lake was determined. This made it possible to establish the ordinate of the water table.

Having established its level and the distribution of contour lines, a bathymetric plan of Mosina Lake was reconstructed, which made it possible to determine the volume of its basin. This value was calculated using Penck′s method, which compares a lake basin to a set of truncated pyramids topped by a cone. By calculating the partial volume of each of those solids and summing the figures up, it was possible to determine the capacity of the lake basin. The calculations were made in the Quantum GIS program. The area of each polygon within a particular isobath was delineated. At the next stage, this permitted the determination of its surface area.

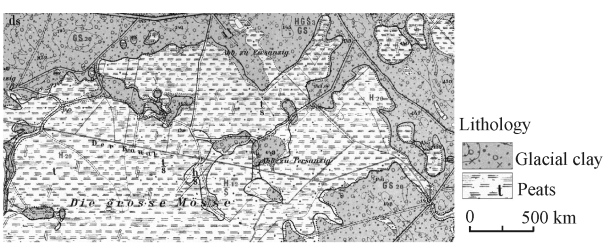


Fig. 2 Fragment of a geological map from the late 19th century: a peatland left in place of non-existent Mosina Lake

3 Results and Discussion

The potential original range of Mosina Lake is presented in Fig. 3, and its remnants from the 19th century in Fig. 4.

As the figure shows, Mosina Lake occupied a considerable area. Initially probably it covered 1017 ha and its volume can be estimated at about 1.76×10^7 m^3. Today there only exist its deepest fragment (lake marked in Fig. 3, with an area 150 ha, a volume of 8.1×10^6 m^3 and a maximum depth of 11 m). The basin of the former lake is occupied by a dense network of canals and ditches, which carry away water from the area to Trzesiecko Lake. Given the average area of lakes in Poland amounting to 39.7 ha (Choiński, 2007), the non-existent lake must be considered very large; it would be classified as 29th among the total of 7000 lakes.

Because the road infrastructure and settlement network has expanded since the time of lake drainage, its potential renaturalisation was assessed with a view to minimising material losses involved in the inundation of those elements. It was established that the new lake could have an area of about 320 ha and some 3.6×10^6 m^3 of water (Fig. 5).

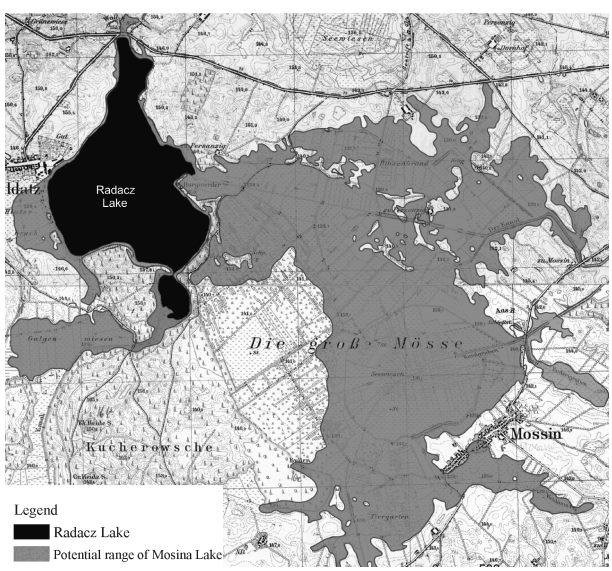
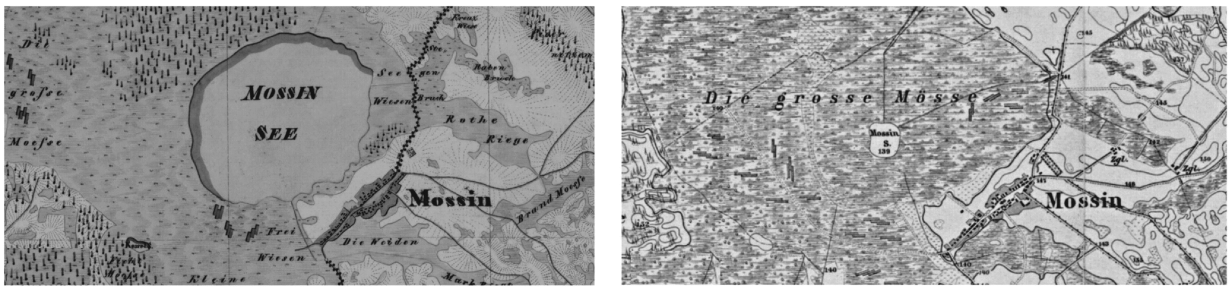


