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Threats to and Deterioration of Small Water Reservoirs Located within Wyskoć Catchment

R. Juszczak, A. Kędziora*

Department of the Agrometeorology, A. Cieszkowski Agricultural University of Poznań
Ul. Witosa 45, 60-667 Poznań, Poland

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Abstract

Small water reservoirs play many important natural, hydrological and economical functions in the agricultural landscape. They are subjected to very strong anthropogenic pressure, leading to their quantitative and qualitative degradation. A classification proposal for small water reservoirs in an agriculturals from a deterioration point of view is presented in this paper. Classification is based on analysis of the following phenomena and processes: drainage, sewage drops, landfills, cattle pasturage, fish farming, fishing, tress and shrubs cut out as well as bordering on urban areas, country roads, landfill sites or cultivated fields. Four classes of anthropogenic impact were distinguished. Reservoirs free from any anthropogenic impact constitute the first class.

Keywords: small water reservoirs, threats and deterioration of small midfield ponds, protection of reservoirs in agricultural landscape

Introduction

Small reservoirs of surface waters are essential elements of agricultural landscapes typical for post-glacial areas. From natural, hydrological and economic points of view they play many important functions. As local banks of wild species of plants and animal genes, islands and ecological corridors, as well as depots assuring e.g. sheltering, watering and feeding places of hunted games they increase the natural attractiveness of agroecosystems [1, 2, 21, 27]. The water reservoirs have significant influence on ground-water level and soil water economy of adjoining areas [12], as well as microclimate formation [22] and water retention [17]. Therefore, they profitably modify the structure of water and heat balances of their watershed areas [13]. They also play biogeochemical barrier functions by controlling non-point pollution expansion [16, 23, 24, 26]. At the same time, they perform many economic functions [17] as well as increase aesthetical values of landscape [11]. These ecosystems are currently under strong anthropopressure. In the past few decades, a considerable decrease both in numbers and surface of those objects can be observed [8, 19, 20]. These phenomena have been caused by excessive intensification of agricultural production (cultivated field surface enlargement by purposeful filling and draining of small midfield ponds [6, 11, 15, 18]). Small water reservoirs are often used for sewage drops and landfills. Thus, they are subjected to total but slow qualitative and quantitative degradation [3, 5, 7, 28]. Therefore, owing to the progressive process of small water reservoir degradation, we ought to undertake activities assuring protection and natural reconstruction of elements of the natural environment.

*Corresponding author, e-mail: kedan@poczta.onet.pl

Materials and Methods

Area Studies

Inventory control of water reservoirs were carried out in 1999 and 2001 in the Wyskoć catchment area. This watershed is situated in the central part of Kościan Plain Region

Table 1. The kind of threats and classes of anthropogenic pressure put on water reservoirs in agricultural landscapes.

Classes of antropogenic pressure	Type of threat	Character
I	• Lack of negative anthropogenic influence.	The negative influence of anthropogenic factors was not observed. There are most valuable reservoirs with large ecological values. They should be protected as ecological sites.
II	• It borders on cultivated field • It borders on country road • It borders on urban area	The anthropogenic pressure is small. There are reservoirs that usually have large ecological values. Legal protection is recommended.
III	• Fish farming • Fishing • Trees and shrubs cut out • Cattle pasturage	Strong anthropogenic pressure put on reservoirs causes deterioration of their ecological values. These processes should be controlled. One has to make an effort to legally protect reservoirs, so as to prevent their progressive degradation.
IV	• Drainage • Sewage drops • Landfills • It borders on landfill site	Anthropogenic pressure put on reservoirs is very strong. Within the class there are reservoirs subjected to deterioration and even demotion. Protection and reclamation activities should make an urgent effort to restore their ecological and landscape values.

(in Wielkopolska region), which is a part of Leszczynskie Lake District in the Odra river basin. The catchment area is equal to 182.46 km^2 and clearly divides into two parts: the western part of about 101.35 km^2 (typically rural landscape), as well as the eastern part of about 81.11 km^2 (with larger part of forests, lakes and swamps) [10].

