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DISAPPEARANCE OF THE MID-FIELD PONDS AS A RESULT OF AGRICULTURE INTENSIFICATION

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ABSTRACT

The paper presents the results of an introductory historical analysis in occurrence of mid-field ponds on the situated in the area (9039 km²) of younger pleistocene landscapes of Pomerania. The analysis was based on the comparison of topographical maps from 1888 and 1980. Loss of the ponds was presented in relation to respective mesoregions and the character of surface features, taking into consideration the water surface size and melioration works conducted in the drainage basin area. For the analysis purposes mid-field ponds located in the areas which usage in compared periods has not changed were chosen.

Average loss of mid-field ponds between the end of the 19th century and a second half of the 20th century in the whole research area was estimated at 70.2%. Larger degree of mid-field ponds disappearance was ascertained on the fields with land melioration. The largest disappearance occurred in the area of Nowogard Plain, which as compared to the analysed Lake District area – has worst soils. Loss of mid-field ponds in this mesoregion on farmlands, which are not covered with melioration works, amounted to 49%, while in meliorated areas 71%.

Key words: water ponds, agricultural landscape, historical analysis

INTRODUCTION

The landscape of Northern Europe is created by various postglacial forms, amongst them interior terrain depressions filled with water, referred as water ponds. They are located both north as well as south of the line determining the maximum range of the Baltic glaciation. They are the most characteristic for the areas of moraine plateaus – ground and end moraine in the range of the last Baltic icing, whereas they have disappeared on the older areas. The area of the ponds varies between 0.1 to 1.0 ha.

All of the water ponds and especially the mid-field ponds undergo the process of land formation, which to the great extent was modified by human activities. Accelerated filling of depressions appeared already during intensive settling phases, as a result of introduction of listers skids and ploughs in early medieval age [15]. After the Second World War on the area of Pomerania agriculture intensification and creation of large area farms was started. The shaping of the agrarian sphere was at that time directed to creation of very large crop rotation fields without any other agricultural land use [4]. It led to elimination of all obstacles, water ponds were amongst those obstacles [9].

Melioration had as well influence on mid-field ponds and marshes disappearance [12]. Particular intensification of melioration works in Pomerania took place in the twenties and thirties of the 20th century, when majority grasslands were meliorated. From 1946 to the beginning of the seventies on the area of former Szczecin's Voivodeship 44.8 thou. ha of grasslands and 51.2 thou. ha of farmlands were meliorated, 74.5% out of which was the renovation of the existing drainages [17].

All of the above activities led to disappearance of the substantial number of ponds, which in turn entailed a series of negative phenomena within aquatic biocenosis, both in flora and fauna. Up till now in Poland mid-field ponds were ranked as wastelands, but their more and more documented biocenotic and phytocenotic role caused that presently activities are being undertaken in order to preserve them. The starting point for work associated with ponds preservation, except from recognition of their role in the landscape is inventory of the reservoirs preservation along with recognition of the factors which shape the dynamics of their disappearance.

Therefore the objective of this research was to determine the changes that mid-field ponds underwent on the area of Pomerania during last hundred years. Disappearance of the water bodies was presented in relation to respective mesoregions and the character of surface features, taking into consideration water surface size and melioration works conducted in the basin area.

MATERIALS AND METHODS

Topographic maps from the 19-hundreds (Koenigliche Preussische Landesaufnahme) in scale 1:25 000 and topographic maps from 1980 using the state co-ordinate system "1965" in scale 1:25 000 (GEOKART) were used for the analyses of mid-field ponds disappearance. The information pertaining location of the ponds, their size and the closest surroundings was obtained from the topographic maps in the scale 1:25 000. The research took into account the reservoirs with water surface up till 1.0 ha.

In order to ascertain the precision of the Polish topographical maps in the scale 1:25 000 as well as in cases where separation of the ponds on the maps was obstructed, topographical maps in scale 1:10 000 along with aerial pictures from 1948 and 1997 were used. During the analyses of melioration locations "Map of meliorated farmlands and regional directions of agricultural production" elaborated by Kowalczyk *et al.* was used [8].

The problem of the accurateness of the results achieved in case of such a small elements like water ponds was noted by the authors analysing the disappearance of the ponds [14, 3]. It is assumed that the topographic maps from the end of the 19-hundreds (Koenigliche Preussische Landesaufnahme) in respect to location of the water ponds are relatively accurate.

