Contemporary Problems of Management and Environmental Protection
Vol. 3, 2009. Natural and Cultural Transformation of Landscape: 83-96

CHAPTER 7

Krzysztof Starczewski, Szymon Czarnocki

CHANGES IN AGRICULTURAL LANDSCAPE BASED ON TRANSFORMATION OF MID-FIELD PONDS

Introduction

Cultural landscape is a landscape in which you can see a distinct change resulting from human activity. At the same time its existence is only possible thanks to the constant human handling sometimes preventing complete devastation. If human activities are adapted to the character of the natural and geographic environment there is a harmonious cultural landscape, but if humans violate the natural balance of components of biocenosis, and thus create durable and progressive adverse effects, such action results creation a cultural landscape degenerated (BOGDANOWSKI et al. 1979). Agricultural landscape is one of the types of cultural landscape. Among its parts natural and semi-natural in different degree changed by man can be found mid-field and mid-forest ponds. Features common to these objects are small size (surface area not exceeding 1ha) and mostly small depth (generally not exceeding 2m). Due to the location in the areas of human economic activities small water tanks are subjected to very strong anthropopressure.

The purpose of this study is to attempt to present the problem of disappearance of mid-field and mid-forest ponds, identify the causes of this state of affairs and possible prevention of further adverse changes in the future.

Small water reservoirs division

In principle, the water bodies can be divided into two groups:

- the original water bodies, resulting melt masses of the dead ice from glacier,
- secondary water bodies, which are often the direct or indirect result of human activities (after-care: excavation of the chalk, clay, peat, aggregates, quarries; landslides caused by mining damages, settling

tanks and the remnants of the traditional agricultural economy: derelict fish ponds, tanks for soaking flax or watering livestock).

In addition to the ponds is also distinguished wet depressions, which have relatively small catchments area, and at the bottom from impermeable layer formed from the gathering silt. During dry years, such depressions are successfully used for agricultural purposes, however while the winter is rich in precipitation may be even greater part of the growing season filled with water (KLAFS et al 1973).

KLAFS et al. (1973) proposed the division of the original ponds takes into account the successive stages of development. Highlights a typical small water reservoirs undrained and drained, flooded and covered.

Depending on water conditions the small water reservoirs can be divided into permanently and temporarily filled with water. Water bodies permanently filled with water can be divided into eutrophic, polytrophic and hypertrophic, those one on periodic and episodic fill with water (LUTHARDT, DREGER 1996).

While the number and spacing in the area of secondary small water reservoirs depends primarily on the intensity of human activity, then the presence of the original small water tanks is a very characteristic element of the landscape for rich sculpture of the earth's surface Polish Lowland areas covered by the last glaciation. In Poland, especially its northern part is the highest level of European lakes and other water reservoirs. KONDRACKI (2000) reported that in 1978, throughout the country, there were 23 580, of which 45% of the tanks were less than 1 hectare. SZAFRANSKI (1997) provides for other authors, that the number of ponds in earlyglaciar areas comes to 200 per 100 km^2, and in same places up to 100 per 1km^2. The Masurian Lake District density of small reservoirs ranges from 0.67 to 9.64 per 1 km^2, sometimes exceeding 30 per 1 km^2 (SOLARSKI, NOWICKI, 1990). In the area of north-western Polish highest density small water reservoirs was observed on the Wełtyńska Plain and Pyrzycko-Stargardzka Plain (2.3 per 1 km^2) (PIENKOWSKI 2003). Very similar results obtained JUSZCZAK (2001) analyzing the western part of the catchment area of the trench Wyskoć.

The importance of small water reservoirs

Small water reservoirs are undoubtedly elements which raising value of the landscape and holding a lot of ecological functions. KOC

(2000) as their basic values from the standpoint atractiv of the landscape mentions: elimination of straight lines and planes, extending the line of contact and area of penetration of different landscapes, creating the impression of the natural landscape, harmonious. Also MIODUSZEWSKI (1994) emphasizes the important role of water tanks in enhancing the aesthetics of the landscape.