Experimental Procedures

The study of the negative influence of anthropogenic factors onto values of water reservoirs was carried out in support of the following analysis: drainage, sewage drops, landfills, cattle pasturage, fish farming, fishing, as well as trees and shrubs cut out. In this opinion was also considered the potentially negative impact of areas bordering water reservoirs, i.e. landfill sites, urban areas, country roads and cultivated fields. The qualitative degradation of studied hydrographic objects is caused by mention of the above kinds of treats, especially by intensive eutrophication of reservoir waters.

Four classes of anthropogenic impact were set, so as to evaluate anthropogenic threats and degradation degrees exerted onto studied reservoirs (Table 1). Reservoirs free of any anthropogenic impact constitute the first class. Within that class there are the most valuable reservoirs with large ecological advantages. The second, third and fourth classes of anthropogenic impact include reservoirs that occur in at least one of the above-mentioned types of anthropopressure. The higher the class, the greater the anthropogenic pressure and degradation degree of water reservoirs. About rating the studied reservoirs to a given class of anthropogenic pressure – in accordance with criterion of maximum – factor creating largest threat (belonging to higher class) decides.

The conception of small water reservoirs classification in the context of their degradation and threats was presented in the paper "Ecological and land improvemental valorization of small water reservoirs in agricultural landscape of Wielkopolska" [9].

Results

627 water reservoirs (without artificial pools) were studied in the Wyskoć catchment area. The average density of reservoirs is 3.4 reservoir/km^2. The number of reservoirs is over twice larger in the eastern part of the watershed than in the western part. The density of water reservoirs in the western part of the watershed equals 2.4 reservoir/km^2, whereas in the eastern part equals 4.9 reservoir/km^2 [9]. Most of the studied reservoirs have typically anthropogenic origin. In fact, post-peat reservoirs, reservoirs in excavations of gravel and clay as well as artificial pools reach as much as 74% of studied objects. The percent of post-peat reservoirs in the eastern part of studied catchment is almost twice larger then in the western. However, in the latter case there are over twice as many reservoirs in excavations of gravel and clay and artificial pools. Generally about 36% of reservoirs were numbered to potentially "natural" group of small ponds that have post-glacial origin (Table 2). This would conform with Frielinghaus' studies [4], which affirm that about 40% of water reservoirs in agricultural landscape exemplify post-glacier ponds.

Analysis of maps in 1:10,000 scale from 1983 and aerial photographs from 1986 and 1996 allowed us to observe changes in the number of water reservoirs that took place in 20 recent years on studied watershed area (Table 3). In this period 25 water reservoirs were entirely filled up. These changes concerned generally the smallest reservoirs equal to 100-200 m^2. Simultaneously, 65 reservoirs

Table 2. The kinds of water reservoirs that occur in the Wyskoć watershed (artificial pools were considered in calculations). 2A – proportional part of reservoirs in refer to individual part of the watershed, 2B – proportional part of reservoirs in refer to the whole watershed.

2A

Category of the inventoried reservoirs	Western part		Eastern part	
	Number of reservoirs	Percentage 239=100%	Number of reservoirs	Percentage 401=100%
Post-peat reservoirs	89	37.2	256	63.8
Reservoirs in excavations of gravel and clay-pits	28	11.7	22	5.5
Artificial pools	8	3.3	5	1.2
Others, including natural post-glacial ponds	114	47.8	118	29.5
Total	239	100	401	100

2B

Category of the inventoried reservoirs	Western part		Eastern part		The whole watershed	
	Number of reservoirs	Percentage 640=100%	Number of reservoirs	Percentage 640=100%	Number of reservoirs	Percentage 640=100%
Post-peat reservoirs	89	13.9	256	40.0	345	53.9
Reservoirs in excavations of gravel and clay-pits	28	4.4	22	3.4	50	7.8
Artificial pools	8	1.2	5	0.8	13	2.0
Others, including post-glacial ponds	114	17.8	118	18.4	232	36.3
Total	239	37.3	401	62.7	640	100

Table 3. Change of water reservoirs number in Wyskoć watershed over 20 years from 1980 to 2000 (artificial pools were not considered in calculations). 3A – proportional part of reservoirs in refer to individual part of the watershed, 3B – proportional part of reservoirs in refer to the whole watershed.