In order to compare topographic maps in respect of plotting of the water ponds a data base was elaborated, covering approx. 10% of ponds present at the end of the 19th century on the whole area researched (1100 objects out of 11074). Data relating to the ponds surface was obtained first by scanning and registration of the topographic maps and then by digitising of the water bodies surface. Detailed data base allowed amongst other things to determine accuracy of Polish edition of maps in scale 1 : 25 000 as far as plotting of water ponds and allowed to set a curve revising this error. Detailed description of the curve and the method of estimate calculation of ponds disappearance was presented in a research by Pieńkowski [11].

In case of an estimate evaluation of ponds disappearance, the error in Polish topographic maps was corrected based on the curve set by the author, whereas for the purpose of evaluation of melioration influence larger water bodies from 0.2 to 1.0 ha were chosen. Additionally only those mid-field ponds, which in both compared periods were located in the areas with unchanged land usage were considered. Researched ponds had surface between 0.1-1.0 ha. The ponds were classified to appropriate classes in the ranges presented on fig 2-3 and table 2. Every range of the ponds area corresponded to 1 mm on the map in scale 1 : 25 000 ($1\text{mm}^2 = 0.0625\text{ ha}$).

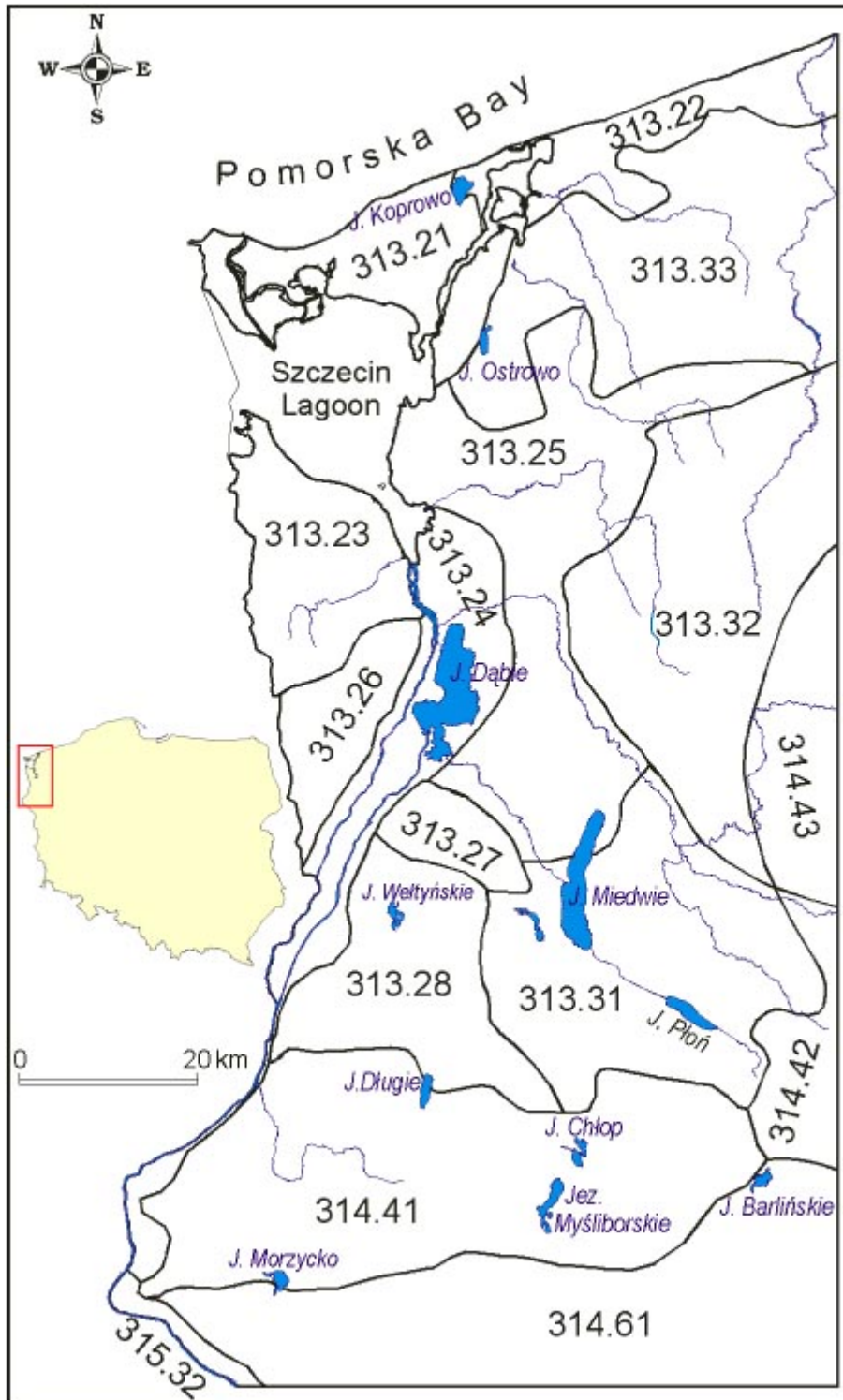
STUDIED AREA

The surface relief of the Pomerania is to the vital extend the effect of Scandinavian ice-sheet activities during the Pleistocene glaciation period. Great climate changes that took place at this time, contributed to formation and vanishing of ice-caps of the continental glacier characteristics.