OLACZEK (1990) scored as the most important biocenotic and physiocenotic features. Especially valuable are mid-field ponds, which, as the refuge environment are a place interim stay migrant fauna. MIODUSZEWSKI (1997) emphasizes that in the area of contact of water and land observed the greatest abundance of biological life, there is a large diversity of forms and species of flora and fauna. Reduce the number of small water tanks leading to the elimination ecotons causes significant depletion of natural resources, and reduce biological diversity. Mid-field ponds fulfill a function as the base of food and water, are a hiding place, a place of multiplication and the exchange of individuals between populations, become a place of temporary stay many of migratory organisms (KOC et al. 2001). Particularly important are the areas with high density of small water reservoirs, because the distance between objects can not exceed the maximum distance, which can overcome the individuals of the species (LAAN, VERBOOM 1990). This applies particularly to amphibians but also the survival of other species may be threatened as a consequence of the liquidation of individual tanks. PIENKOWSKI (2003) indicates that the loss of only two of nine mid-field tanks, prevented the migration of different groups of individuals of the species of aquatic beetles and, consequently, their isolation. Especially dangerous for the existence of certain species is a progressive urbanization. Even if the ponds were not degraded, cut off them from the entire ecosystem through various kinds of roads or human settlements can drastically affect the viability of individual species.

Collection of water in the mid-field tanks increases the resources of water not only within the same tank. Much more important is to raise the groundwater level at a relatively large area adjacent to the reservoir. This allows, in many cases, quite a marked improvement in water balance and stabilization of groundwater levels and mitigate the fluctuations in the outflow (KOC et al. 2001, KOSTURKIEWICZ, FIEDLER 1995, MIODUSZEWSKI 1994). The presence of the water surface contributes to the increase humidity of air in the vicinity of the

tank, thereby reducing the temperature fluctuations, especially during periods of high temperature (KOC et al. 2001, JUSZCZAK 2001).

Mid-field ponds can to a degree protected from the degradation of some natural resources, and thus perform the sozological functions. The collection of nutrients and pollutants to prevent their penetration into other areas (KOC et al. 2001, KOWALEWSKI 1997, MIODUSZEWSKI 1994). However in this case, this feature is often the primary cause of the disappearance of the tank, and above all, manifested by changes among the organisms inhabiting the tank. STRUTYŃSKI and GAŁKA (1997) found significantly higher losses of fish in ponds capture pollution.

SKWIERAWSKI (2005a) emphasizes that the role of individual water bodies due to their different status and anthropogenic transformation is not equal. In extreme cases (objects degraded, impoverished ecosystem structure), such objects can become quite burdensome and detrimental to the organisms inhabiting them and the surrounding areas. Hence the need to identify both the valuable natural waters, as well as the degraded, requiring protective measures and rehabilitation.

Ponds undoubtedly serve economic functions, collecting the water supply available to plants, thus stabilizing yields, especially in deficient rainfall. Especially in dry years around water bodies may become important sources of feed for animals, both wild and farmed (MIODUSZEWSKI 1994). Not without significance is the role which ponds play in enhancing the attractiveness of the tourist area. Some of the small water reservoirs can be used by fishing enthusiasts or hunters.

Small water reservoirs degradation

All mid-forest and mid-field ponds turn to the land process, which is edited largely by the level of anthropopressure. WOŁEJKO et al. (2004), based on analysis of maps of central Wielkopolska, showed that the number of small mid-field reservoirs was reduced from the late nineteenth century to 1961 to 77.5%. NOWICKI (1997) reported that leakage quantity-quality parameters of ponds in each hydrographic catchments in the Masurian Lake District are within the limits of 50-90%. PIENKOWSKI (1996) reported that the number of small water reservoirs of the Wełtyńska Plain fell during the twentieth century by 65%. Newer studies also confirm the results obtained

previously. On Polish north-west territory decrease in the number of ponds in less than 100 years averaged 63%, and in some mesoregions were much higher: Zastoisko Pyrzyckie - 76%, Gorzowska Plain - 72%, Myśliborskie Lakeland - 71% (PIENKOWSKI 2003). It is a universal phenomenon, not only on Polish territory. In a study conducted in Germany the number of ponds disappearance in different periods of the twentieth century, was from 28 to 88% (KALETTKA 1996), while BOOTHBY et al. (1994) confirmed the occurrence of a similar process in the UK.