3A

Category of reservoirs	Western part		Eastern part	
	Number of reservoirs	Percentage 231=100%	Number of reservoirs	Percentage 396=100%
Reservoirs dug	15	6,5	50	12.6
Reservoirs enlarged	2	0,9	19	4.8
Reservoirs filled	10	4,3	15	3.8

3B

Category of reservoirs	Western part		Eastern part		The whole watershed	
	Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%
Reservoirs dug	15	2.4	50	8.0	65	10.4
Reservoirs enlarged	2	0.3	19	3.0	21	3.3
Reservoirs filled	10	1.6	15	2.4	25	4.0

were dug as well as next 21 were rebuilt and enlarged. Nowadays considerable part among them is used for fishing or fish farming. Those processes concerned the eastern part of the watershed in larger scale as 8.0% of reservoirs were dug up and only 2.4% filled up (Table 3B).

Water reservoirs of the studied area are under strong anthropopressure. In case as much as 72% of reservoirs were observed at least one type of threat (from treats exchanged in Table 1), degrading in smaller or larger degree water reservoirs. Thus, only 28% of studied objects were rated among first class of anthropogenic pressure. In such case none of the anthropogenic phenomena mentioned in Table 1 were observed. Among third and fourth classes of reservoirs, which are most menaced of degradation and already demoted, were rated 58% of reservoirs (in general number) (Table 4). The number of water reservoirs rated

Table 4. The classes of anthropogenic pressure put on water reservoirs in Wyskoć watershed (artificial pools were not considered in calculations). 4A – proportional parts of reservoirs in reference to individual part of the watershed, 4B – proportional part of reservoirs in reference to the whole watershed.

4A

Classes of antropogenic pressure	Western part		Eastern part		The whole watershed	
	Number of reservoirs	Percentage 231=100%	Number of reservoirs	Percentage 396=100%	Number of reservoirs	Percentage 627=100%
I	81	35.1	94	23.7	175	27.9
II	37	16.0	51	12.9	88	14.1
III	40	17.3	108	27.3	148	23.6
IV	73	31.6	143	36.1	216	34.4
Total	231	100	396	100	627	100

4B

Classes of antropogenic pressure	Western part		Eastern part		The whole watershed	
	Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%
I	81	12.9	94	15.0	175	27.9
II	37	5.9	51	8.1	88	14.1
III	40	6.4	108	17.2	148	23.6
IV	73	11.7	143	22.8	216	34.4
Total	231	36.9	396	63.1	627	100

among those classes is over twice as large in eastern than in western parts of studied catchment (Table 4B). Therefore, considerably fewer reservoirs no demoted as well as finding under small anthropogenic pressure were located in eastern parts of the watershed (Table 4A). Water reservoirs classified to third as well as fourth classes of anthropogenic pressure ought to be rebuilt, and land reclamation works should take place. Those activities should ensure restoration of hydrological, natural and landscape function played by considered water ecosystems. 42% of studied objects (in general number) were rated among first and second classes of anthropogenic pressure. Owing to a small degree of anthropogenic transformations as well as their natural and landscape worth they should be protected, what at least theoretically, will prevent against their degradation.

