

DRUZNO LAKE BASIN AS AN EXAMPLE OF POLDER FUNCTION AND FUNCTION OF POLDER WATER-MELIORATION SYSTEMS

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A b s t r a c t. The main idea behind the formation of polders was agricultural production. At present polders are used to realize more and more non-agricultural functions. Some polders can be renaturalized.

Polder water-melioration systems determine settlement and economic activities in the polders including farming. They are formed by embankments, pump stations, canals and reservoirs, drain ditch networks, irrigation devices and roads which are indispensable for the system to work.

The aim of the work is identification and estimation of the functions of polder areas using the example of Druzno Lake basin in Żuławy region.

K e y w o r d s: Druzno Lake, polders, polder systems, polder functions.

INTRODUCTION

There are many definitions of a polder. Let us choose one of them which says that a polder is an area which is surrounded by an embankment (sometimes a natural uplift of the terrain that makes the boundary of the polder) and mechanically drained. It has its own water network and water surplus is removed with a pumping system. Polder forms a little catchment where draining systems are separated from the neighbouring water network with the embankments. The level of water is regulated artificially.

Agriculture and other function connected with settlement were the basis for economic activities on the polders for many years. High fertility of soils and good natural conditions made agricultural production more effective and profitable in these areas than elsewhere. Technical progress and industrial means of production belittled the importance of natural conditions for agricultural production. Simultaneously,

other kinds of activity encroached on the agricultural areas and thus on the polders. Macroeconomic conditions make the development of rural areas depend on the improvement of non-agricultural activities. An argument for a multifunctional development of rural areas is also true for the polders.

Polder water-melioration systems determine the settlement and economic activities on the polders, including farming. They are formed by embankments, pump stations, canals and reservoirs, drain ditch networks, irrigation devices and roads which are indispensable for the system to work.

In our opinion the degree of flood protection and water management in the polder should be related to the polder resources and activities which are carried out there. So, the most important is identification and estimation the functions realized on the polder. Then information obtained can be the basis for economic-ecological valuation of polders. It will allow to decide further directions of development or in some cases - renaturalization.

The aim of the present work is identification and estimation the polder function on the basis of the Druzno Lake basin in the Żuławy region as an example.

MATERIAL AND METHODS

The Druzno Lake basin came into existence as a result of polder formation and draining of the former south part of the Vistula Bay. Now, the area is formed by the Druzno Lake and surrounding polders (Fig. 1).

The methodical basis of the work is considering the polders as space systems which definite resources and economic activities. For the description of polder resources and functions realized in the polders the same method as for the economic-ecological estimation of space systems [3] was used.

In the first part of this paper, a characteristics of the basic polder resources in the Druzno Lake basin and then - of the main functions realized in this area is undertaken. To present differences between polders, a more detailed valuation was carried out in five polders: Komorowo, Dłużyna, Stankowo, Topolno and Jelonki.

The present work was prepared using data and information from:

- General Agricultural Registration. 1996,
- other statistical information from gminas and reclamation services, companies and institutions working within the Druzno Lake basin.

The questionnaire was prepared in IMUZ-Żuławy Regional Division in Elbląg. It is the basis for the estimation of the choosen polders.

To analyse the functions of the polders which are within limits of some gminas, data for gmina Markusy was used (the area of all the gmina is on the polders, mainly the polders of the Druzno Lake).