Fig. 3 Potential original range of Mosina Lake



a. 1839 b. 1877

Fig. 4 Range of Mosina Lake in the 19th century

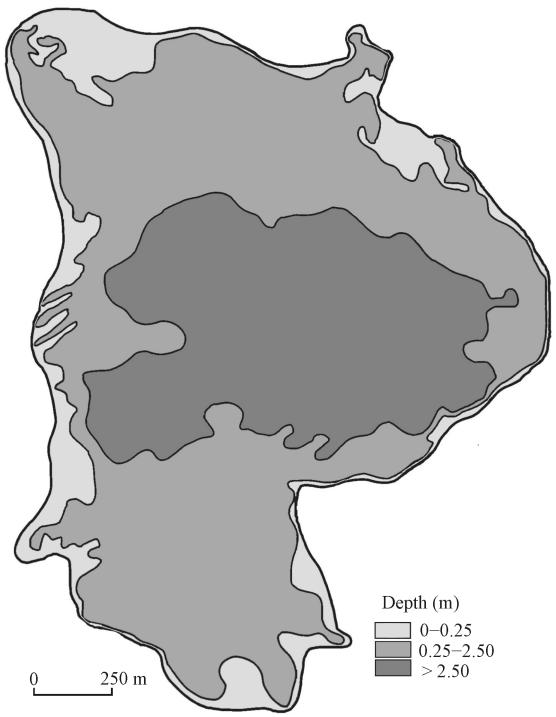


Fig. 5 Potential extent and bathymetric plan of Mosina Lake

The adaptation of elements of a hydrographic system has often been, or been supposed to be, the chief stimulus for the development of a region or country. Aral Lake can serve as an example. Directing the waters of its principal tributaries to the irrigation system was supposed to be of key significance for the production of cotton in Kazakhstan. However, the effect of this action has been one of the greatest ecological disasters in the world. Apart from its natural aspect, this situation is also not indifferent to the local population mostly living from fishing (White, 2013). What used to be the fourth biggest lake in the world (Micklin, 1988) has only survived in a residual form today. And while there are plans of its reconstruction, they can not be fully implemented for financial reasons. Economic reasons are also among significant factors that hinder saving Chad, another lake located in a warm climatic zone, from disappearance (Chimtom, 2013). Lakes transformed by man, whether consciously or shortsightedly (as in the case of Aral Lake), can be found in various regions of the world. In China the primary factor of lake disappearance is thought to be land reclamation that turns lakes into rice fields, building sites, *etc*. (Cui *et al*., 2013; Yang and Lu, 2014). There are also many heavily drained lakes in North America (Galat *et al*., 1981; Jellison *et al*., 1998; Beutel *et al*., 2001) and in Europe (Zuur, 1952; Iversen *et al*., 1993; Soto *et al*., 2011).

As to Poland, hydraulic works intended to reduce the area of lakes or drain them completely were fairly common especially in the 18th and 19th centuries. In most cases they were dictated by the need to obtain new land for farming (Choiński *et al*. 2012). However, the several decades of social transformation in Poland are now reflected in the structure of employment; in the agricultural sector this indicator has been declining. As a result, many formerly agrarian areas have stopped being used for farming. From the perspective of time, decisions involving complete drainage of lakes can be assessed as not always right. There are many examples of lake basins once drained by man that have turned into water ecosystems again. Examples are Ardung Lake (Koc *et al*., 2005) or Objezierze Lake, a part of the former basin of which is currently occupied by a fish pond. The maintenance of water conditions other than the initial lake-related ones requires a highly efficient drainage network. This means a cyclic conservation of the system of ditches, canals and drain pipes. Its cost can be very high, up to 3.2×10^6 USD (U. S. dollars), as in the case of the non-existent Sajny Lake (Nowicki and Cymes, 2000). A decline in the efficiency of a drainage system

leads to a reduced flow capacity of its individual components and causes water to stagnate in the former lake basin. This can lead to the formation of a backwater area (e.g., the Morąg Backwater, the remnant of the former Morąg Lake), which shows that (unlike in the case of the lakes from the warm climatic zone mentioned above) relatively low outlays of labour and money are necessary for the regeneration of the original elements of the environment, basically requiring the discontinuation of the hydraulic works conducted. Today there is no comprehensive work concerning drained lakes in Poland. As the literature on the subject shows (Choiński *et al*., 2012; Kaniecki, 2013), their set can be estimated at a few dozen, or even a few hundred, lakes. This issue certainly needs a more detailed analysis in the future.