Threats to water tanks due to human activities. JUSZCZAK (2001) counted to them: drying meliorations, sewage drop, waste disposal, neighborhood dumping sites, buildings, farmland and roads paved, the farming of fish, fishing, cutting trees and shrubs, and grazing cattle. To the basic causes of decline mid-field or mid-forest hollows without outflow are, however, activities related to the intensification of agriculture.

The most serious cause of loss of wetlands WOŁEJKO et al. (2004) found a change in their hydrological regime, caused by dehydration. Intensification of melioration work resulted in the decimation of ponds. PIENKOWSKI (2003) found that the greatest degree of decline occurred ponds on arable land, particularly those covered meliorations drainage. Such works in Poland have been performed especially strongly in the 60s and 70s of the twentieth century (NOWICKI, 1997). PIENKOWSKI (2003) says that such actions resulted in reducing the level of groundwater in the West Pomerania of 20-30cm.

Human activity has contributed to rapid growth, natural otherwise, the aging process of water tanks, depending on the pass tanks from the natural state of oligotrophic to eutrophic (WOŁEJKO et al. 2004). Eutrophication is a process of increasing nutrients in the water, mainly nitrogen and phosphorus, and the related to them development of aquatic plants (DOJLIDO 1995).

Mans work caused that eutrophication in many cases goes beyond the pace of natural transformations (KOC, SKWIERAWSKI 2004). Fertile substances hit the water with industrial waste water and municipal and flow from the surface of ground, mostly from areas of intensive agricultural crops (DOJLIDO 1995), or rural settlements, which are still in the vast majority are not channelized (KOC, SKWIERAWSKI 2004). Depending on the type of catchment areas to the water goes pollution with different chemical composition. The catchment areas collects

water from the housing and hamlet estate are dominated by phosphates, chlorides and potassium compounds, while in the catchment forest significantly higher than in the agricultural catchment are concentrations of ions K^+ and NH_4^+ (PIJANOWSKI, KANOWNIK 1997). Quantity contained in the waters of the compounds is also varied throughout the year. Maximum concentrations of most components were observed during the summer months, only the concentration of ammonium and nitrate nitrogen in the summer was at its lowest (KOC, SKWIERAWSKI 2004, MICHALCZEWSKI, GORALCZYK 1997, PIJANOWSKI, KANOWNIK 1997).

Further the effect of eutrophication is a gradual succession of vegetation, which consequently leads to shallow the ponds as a result of increased transpiration and deposition of dead debris on the bottom of the tank. Analysis of the sediments of selected ponds in the area of Mecklenburg showed that in the second half of the twentieth century, the rate of sedimentation has increased more then dozen times (PIENKOWSKI 2003). In the small water reservoirs there is also the sedimentation of material from the surrounding areas with flow surface, and the severity of erosion is associated with changes in the structure of land use in catchment areas (eg intensive farming on organic soils) (KOC, SKWIERAWSKI 2004), or destruction shoreline vegetation (KLOSS et al. 1987). In studies PIENKOWSKI (2003) the number of small water reservoirses surrounded by a belt of coastal vegetation has decreased in 100 years by 33%. Due to reduced depth of ponds more often comes to their periodic drying out, which further promotes the succession of plant species. Drying reservoirs is also greatly accelerated by water pollution. With the increase in water turbidity, increasing albedo, and so much more water is heated and evaporates quickly.

Dangerous to the continued existence of many ponds are recurring periods of drought. FIEDLER (2005) showed that the variability of water resources in the analyzed mid-field ponds, both during the year and many years, was associated mainly with the course of weather conditions. Some of the small mid-field ponds dry up completely in dry years. This is also confirmed by KORYTOWSKI et al. (2005), who also note a strong influence on the process of water supplies stored in a half-winter. Research of SKWIERAWSKI (2005b) conducted at the Olsztyn Lakeland showed that only 56% of the small water reservoirs

always maintained a mirror of water, while the rest of the periodically desiccated.

In many cases, people take a much more radical action to tackle mid-field ponds. Tanks are inundated soil derived from different types of excavations, or other materials such as stones, straw and garbage (KOCHANOWSKA et al. 1996). Such practices are particularly dangerous for the smallest ponds.