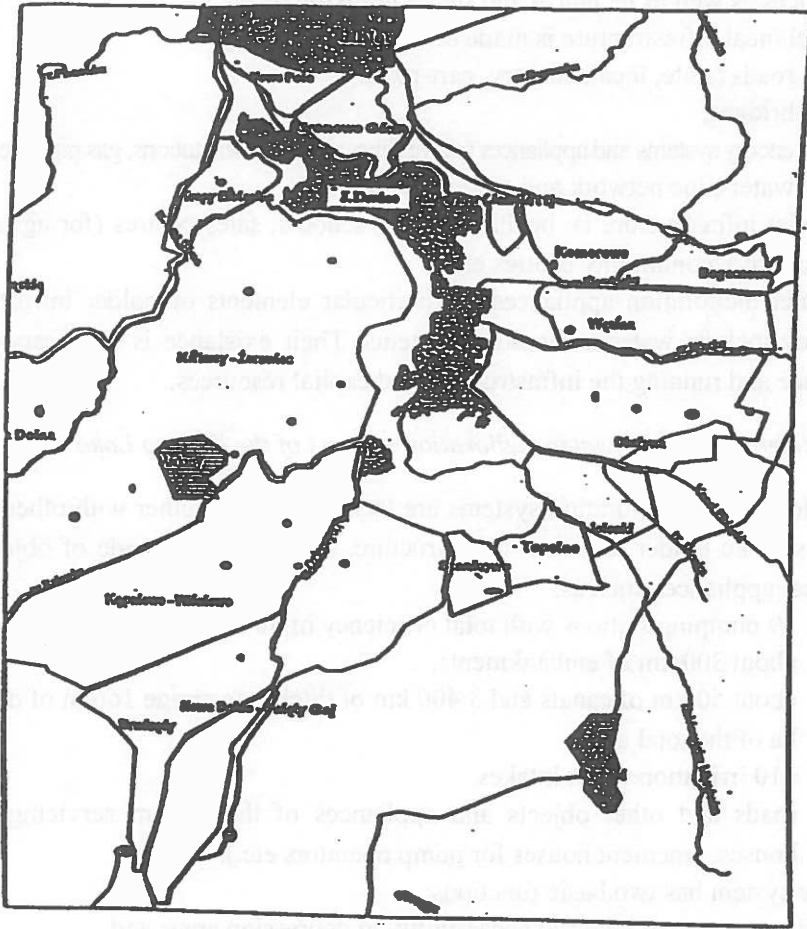


Fig. 1. Protected areas (polders) of Drużno Lake basin.

RESULTS

Polder resources

The same resources which occur in space systems occur in the polders. They are: human resources, natural resources, permanent capital and financial capital. The main polder resources are: soils, waters, plants, animals and others, difficult to measure values as, e.g., topographic features, landscape etc.

Resources of the fixed assets are: buildings and infrastructure, machines and appliances as well as technical and social infrastructure.

Technical infrastructure is made of:

- roads (state, local, country, cart-roads),
- bridges,
- energy systems and appliances (power lines, transformer stations, gas pipelines etc.),
- water-pipe network and sewerage network.

Social infrastructure is: health services, schools, sales centres (for agricultural products etc.), community centres etc.

Water-melioration appliances are particular elements of polder infrastructure and they include water-melioration systems. Their existence is necessary for the existence and running the infrastructure and capital resources.

Elements of polder water-melioration systems of the Druzno Lake

Polder water-melioration systems are technical and together with other similar systems make polder technical infrastructure. The system is made of objects and technical appliances such as:

- 39 pumping stations with total efficiency of $30 \text{ m}^3 \text{ s}^{-1}$,
- about 300 km of embankments,
- about 50 km of canals and 3 400 km of ditches (average 166 m of ditches/1 ha of the total area),
- 110 irrigation water intakes,
- roads and other objects and appliances of the system servicing (warehouses, tenement houses for pump operators etc.).

The system has two basic functions:

- 1) it ensures existence and accessibility to depression areas and
- 2) controls water conditions in the polder to satisfy the needs of plant production.

The system secures the existence of 20 polders with area of 204.24 km^2 , in which about 110 km^2 are depression areas.

The share of depression in the total area and embankment length per 1 ha of the protected area differentiate polders from protected areas.

The share of depression in the total area is 40-90% and embankment length is $9.5\text{-}47.2 \text{ m}^{-1} \text{ ha}$.

Polder water-melioration systems affect, in indirect or direct way, all other polder resources and functions.

They broke paludial process and affected formation of particular soil sub-types. Water-melioration appliances, regulating water conditions, affected the processes

which take place in the soils. Liquidation of these appliances can initiate a repeated paludial process in the soils which are agriculturally utilized at present.

By securing drainage of polders and protecting them against flood most often from more than one source, polder water-melioration systems create conditions for the investment in of the remaining infrastructure such as houses and farm buildings. Pumping stations pump water to the lake and water supplies for irrigation regulate water exchange between the lake and polders. So, it influences the nature reserves related to the lake basin.

Soil resources

The High Żuławy areas were formed by the natural alluvial process while the Low Żuławy were mainly man - formed. Many hundred years of melioration in the Żuławy broke paludial process.