The landscape of the studied area had been formed during the last glaciation (Vistulian), particularly Pomeranian stage. Flat and undulating plains of the ground moraine, split by a net of subglacial channels and river valleys are the dominant landscape features. Characteristic of this region are also wide, sandy areas of the Odra flood plain and Pyrzyce ice-dammed basin, filled with silt and clay formations. Lessive and brown earth cover the largest area upon clay and loamy sands. These are present mostly in the south, east and northeast part of this region. In the central and west central part sandy soils are dominant, common particularly on the Odra flood plain. Western Pomerania is characterised by a large area of black earths in the region of Pyrzyce ice-dammed basin, which because of their fertility were deforested rather early [10].

The researched area covering 9039 km² as per physico-geographical regionalisation of Poland [7] based of morphogenetical and landscape features, covers western part of the macro-regions: Southern Pomerania Lakeland, Western Pomerania Lakeland, and a fragment of the mesoregion of the Freienwald Basin, being a part of Torun-Eberswalde marginal stream valley. Mesoregions which are part of the area researched, with classification in decimal system is presented in [Fig. 1](#).

Fig. 1. Division of research area into mesoregions.
 313.21 – Uznam and Wolin, 313.22 – Trzebiatów Coast,
 313.23 – Wkrzańska Plain, 313.24 – Lower Odra Valley,
 313.25 – Goleniów Plain, 313.26 – Szczecin Hills,
 313.27 – Bukowe Hills, 313.28 – Weltyń Plain,
 313.31 – Stargard-Pyrzyce Plain, 313.32 – Nowogard Plain,
 313.33– Gryfice Plain, 314.41 – Myślibórz Lakeland,
 314.42 – Choszczno Lakeland, 314.43 – Ińskie Lakeland, 314.61 – Gorzów Plain