Studied reservoirs were indeed demoted by following anthropogenic factors (Table 5): landfills (25.5%), drainage (8.8%), sewage drops (3.7%) as well as illegal landfills site (1.7%) that occur in nearest surroundings of reservoirs. Those threats are the reason for quantitative and qualitative degradation of water reservoirs. The wrongly executed land melioration within reservoirs area is one of the pointed reasons for small water reservoir disappearance in the agricultural landscape. Dried reservoirs do not play any hydrological or even natural function. In the register of soils they are mentioned as "waste land". All these factors lead to subsequent and purposeful filled and in consequence to disappearance of these ecosystems. Such processes as sewage drops, landfills, etc. are the cause of slow "biological death" of reservoirs (apart from chemical degradation of reservoir waters) and in consequence contribute to their disappearance, as well. The reservoirs that were demoted by some types of threats above mentioned were rated among fourth class of anthropogenic pressure.

The reservoirs rated among third class of anthropogenic pressure were demoted by the following threats: fishing (12.0%), fish farming (10.4%), cattle pasturage (8.1%) as well as trees and shrubs cut out (9.2%). Those processes essentially change qualitative parameters of water environment and also surrounding areas of small water reservoirs. Platforms, artificial consolidations of shores, fish farming requiring artificial sources of fodder, purposeful cleaning of reservoir shores by burning rushes or trees and shrubs cut out, fires, paths and dirt roads lead to reservoirs, trampling of shores by cattle, as well as faeces and urine dismissed by grazing animals, etc. – all these phenomena lead to qualitative degradation of water reservoirs as well as deterioration of their ecological and landscape values.

The reservoirs bordered on farm building (12.6%), country roads (12.0%) or cultivated fields (29.8%) belong to second class of anthropogenic pressure. These areas bordered directly on reservoirs were considered as potential threats causing chemical degradation of water reservoirs. Considerable quantity of nutrients, heavy metals as well as other different pollution is transported to a given reservoir by surface and subsurface run-off from reservoir watershed area. All contaminants mentioned above are

Table 5. Number of small water reservoirs undergo to particular anthropogenic threats in Wyskoć watershed (any reservoir can undergo to any threats; artificial pools were not considered in calculations). 5A – proportional part of reservoirs in reference to individual parts of the watershed, 5B – proportional part of reservoirs in reference to the whole watershed.

5A

No	Type of threat	Western parts		Eastern part	
		Number of reservoirs	Percentage 231=100%	Number of reservoirs	Percentage 396=100%
1	Drainage	30	13.0	25	6.3
2	Sewage drops	10	4.3	13	3.3
3	Landfills	44	19.0	116	29.3
4	It borders on landfill site	6	2.6	5	1.3
5	Fish farming	15	6.5	50	12.6
6	Fishing	37	3.5	67	16.9
7	Cattle pasturage	8	16	14	3.5
8	Trees and shrubs cut out	5	2.2	53	13.4
9	It borders on urban area	31	13.4	48	12.1
10	It borders on country road	24	10.4	51	12.9
11	It borders on cultivated field	65	28.1	122	30.8
12	Lack of negative anthropogenic influence.	81	31.6	94	23.7

5B

No	Type of threat	Western parts		Eastern part		The whole pressure	
		Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%	Number of reservoirs	Percentage 627=100%
1	Drainage melioration	30	4.8	25	4.0	55	8.8
2	Sewage drops	10	1.6	13	2.1	23	3.7
3	Storing of wastes	44	7.0	116	18.5	160	25.5
4	It borders on landfill site	6	0.9	5	0.8	11	1.7
5	Fish farming	15	2.4	50	8.0	65	10.4
6	Fishing	37	5.9	67	10.7	75	12.0
7	Cattle pasturage	8	1.3	14	2.2	51	8.1
8	Trees and shrubs cut out	5	0.8	53	8.5	58	9.2
9	It borders on urban area	31	4.9	48	7.7	79	12.6
10	It borders on country road	24	3.8	51	8.1	75	12.0
11	It borders on cultivated field	65	10.4	122	19.5	187	29.8
12	Lack of negative anthropogenic influence.	81	12.9	94	15.0	175	27.9

the basis of the intensive eutrophication, high acidification as well as bacteriological and chemical contamination of water reservoirs. In consequence, those processes contribute to slow "biological death" of water ecosystems as well as to their later disappearance. Urban areas, dirt roads and cultivated fields, located in the vicinity of reservoirs, lead to appearance threats characteristic of fourth class anthropogenic pressure. Thereby leading to further degradation of water reservoirs.