In the light of the above, it is justified to ask if all lakes once drained by man should maintain their present state. In the case of Poland, the key issue is stopping or slowing down the outflow of water from its area. This matter has become so significant that in the mid-1990s decisions were made at the inter-ministerial level intended to enlarge the country′s water resources. The principal venture is the so-called Small Retention Programme, the chief purpose of which is to build and rebuild water-storing hydraulic engineering facilities (small water bodies, water gates on rivers, impounding of natural lakes). The assumptions of this programme well agree with the idea of potential renaturalisation of non-existent lakes (i.e., natural elements of the environment) that were present in it for centuries and that have disappeared as a result of expansive human activity. The reconstruction of natural lakes seems more rational than projects intended to create completely new elements of the hydrographic network, radically changing the existing environmental conditions. As has already been observed, the maintenance of polders reclaimed from lakes can involve considerable costs. In the case of agricultural activity, those costs are recompensed in a specified period of the year embracing the growing season. Thus, they should be calculated from an economic point of view. A detailed analysis could provide an answer to the question of what would be more profitable at the given place: a network of ditches and canals, or a lake with a hotel, a leisure centre, agritourist pensions, recreational paths, *etc*., on the shore. This approach is worth considering if only because of the fact that in Poland the proximity of lakes is one of the key elements deciding about the choice of a recreation site (Ptak, 2012).

The chief fears connected with the renaturalisation of lakes concern the quality of their waters. However, as demonstrated in one of the few works dealing with this matter in Poland (Sobczyńska-Wójcik, 2009), the example of Lake Nowe Włóki shows that, after 25 years of existence, it is a stable ecosystem. As the author emphasizes, the reconstruction of this lake has been rational and can contribute to an improvement in the country′s water resources.

4 Conclusions

Mosina Lake presented in this paper is one of the many water bodies in Poland (but also in the world) that have ceased to exist as a result of human impact. Over the decades since its drainage, there have been many changes in Poland, both in its natural and socio-economic conditions. Readily notable are successively deeper water deficits and a greater intensity of extreme meteorological-hydrological events (floods, droughts). Hence, measures taken today by government organs to increase retention will have to be augmented with new elements in the future. Such elements can include natural lakes which once ceased to exist because of the economic needs of the community of that time. Many examples of restored lakes show that a more rational approach is their return to the original state (i.e., one from before the artificial transformation of the natural environment).

By analysing archival maps, historical records, *etc*., it is possible to make a survey of the natural elements of a hydrographic system that exists no longer today, which has been demonstrated on the example of Mosina Lake. The data acquired in the process concerning its location, area, volume, *etc*., can serve as a point of departure for a closer analysis and its possible renaturalisation. The restoration of natural lakes can turn out to be a more appropriate step than those adopted today, and the benefits that such measures can produce will be visible not only on a purely natural plane but also on an economic one.

References

Beutel M W, Horne A J, Roth J C *et al*., 2001. Limnological effects of anthropogenic desiccation of a large, saline lake, Walker Lake, Nevada. *Hydrobiologia*, 466: 91–105. doi: 10.1023/A:1014569521381

Chimtom N K, 2013. Saving Lake Chad will cost billions. *Water Sewage and Effluent*, 33(2): 14–15.

Choiński A, 2007. Physical limnology of Poland, Poznań Wyd. Nauk. UAM. (in Polish)

Choiński A, Ptak M, Strzelczak A, 2012. Examples of lake dissapearnce as an effect of reclamation works in Poland. *Limnological Review*, 12(4): 161–167. doi: 10.2478/v10194-012-0056-2

Cui L, Gao C, Zhao X *et al*., 2013. Dynamics of the lakes in the middle and lower reaches of the Yangtze River Basin, China, since late nineteenth century. *Environmental Monitoring and Assessment*, 185(5): 4005–4018. doi: 10.1007/s10661-012-2845-0

Demin A P, 2014. Water resources and food program. *Water Resources*, 41(3): 232–241. doi: 10.1134/S0097807814030051