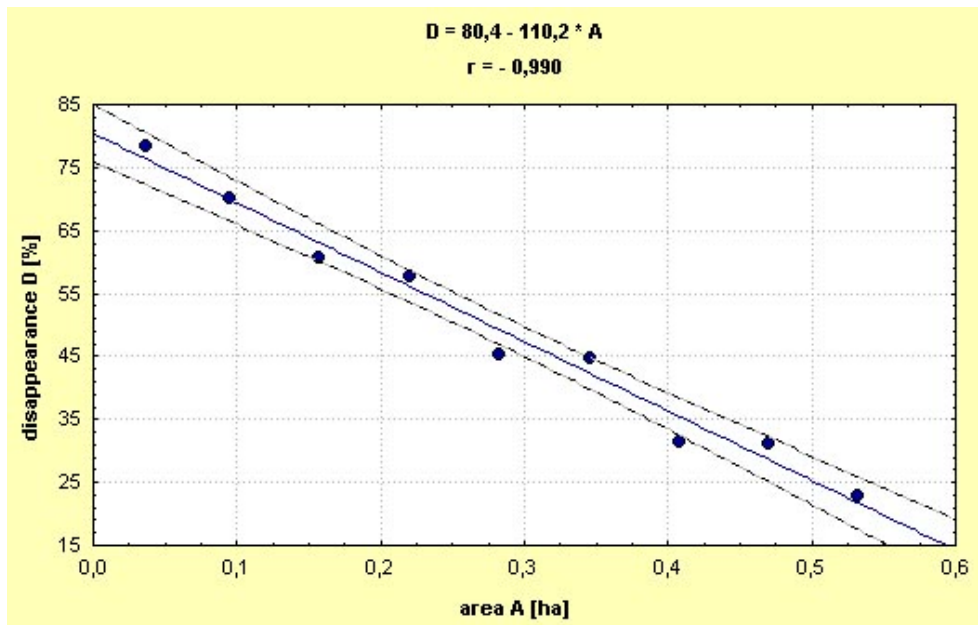


RESULTS AND DISCUSSION

Mid-field ponds at the end of the 19th century accounted for 59.4% of all small water bodies plotted on the maps. In comparison with the ponds located within the forested areas, meadows and in inhibited areas they were subject to land forming processes to much greater degree, therefore their share in a group of all small water bodies during the period of less than hundred years dropped to 39.4%.

Average disappearance of mid-field ponds between the end of the 19th and second half of the 20th century on the whole area researched was estimated at 70.2%. To a lesser degree disappeared ponds located on the meadows (65.5%), in the forests (63.0%) and in inhibited areas (39.5%). Diversification of disappearance rate between forested areas and fields was earlier noted by Ringler [14], who in the area of Wasserburg on the territory of 150 km² (between 1856-1974) ascertained disappearance of mid-field ponds amounting to 68%, whereas in forests disappearance did not exceed 22%. Similar, although not so high as by Ringler, diversification of disappearance on both forms of usage confirms the influence of agriculture and farming intensity on the number of ponds and as well of the role of forested areas where small basins are being preserved. This particularly takes place on abundantly formed areas, where favourable influence of the forest increases retention and decreases erosion phenomena. As it should be assumed amongst mid-field ponds the smallest ones disappeared faster (Fig. 2).

Fig. 2. Disappearance of mid-field ponds (D) depending on water surface (A) [11]



Considerable diversification of ponds disappearance was ascertained, both in relation to the mesoregions as well as to respective geomorphological structures, as presented in Table 1. Relatively high result of average disappearance of mid-field ponds was influenced by their very large degree of disappearance on Myślubórz Lakeland and Gryfice Plain, within which territories 53% of all mid-field ponds were located at the end of the 19th century. The lowest loss amounting to 46.4%, occurred on Trzebiatów Coastline, where in the area of morainic plateau only 36.6% ponds disappeared. Small losses of ponds occurred as well in the analysed part of Choszczno Lakeland, particularly in the area located within its plateau borders with large number of melt-out areas, where only 19,5% mid-field ponds disappeared. In comparison to disappearance results obtained for areas in Germany and Great Britain, disappearance of ponds on the researched fragment of Pomerania (9039 km²) considered as very high. Although quantities of ponds disappearance quoted by the German authors are very diversified and depending on the area researched vary from 28 to 88% [2, 5, 6, 13, 14, 16], those results however pertain to relatively small areas. For example the highest disappearance rate ascertained by Ringler [14] amounting 88%, was calculated for the area of 55 km². High degree of disappearance for intensely utilised farmlands is given as well by British authors. On the area of County Cheshire (named “pond capital” of Great Britain) disappearance of ponds between 1882 and 1985 amounted to 58.8%. Boothby [1] based on the data from 1872-1969 estimated average yearly disappearance at 0.50%. For the similar time period average disappearance on the whole researched area amounted 0.70% and it fluctuated from 0.47% on Wkrzańska Plain to 0.74% on Myślubórz Lakeland.

Table 1. Disappearance of mid-field ponds between the end of 19th and second half of the 20th century within the area of respective mesoregions and geomorphological forms

Forms of landscape	Pond loss [%]	Mesoregions	Pond loss [%]
Moraine plateau flat and wavy	68.9	Uznam and Wolin	68.0
Plateaus with large number of outwash	63.1	Trzebiatów Coast	46.4
Frontal moraines and other marginal forms	72.6	Wkrzańska Plain	65.2
Higher level plateau with glacial-tectonic structures	68.3	Lower Odra Valley	68.4
Outwash plains	67.0	Goleniów Plain	63.8
Subglacial channels	69.6	Szczecin Hills	66.1
I level Pyrzyce ice-dammed basin	57.1	Bukowe Hills	69.4
II level Pyrzyce ice-dammed basin	100.0	Wełtyn Plain	63.7
III level Pyrzyce ice-dammed basin	88.0	Stargard-Pyrzyce Plain	65.8
IV level Pyrzyce ice-dammed basin	87.9	Nowogard Plain	65.6
V level Pyrzyce ice-dammed basin	80.0	Gryfice Plain	71.3
I level Odra flood plain	70.0	Myślibórz Lakeland	73.6
II level Odra flood plain	68.4	Choszczno Lakeland	57.1
III level Odra flood plain	79.4	Irńskie Lakeland	62.7
IV level Odra flood plain	85.2	Gorzów Plain	67.1