The soils in the Druzno Lake basin are hydrogenic soils. Bog soils, drained and agriculturally utilized were transformed, step by step, into other derived soil sub-types. Bog soils, peat soils and muck-peat soils at different stages of development and transformation can be found in the basin. Three hydrogenic soil sub-types can be distinguished: peat-muck soils, mud-muck soils and mucky soils.

Peat-muck soils - soils developed from deep peat in which there are no peat-forming process but only muck-forming process. They are around Druzno Lake next to the lake embankment, that is in North of the Nowe Pole area, in East - in the polders: Komorowo and Dłużyna also to some extent - in Jelonki polder. On the west bank of the lake they cover junction of the Dzierzgonka and Balewka streams and the Jurandowo-Druzno polder along the lake banks also near Tropy village. They are used under permanent grassland as meadow and pastures.

Mud-muck soils - developed from mud formations admixture, underlain with alluvial sediments or lake sediments (gyttia). The fundamental feature which differentiates peat-muck soils from mud-muck soils is type of subsoil. In the first case the subsoil is in the form of deep peat sediments, in the second - organic-mineral or mineral sediments. These are very significant differences which affect on differentiation of basic water-physical properties of both soil sub-types.

These soils are used as permanent grassland but most often they are used both as grassland and arable land [2]. They cover the surroundings of the following villages: Janowo, Jelonki, Dłużyna, Nowe Dolno and Krzewsk

Mucky soils - their properties are intermediate between alluvial soils and muck soils. Humus horizon in mucky soils is of permanent granular structure. It is friable and loose. Silt alluvium makes deeper profile layers. Sometimes directly under mucky horizon there are silting older peats or gyttia sediments. The soils are most

often utilized as arable land and also - grassland. From the user's point of view, these soils are very difficult for cultivation. They need proper moisture regulation in the surface layer of soil profile. The soil humidity should be controlled in a way that ensures the best conditions for cultivated plants taking into account hydrometeorological conditions at the same time. Soil moisture control can be carried out by a well-designed, drainage-irrigation network of systematic melioration.

Functions of polder areas as spatial systems

The following functions are realized by the polder areas of the Druzno Lake:

- agricultural function
- settlement function
- recreational function
- ecological function
- non-agricultural activity (industrial function).

Agricultural characteristic of the Druzno Lake basin

Agricultural land covers about 80% of the total area of the polders in the Druzno Lake basin. The remaining areas are: waters, forests, under roads, buildings etc., barren land.

Structure of agricultural land are under:

- arable land - about 51%
- grasslands - about 48%
- orchard and long-term plantations - about 1%.

Soils, terrain hypsometry and the existing melioration system predispose most polders to be grasslands.

Size structure of farms is various. In the past there were state farms which has occupied about 50% of agricultural land in this area. Most of them, after restructuring, were privatized but sale of land between farmers still goes on.

Structure of the farm size is presented in Table 1.

Farm size structure is typical for the north of Poland and is more advantageous than the general structure in Poland.

The average area and structure of a individual farm is presented in Table 2.

Cereals, mainly wheat and barley, dominate. They are about 70% of all crops. Fooder crops are about 11%, sugar beet - more than 8% and potatoes - about 6%.

High share of cereals is well-founded because straw is used as bedding for animals.

Live-stock density is high in the basin. On 100 ha of arable land there are more than 78 heads of cattle, in this 30 dairy cows, and about 85 heads of pigs.

In the basin farms with mixed production dominate - their share in the total number of farms in the basin is 44%, farms with animal production - 36% and with plant production - 20%.

The average yield of cereals is about 40 dt ha⁻¹, sugar beet - 440 dt ha⁻¹ and yield of green mass from grasslands is about 250 dt ha⁻¹.

Taking productive and economical results as the basis for comparison, differences between polders and even bigger differences - between farms are visible.

Value of live-stock calculated for 5 polders (per 1 ha) is one of the indices which prove differences in the production intensity. Taking the value estimated for the Jelonki polder as an index = 100, the values for the rest polders are as follows: Topolno - 238, Komorowo - 300, Dłużyna - 328 and Stankowo - 503. Generally, it can be noted that level of agriculture in the basin estimated by production intensity, productive results and the state of basic funds is lower than in the High Żuławy.

Functions of settlement

In the basin there are 44 statistic resorts, in this 1 gmina resort. Population density is about 37 persons/km². 7.500 people live on the polder with the area of 2.044 ha. There is a big differentiation in the population density among polders; it ranges from 7 to 58 persons/km². It proves differences in the settlement function in particular polders.