Discussion

All kinds of phenomena described above testify to the low levels of ecological culture and consciousness of watershed inhabitants. They also contribute to quantitative and qualitative degradation of small water reservoirs. The results of these activities are: decrease of surface water resources, disturbance of the natural hydrological cycle, draining of the watershed area, atrophy of many forms

of biological lives as well as devastation of agricultural landscape [25]. Therefore, the urgent protective and reclamation works are necessary to undertake in order to keep ecological and landscape values of water reservoirs as elements of the natural environment. In this way we will be able to accelerate the process of natural reconstruction of water reservoirs located on studied catchment areas. Obviously, ecological consciousness of the catchment's inhabitant must be simultaneously improved, so that the above-mentioned working make sense and finally bring expected results. The increasing anthropogenic pressure put onto water reservoirs makes that activity more essential, all the more, as the pressure will increase owing to reservoirs bordered on cultivated fields, farm buildings and country roads [7].

The legal protection of small reservoirs in the agricultural landscape (e.g. in form of ecological site) should be recommended with regard to the least anthropogenic transformed reservoirs. The pace limitation of those deterioration processes – owing to strong anthropogenic pressure put onto reservoirs – would make at least possible, if one introduced such form of protection. The process of formation of new biogeochemical barriers (e.g. grasslands, shelterbelts etc.), and also protection of already existing barriers (swamps, shrubs etc.) are effective and easy forms of water reservoir protection [24, 26]. Water reservoirs subjected to strong anthropogenic pressure (rated among third and fourth class of anthropogenic pressure) should be reclaimed (e.g. by their deepening, removal of bottom sediments, liquidation of contaminant sources, etc.). In this way we will be able to make possible a process of natural reconstruction of those ecosystems. If we do not inform occupants of the watershed area about functions and meaning of small water reservoirs in agricultural landscape the whole works mentioned above will not bring expected results. The maintenance and even reconstruction of small water reservoirs will be possible just by enlargement of ecological consciousness of the owners of the area that small midfield ponds occur on. So, it would be necessary to create such conditions that would encourage farmers to execute of above-mentioned works, e.g. by created communal programmes of water reservoir reconstruction as well as by a suitable tax relief system. In fact, the present owners and tenants of ponds are interested in possibilities for their economic and recreational use (e.g. fishing and fish farming). So we can suppose that those proposals could bring desirable results. The protection of water ecosystems should join with reservoirs and whole catchment retention increasing, so as to improve water conditions in areas where currently the largest water deficits occur [14]. We can achieve that goal by using small midfield and meadow ponds to drain outflow retention as essential elements of so-called "small retention" [7, 8].

Conclusions

1. Small water reservoirs, which are located on the Wyskoć catchment area, are under strong anthropopressure, deteriorating their ecological and landscape values.
2. Anthropogenic pressure put onto reservoirs will soon grow up owing to cultivated fields, country roads and farm buildings neighbouring these reservoirs.
3. In order to prevent atrophy of water reservoirs located on studied watersheds, protection and reclamation activities of small water reservoirs should be make an effort. Only in this way shall we be able to eliminate negative anthropogenic factors affecting water reservoirs, or at least limit the rate of these processes.
4. Protection of small water reservoirs should be realized by: legal protection of such reservoirs in the form of ecological site; extension and protection of coastal zones playing biogeochemical barriers function; direct reclamation of demoted reservoirs; as well as by enlargement of ecological consciousness of inhabitants of watershed area.

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