Disappearance of mid-field ponds described earlier pertained instances of disappearance of the water surface not taking into account the information if this was related with total liquidation of the basin and taking it over for agricultural usage, or if there was a waterless depression left where the pond was earlier. Therefore during comparison of topographic maps diversification of the structures left behind the water ponds, separating reservoirs, which disappeared completely (ponds area was taken over by farmlands) or where in the vicinity of dried out water pond's basins vegetation marked on the maps as meadows, swamps or scrubs.

Out of the group of mid-field ponds, which in the 19th as well in the 20th centuries were located in the fields area, around 76% transformed to farmlands, and the reminding 22% account for agriculturally unused waterless depressions. The smallest ponds were primarily turned into farmlands this was due to their susceptibility for drying and possibility of ease for levelling the basin. During the time period of less than one hundred years 80.1% of the smallest ponds were taken over for farmlands, whereas over half of larger water bodies (0.5–1.0 ha) reminded as unused dry depressions (Table 2).

Table 2. Objects, which were formed from dried out mid-field ponds depending on the water surface size at the end of the 19th century

Kind of object on the map	Water surface size [ha]											
	0.010-0.065		0.066-0.125		0.126-0.188		0.189-0.500		0.501-1.000		0.010-1.000	
	Number (L) and percentage share (U) of objects in a group of ponds with given water surface size											
	L	U	L	U	L	U	L	U	L	U	L	U
Farmland	2042	80.1	620	74.6	241	70.2	210	64.4	18	36.7	3131	76.4
Meadow	263	10.3	74	8.9	26	7.6	30	9.2	5	10.2	398	9.7
Water-logged meadow	110	4.3	63	7.6	40	11.7	54	16.6	19	38.8	286	7.0
Shrubs	97	3.8	55	6.6	26	7.6	16	4.9	2	4.1	196	4.8
Ditch	32	1.3	15	1.8	9	2.6	16	4.9	4	8.2	76	1.9
Other	4	0.2	4	0.5	1	0.3	0	0.0	1	2.0	10	0.2
Total	2548	100.0	831	100.0	343	100.0	326	100.0	49	100.0	4097	100.0

In the case of drying out of the mid-field ponds reminding from the late 19-hundreds it was observed that the water surface has diminished significantly in respect of larger basins (Fig. 3). Amongst ponds 0.5–1.0 ha (state as of 19th century) in over 80% cases decrease of the water surface was ascertained. Therefore it should be taken in consideration that larger water bodies, even though during hundred years disappeared to the lesser degree, went through processes leading to complete disappearance.

Fig. 3. Changes of water surface of mid-field ponds which survived until the second half of the 20th century as compared to the water surface at the end of the 19th century.;
1 – surface decrease, 2 – no changes of the surface, 3 – surface increase