Small water reservoirs protection

Protecting ponds will undoubtedly linked to the advanced work aimed both to halt the dying process and replacement of damaged and building new small water reservoirs. Most authors recommend to start from the shares awareness of the area residents about the functions and importance of small water reservoirs (JUSZCZAK 2001, MIODUSZEWSKI 1996, NOWICKI 1997). Durability ponds also depends on the general mechanisms, including economic, conducive to maintaining such facilities. This may be the agri-environmental programs designed to protect the natural and rural environment (PIENKOWSKI 2003). Ponds most valuable for nature should be protected, for example, recognizing them as ecological use or position of the evidentiary (JUSZCZAK 2001).

Recommendations for the protection of mid-field ponds can be broadly divided into two groups: the prevention of further degradation and reconstructing conditions in facilities in varying degrees of transformation (JUSZCZAK 2001, MIODUSZEWSKI 1994, NOWICKI 1997).

Prevention should consist in an appropriate land use of catchment agricultural area, antierosional measures, phytomelioration and agromelioration having a major impact in slowing the circulation of water and matter and thus restricting the movement of pollutants (MIODUSZEWKI 1994). A very effective form of protection of water reservoirs is the creation or protection of existing biogeochemical barriers. Such function can be grasslands, shrubs or trees arranged along the banks of ponds. The width of such zones should be dependent on soil and geological conditions, land slope and the possibility of exempting the land from agricultural production or a change in management (JUSZCZAK 2001, MIODUSZEWSKI 1994).

Phot. 1. Flooded peat excavation Hodzież community Serokomla Province. Lublin, *photo: S. Czarnocki*

Phot. 2. Shallowed mid-field pond around Korczew Province. Mazovia, *photo by K. Starczewski*

Phot. 3. Completely overgrown mid-field pond Czarnoty community Paprotnia Province. Mazovia, *photo: S. Czarnocki*

Phot. 4. Mid-field pond in the village Latowicz Province. Mazovia. June 2008, *photo E. Bogusz*

Phot. 5. Mid-field pond in the village Latowicz Province. Mazovia, April 2009, *photo E. Bogusz*

Phot. 6. Mid-field pond created for commercial purposes - Czarnoty community Paprotnia Province. Mazovia, *photo: S. Czarnocki*

Tanks that have been degraded to the extent that self-cleaning should be covered by the reclamation works. Such work may include: removal of organic silts or refuses and deepen (JUSZCZAK 2001).

Is vitally important water monitoring in rural areas, thus ensuring continuous processes occurring in the surrounding water areas (MIODUSZEWSKI 1996).

Increasingly important part among mid-field ponds are newly created objects, usually by various excavations. This is partly due to legal regulations, as exploitation of minerals, now at the stage of the authorization by the investor, is associated with the corresponding need of remediation. Depressions after extract materials is very often filled with water, due to the fact that it is the most economical solution (PIENKOWSKI 2003, WOŁEJKO et al. 2004). However, in the case of new tanks process of succession of vegetation and fauna is usually long, especially since very often these tanks do not meet the requirements of nature conservation and landscape. WOŁEJKO et al. (2004) specify what features should be characterized by optimal natural water reservoir. Basic requirements include: large parts of the edge should be flat (low slope), fragments of shallow and deeper place, large parts of the aquatic or marshland vegetation , the water surface should has fragments of sunny and shady parts and pure water.

MIODUSZEWSKI (1996) recommends the inclusion of the construction program of small water reservoirs in the regional spatial development plans and provide free advice to individual investors in the planning, implementation and utilization of small water reservoirs.

Summary

Halt disappearing mid-field ponds will be a very difficult task. This process can not oppose even bigger tanks. PŁYWACZYK and KOWALCZYK (2007) by the other authors indicate that the number of inventoried lakes in the Poland territory decreased in the second half of the twentieth century from 9296 to 7081.

Much easier to prevent or eliminate the risk if they are properly identified, hence the need to take a problem or a hazard classification or valuation mid-field ponds on the basis of their exposure to various hazards. Presented a review shows that this theme is carried out by many researchers, which allows you to believe that sytuation will be noticeable improve.

Important will be provide funding from the state budget, local administrations and other institutions or organizations to support efforts to protect the mid-field ponds (MIODUSZEWSKI 1996).