Galat D L, Lider E L, Vigg S *et al*., 1981. Limnology of a large, deep, North American terminal lake, Lake Pyramid, Nevada. *Hydrobiologia*, 82: 281–317. doi: 10.1007/BF00048722

Hildebrandt-Radke I, Przybycin J, 2011. Changes in the hydrographic network and area under forest in the context of the Middle Obra melioration (central Wielkopolska region), in the light of historical data and cartographic material. *Przegląd Geograficzny*, 83(3): 323–342. (in Polish)

Ismaiylov G K H, Fedorov V M, Sadati Nezhad S D, 2007. Assessment of possible anthropogenic changes in the runoff of the Syr Darya River on the basis of a mathematical model. *Water Resources*, 34(4): 359–371. doi: 10.1134/S00978078070 4001X

Iversen T M, Kronvang B L, Lauge P N *et al*., 1993. Re-establishment of Danish streams: restoration and maintenance measures. *Aquatic Conservation*: *Marine and Freshwater Ecosystems*, 3: 73–92. doi: 10.1002/aqc.3270030203

Jamorska I, 2013. Changes in water resources in the upper Noteć drainage basin caused by anthropogenic activity in the 19th and 20th century. *Gospodarka Wodna*, 3: 103–109. (in Polish)

Jellison R, Romero J, Melack J M, 1998. The onset of meromixis during restoration of Mono Lake, California: Unintended consequences of reducing water diversions. *Limnology and Oceanography*, 43: 706–711.

Kalinowska K, 1961. The disappearance of glacial lakes in Poland. *Przegląd Geograficzny*, 33(3): 511–518. (in Polish)

Kaniecki A, 1991. Problems of Wielkopolska Lowland drainage over the last 200 years and changes in its water conditions, Materiały konferencji *'Ochrona i racjonalne wykorzystanie zasobów wodnych na obszarach rolniczych w regionie Wielkopolski'*. Akademia Rolnicza, Poznań. (in Polish)

Kaniecki A, 2013. Disappearance of lakes in the Poznań Lake District. *Badania Fizjograficz*ne, *IV*, *A*, 64: 91–104. (in Polish)

Koc J, Nowicki Z, Sidoruk M, 2005. Problems of lake renaturalisation: the example of Lake Ardung in the Łyna drainage basin. *Inżynieria Ekologiczna*, 13: 11–21. (in Polish)

Kowalczak P, Farat R, Kepińska-Kasprzak M *et al*., 1997. Hierarchy of small retention areal needs, Materiały badawcze, Seria: *Gospodarka Wodnao Ochrona Wód*, 19, Warszawa, IMGW. (in Polish)

Micklin P P, 1988. Desiccation of the Aral Sea: a water management disaster in the Soviet Union. *Science*, 241: 1170–1176.

Nowicki Z, Cymes J, 2000. Renaturalisation of water and drainage systems in Mazuria Lakeland. In: Michalczyk Z (ed.). *Renaturyzacja obiektów przyrodniczych-aspekty ekologiczne igospodarcze*, *Wyd.*. Lublin, UMCS: 131–137. (in Polish).

Ptak M, 2012. Lakes of the Wialkoposlak-Kujavia Lakeland as a recreational base. *Badania Fizjograficzne A*, 63: 111–120 (in Polish).

Saliszczew A K, 2003. General cartography, PWN, Warszawa, PWN. (in Polish)

Sobczyńska-Wójcik K., 2009. Quality of waters of the restored Nowe Włóki reservoir as an indicator of the effectiveness of restoration. *Proceedings of Ecopole*, 3(2): 509–514 (in Polish).

Soto M F, García A F, Cuesta G F *et al*., 2011. The drying of the Antela Lake. *Boletin de la Asociacion de Geografos Espanoles*, 57: 455–457.

White K D, 2013. Nature-society linkages in the Aral Sea region. *Journal of Eurasian Studies*, 4(1): 18–33. doi: 10.1016/j.euras. 2012.10.003

Yang X, Lu X, 2014. Drastic change in China′s lakes and reservoirs over the past decades. *Scientific Reports*, 4(6041): 1–10. doi: 10.1038/srep06041

Zuur A J, 1952. Drainage and reclamation of lakes and of the Zuiderzee. *Soil Science*, 74: 75–89.