On the basis ground of estimation of 141 house buildings which are in the polders it is noted that about 65% of them are buildings from before 1945, about 16% - from the period 1945-1970 and about 17% after seventies.

Non-agricultural functions

In the gmina office of Markusy 130 companies with non-agricultural activities are registered. They are not included firms registered in Economic Court. It can be estimated that 240 firms provide non-agricultural activities in this terrain.

Non-agricultural activities are in the following areas:

- trade (wholesale trade, grocer's, industrial shops, milk and cattle purchase etc.),
- processing (slaughter-houses, pork butcher's, bakeries etc.),
- services (veterinary services, repair shops, craft workshops etc.),
- building industry (brickwork services, installation services etc.),
- industry (joinery, purse making etc.).

Recreation function

Recreation function of polder area in the Druzno Lake basin is related to the natural values of the Lake and its rich water network. It is also close to such a big

center as Elbląg. Common form of recreation is travelling by the Elbląg-Ostróda Canal. The canal formed, among others, by the Druzno Lake and the embanked sections of the neighbouring polders. In period of May-September 1998, 649 ships sailed across the shipway at Całuny (the nearest to Druzno Lake). They belong to shipping firms and 844 of them are private. It can be estimated that about 40000 people sailed across the Canal. Near 50% of them were foreign tourists.

Polder water-melioration systems are used also for angling. About 5 000-5 500 anglers use the streams and canals which form polder water-melioration system of the Druzno Lake. Beside the registred anglers a large group of people without formal authorisation use the waters. Destruction of the plant consolidation of the embankments is observed on the canal fragments intensely utilized by anglers.

Ecological function

The right part of Druzno Lake is of particularly importance and is protected together with the surrounding rush plant communities, willow scrub and alder forest as a nature reserve. The reserve is a breeding site and water and mud birds sanctuary. About 44% of all birds observed in Poland can be found here. It is also a place for rest on the Scandinavian-Iberian bird migration route. Many research and educational tasks can be carried out here thanks to reserve of natural resources.

Agriculturally productive space in the basin needs detailed ecological analysis. Great part of the polders can be utilized both as grassland and arable land. It depends only on the degree of drainage. Areas like that are named the areas of facultative utilization. Grasslands not only produce bulky feed. They also have a non-productive value resulting from their ecological functions [3] such as:

- accumulation of precipitation water,
- water discharge from precipitation and counteracts surface water eutrophication,
- effects on the microclimate and air self-cleaning by evapotranspiration moisture supply to the environment,
- landscape enrichment with a diversity of plant and animal.

Ecological value of grassland cannot be examined without considering destination of crop. Requirements of rational agriculture show the necessity to use crop where it is produced - in the farm. Grassland is connected with cattle keeping as a processing activity. That is a reason for higher cattle density in the basin in comparison to the neighbouring areas. But the degree of plant products used by animals is low; it is seen in the N-balance in the farm with dairy production; 75-90% of nitrogen carried to the farm is lost [4]. N-losses can be decreased by the right storage and spreading solid manure and urine or slurry (manure pits, tanks, appliances for spreading, spreading time and doses etc.) In farms with mixed production utilization of nitrogen

is better. Therefore the share of arable land in the total farm area, should be ensured by the melioration system, where there are technical possibilities for facultative utilization of land in the polder areas.

RECAPITULATION AND CONCLUSIONS

Evaluation of the polder area of the Druzno Lake basin shows they are of multifunctional space systems with differentiated share of agricultural, settlement, ecological and non-agricultural functions. Existence of polder areas and realisation of greater parts of their functions depends on the polder water-melioration systems which consist of: embankments, canals, ditches and other technical appliances. Users of the systems should be included in its financing and also in taking a decisions on the direction of its development and modernization.

Decisions about renaturalization of the chosen polder areas should take into account profits and losses of all polder resources and functions which are connected with them. It generates the needs for economical evaluation of natural resources and ecological functions.

Agriculture will be an important function realized in the polders because of the soil quality. Melioration treatment and the way soil is utilized should ensure protection of soil resources against mineralization. It can be achieved by a bigger share of grasslands in the structure of agricultural land. Cattle production connected with grasslands requires to take into account the system of soil and water-melioration (drainage degree), land utilization structure, influence of animal production on the environment in order to evaluate the role of agriculture from the ecological point of view.

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