REFERENCES

BOGDANOWSKI J., ŁUCZYŃSKA-BRUZDA M., NOWAK Z. 1979. *Architektura krajobrazu*, Warszawa-Kraków

BOOTHBY J., HULL A.P., JEFFREYS D.A. 1994. *Ponds Landscapes; fragmentation pressures and survival mechanisms. in "Fragmentation in agricultural landscapes*". Preston 13-14th September 1994. IALE: 54-61

DOJLIDO J. R.1995. *Chemia wód powierzchniowych*, Wyd. Ekonomia i Środowisko, Białystok

FIEDLER M. 2005. *Zmienność zasobów wody retencjonowanej w śródpolnych oczkach wodnych na Pojezierzu Gnieźnieńskim.* Zesz. Probl. Post. Nauk Rol. 506: 145-150.

JUSZCZAK R. 2001. *Inwentaryzacja, waloryzacja i ochrona małych zbiorników wodnych w krajobrazach rolniczych*. Zesz. Probl. Post. Nauk Rol. 476: 379-387.

KALETTKA T. 1996. *Die Problematik der Sölle (Kleinhohlformen) im Jungmoränengebiet Nordsostdeutschland.* Naturschutz u. Landschaftspflege in Brandemburg, Sonderheft "Sölle": 4-12

KLAFS G., JESCHE L., SCHMIDT H. 1973. *Genese und systematik wasserführender Ackerhohlformen in den Nordbezirken der DDR*. Arch. Naturschutz und Landschaftsforschung 13: 287-302.

KLOSS M., KRUK M., WILPISZEWSKA I. 1997. *Geneza, charakterystyka przyrodnicza i przekształcenia antropogeniczne zagłębień bezodpływowych we współczesnym krajobrazie Pojezierza Mazurskiego*. Kosmos 36 (4): 621-641.

KOCHANOWSKA R., BOROWIEC S., WOŁEJKO L. 1996. *Różnorodność śródpolnych użytków ekologicznych na Pomorzu Szczecińskim*. Prz. Nauk. Wydz. Melior. Inż. Środ. 10:25-32

KOC J. 2000. *Ekologiczne znaczenie ochrony i renaturyzacji oczek wodnych w:' Renaturyzacja obiektów przyrodniczych – aspekty ekologiczne i gospodarcze*. Wyd. UMCS Lublin: 123-130

KOC J., CYMES I., SKWIERAWSKI A., SZYPEREK U. 2001. *Znaczenie ochrony małych zbiorników wodnych w krajobrazie rolniczym*. Zesz. Probl. Post. Nauk Rol. 476: 397-407.

KOC J., SKWIERAWSKI A. 2004. *Uwarunkowania jakości wody małych zbiorników na obszarach wiejskich*. Zesz. Probl. Post. Nauk Rol. 499: 121-128.

KONDRACKI J. 2000. *Geografia regionalna Polski*. PWN Warszawa.

KORYTOWSKI M., SZAFRAŃSKI CZ., STASIK R. 2005. *Zmiany retencji wody w mikrozlewni leśnej w roku wilgotnym i suchym*. Zesz. Probl. Post. Nauk Rol. 506: 261-267.

KOWALEWSKI Z. 1997. *Małe zbiorniki wodne jako element poprawy jakości wód powierzchniowych. w „Zbiorniki wodne. Rola w Krajobrazie rolniczym".* IMUZ Falenty: 29-50.

LAAN R., VERBOOM B. 1990. *Effects of pool size and isolation on amphibian communities*. Biol. Conserv. 54: 251-262.

LUTHARD V., DREGER F. 1996. *Ist-Zustands-Analyse und Bevertung der Vegetation von Söllen in der Uckermark*. Naturschutz u. Landschaftspflege in Brandemburg, Sonderheft „Sölle": 31-38.

MATUSZEWSKI W. 1996. *Kształtowanie retencji wodnej w krajobrazie rolniczym, w „Potrzeby i możliwości zwiększania retencji wodnej na obszarach wiejskich",* IMUZ Falenty: 7-11

MICHALCZEWSKI M., GÓRALCZYK M. 1997. *Badania jakości wód powierzchniowych w zlewni wskaźnikiem monitoringującym zmiany oddziaływania rolnictwa na środowisko wodne*. Rocz. AR Pozn. CCXCIV, Melior. Inż. Środ. cz. II: 339-345.