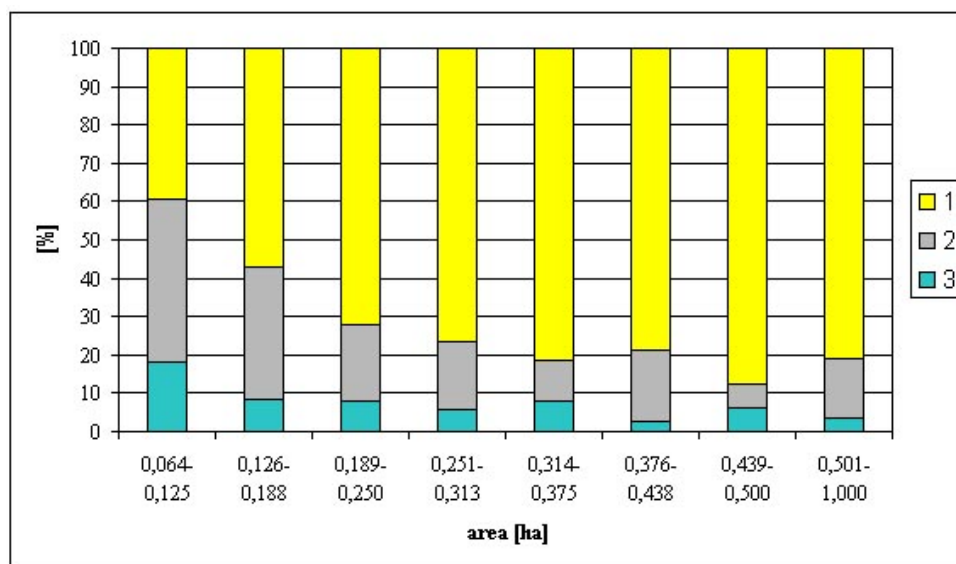


Table 3. Diversification of disappearance of mid-field ponds (area >0.2 ha) in the area of chosen mesoregions depending on melioration works conducted in 1946–1975 period

Mesoregions	Areas not covered with melioration			Areas covered with melioration			Difference of ponds disappearance on meliorated and non meliorated areas
	number of ponds in 19 th century.	number of ponds which survived till the second half of the 20 th century.	ponds disappearance [%]	number of ponds in 19 th century.	number of ponds which survived till the second half of the 20 th century.	ponds disappearance [%]	
Nowogard Plain	211	108	48.8	72	21	70.8	22.0
Gryfice Plain	159	58	63.5	42	10	76.2	12.7
Wełtyń Plain	230	74	67.8	80	22	72.5	4.7
Myślibórz Lakeland	535	205	61.7	153	57	62.7	1.0
Pyrzyce-Strag. Plain	145	57	60.7	67	26	61.2	0.5
Entire research area	1280	502	60.8	414	136	67.1	6.3

Table 4. Diversification of disappearance of mid-field ponds (area >0.2 ha) in the area of chosen geomorphological forms depending on melioration works conducted in 1946-1975 period

Geomorphological units	Areas not covered with melioration			Areas covered with melioration			Difference of ponds disappearance on meliorated and non meliorated areas
	number of ponds in 19 th century.	number of ponds which survived till the second half of the 20 th century.	ponds disappearance [%]	number of ponds in 19 th century.	number of ponds which survived till the second half of the 20 th century.	ponds disappearance [%]	
Frontal moraine	57	22	61.4	10	2	80.0	18.6
Plateaus with large number of melt-outs	220	103	53.2	65	20	69.2	16.0
Subglacial channels	179	80	55.3	31	10	67.7	12.4
Moraine plateau flat and wavy	840	310	63.1	284	103	63.7	0.6
Levels Pyrzyce ice-dammed basin	44	8	80.5	20	4	80.0	-0.5
Outwash plains	67	29	56.7	5	2	60.0	3.3

Diversified disappearance of water ponds on the areas of mesoregions under research was observed, depending on melioration works conducted during post-war years. (Table 3). The biggest difference occurred in the area of Nowogard Plain, which as compared with analysed Lakeland can be characterised and as having worst soils. In this mesoregion disappearance of ponds in the areas not covered with melioration amounted to 48,8%, whilst in meliorated areas reached as far as 70.8%. Diversification of mid-field ponds disappearance in relation to surface features (Table 4) allows to assume that the greatest influence of the melioration works conducted took place on richly formed areas of the frontal moraine and a plateau with a large number of melt-out areas, and smaller effect on surface moraine and levels of Pyrzyce Hollow.

CONCLUSIONS

1. Mid-field ponds at the end of the 19th century constituted 59% of all water bodies located in the area researched. Due to the fact that they underwent land forming processes to the greater degree, their share in all water bodies count during the period of less than hundred years has dropped to 39%.
2. The smallest ponds were primarily turned into farmlands this was due to their susceptibility for drying and possibility of ease for levelling the basin. Whereas over half of the larger dried out ponds (0.5-1.0 ha) reminded in a form of unused depressions. Dry depressions are abundant in the areas where melioration works were conducted in the past-war period.
3. Larger degree of mid-field ponds disappearance was ascertained on the fields with land melioration. The largest disappearance occurred in the area of Nowogard Plain, which as compared to the analysed Lake District area – has worst soils. Loss of mid-field ponds in this mesoregion on farmlands, which are not covered with melioration works, amounted to 49%, while in meliorated areas 71%.
4. Diversification of mid-field ponds disappearance between meliorated and non meliorated areas in relation to surface features allows to assume that the greatest influence of the melioration works conducted took place on richly formed areas of the frontal moraine and a plateau with a large number of melt-out areas, and smaller effect on surface moraine and levels of Pyrzyce ice-dammed basin.

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