MIODUSZEWSKI W. 1994. *Ochrona i kształtowanie zasobów wodnych w małych rolniczych zlewniach rzecznych*. Mat. Inf. IMUZ Falenty

MIODUSZEWSKI W. 1997. *Rola małych zbiorników w środowisku przyrodniczym, w „Zbiorniki wodne. Rola w Krajobrazie rolniczym*". IMUZ Falenty: 7-18

NOWICKI Z. 1997. *Problematyka degradacji oczek wodnych na Pojezierzu Mazurskim*. Rocz. AR Pozn. CCXCIV, Melior. Inż. Środ. cz. II: 365-371.

OLACZEK R. 1976. *Siedliska marginalne w systemie klasyfikacji gruntów i problemów ekologicznych. w „Użytki ekologiczne w krajobrazie rolniczym".* SGGW-AR, Warszawa; 7-24.

PIEŃKOWSKI P. 1996. *Przekształcenia oczek wodnych na przykładzie północnej części Równiny Wełtyńskiej*. Zesz. Nauk. AR Szczecin Ser. Rol. 63:37-41.

PIEŃKOWSKI P. 2003. *Analiza rozmieszczenia oczek wodnych oraz zmian w ich występowaniu na obszarze Polski Północno-zachodniej*, AR Szczecin

PIJANOWSKI Z., KANOWNIK W. 1997. *Zmienność stężeń wybranych substancji chemicznych w wodach powierzchniowych przepływających przez tereny wiejskie o różnym zagospodarowaniu*. Rocz. AR Pozn. CCXCIV, Melior. Inż. Środ. cz. II: 347-358.

PŁYWACZYK A., KOWALCZYK T. 2007. *Gospodarowanie wodą w krajobrazie*. UP Wrocław 2007

SKWIERAWSKI A. 2005 a. *Ocena stanu małych zbiorników wodnych na terenach wiejskich.* Cz. I. Metoda waloryzacji małych zbiorników. Zesz. Probl. Post. Nauk Rol. 506: 391-401.

SKWIERAWSKI A. 2005 b. *Ocena stanu małych zbiorników wodnych na terenach wiejskich.* Cz. II. Zastosowanie metody do oceny stanu małych zbiorników na Pojezierzu Olsztyńskim. Zesz. Probl. Post. Nauk Rol. 506: 403-413.

SOLARSKI S., NOWICKI Z. 1990. *Możliwości retencyjne oczek wodnych na Pojezierzu Mazurskim*. Acta Acad. Agricult. Tech. Olst., Geod. Rul. Regul. 20: 173-183.

STRUTYŃSKI J., GAŁKA A. 1997. *Stawy rybne jako bariery dla zanieczyszczeń wnoszonych z wodami zasilającymi.* Rocz. AR Pozn. CCXCIV, Melior. Inż. Środ. cz. II: 319-325.

SZAFRAŃSKI CZ. 1997. *Rola zabiegów agromelioracyjnych w gospodarce wodnej i w ochronie przeciwerozyjnej terenów bogato urzeźbionych, w „Agromelioracje w kształtowaniu środowiska rolniczego"* AR Poznań: 160-207.

USTAWA 2004. Ustawa o ochronie przyrody z dnia 16 kwietnia 2004 r. Dz. U. z dnia 30 kwietnia 2004 r.
WOŁEJKO L. STAŃKO R., PAWLACZYK P., JERMACZEK A. 2004. *Poradnik ochrony mokradeł w krajobrazie rolniczym.* Wyd. Klubu Przyrodników, Świebodzin.

Krzysztof Starczewski
Department of Grassland And Creation Of Green Areas
University of Podlasie, Siedlce,
B. Prusa Street,
08-110 Siedlce, Poland
tel. +48/25/643-13-17, fax +48/25/643-13-09
Szymon Czarnocki
Department of General Cultivation Of Soil, Plants And Agricultural Engineering
University of Podlasie, Siedlce,
B. Prusa Street,
08-110 Siedlce, Poland
tel. +48/25/643-13-06, fax +48/25/643-13-09