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THE CONCEPT FOR PROTECTION OF FLOOD PLAIN FORESTS IN THE UROCZYSKO WARTA FOREST DISTRICT

Summary

Flood plain forests are the richest and highly picturesque forest ecosystems. Unfortunately, river regulation and flood control contribute to their degradation. In Poland only 0.2% of total area is covered by flood plain forests. The Uroczysko Warta forest district constitutes one of the most important clusters of these sites. The construction of the Jeziorsko reservoir in the middle course of the Warta River has contributed to changes in the river regime (reduced flooding areas and decreased flooding frequency). It seems that the use of simple land improvement systems, i.e. gates, river bars and culverts with flap check valves, may result in the recreation of advantageous hydrological conditions. In such a case storage volume of oxbow lakes would be increased and ground water would be maintained at a higher level over longer periods of time. This study presents a concept for protection of the Uroczysko Warta, thanks to the construction of appropriate engineering infrastructure.

Key words: the Uroczysko Warta, flood plain forests, ground water level, small water retention

INTRODUCTION

Flood plain forests are the richest broad-leaved forest ecosystems in Poland. Despite the fact that according to the potential vegetation map flood plain forests in Poland cover almost 9% of total area, in the structure of forest sites in Poland site types corresponding to flood plain forest communities occupy as little as 0.7% of area, including flood plain forests at 0.2% [Danielewicz 1993]. A major factor determining the occurrence and proper functioning of flood plain forests, as well as ecosystems connected with oxbow lakes, occurring

naturally in river valleys, is their periodical flooding by rising waters. The absence of flooding leads to the degradation of flood plain forest sites, i.e., their transformation into oak-hornbeam forests, and in case of oxbow lakes the processes of their overgrowing and drying out are accelerated. The most adverse factors affecting these ecosystems include the reduction of flooding areas by the construction of flood embankments and changes in the hydrological regime of river waters due to the construction of large storage reservoirs.

An important aspect in the preservation of sites in river valleys is their protection. In a case such as that in the Uroczysko Warta forest district, where as a result of changes in the natural hydrological regime of the Warta River the area affected by flooding as well as the frequency of such events have been limited (e.g. due to the construction of the Jeziorsko reservoir) good results may be brought about by the use of simple land improvement systems thanks to which it is possible to recreate advantageous hydrological conditions, as well as to increase the storage volume of oxbow lakes. Ground waters will then be maintained at a higher level over longer periods of time.

When presented in the synthetic form, the concept for the protection of flood plain forests in the Uroczysko Warta forest district, constituting the subject of this study, is to rely on the buffer capacity of oxbow lakes in the periods of high water stages in the Warta and Lutynia Rivers. The concept for the improvement of water relations in the flood plain forest areas in the Uroczysko Warta district is based using the following premises. Oxbow lakes, due to their high number and hydrogeological conditions of the forest district area, may have an advantageous regulatory effect on water relations in soils of flood plain forests in case when an additional water supply is provided and water storage capacity is enhanced in these objects. Preventing the discharge of floodwaters in the periods of overbank stages on the Warta River and water transfer from the Lutynia River my provide additional water storage capacity in oxbow lakes. Such a method of providing additional storage capacity reserves is related with the natural hydrological processes occurring in ecosystems of valley flood plain forests, since waters supplying them do not stagnate, but are transferred into the ground.

CHARACTERISTICS OF THE UROCZYSKO WARTA AREA

The Uroczysko Warta forest district is a forest complex, located in the inundation terrace on the left bank of the Warta River, between 332 and 337.5 km of its course and the confluence section of the Lutynia River (0 to 3.2 km) (figs. 1 and 2). In terms of the administrative division the entire area is located in the Wielkopolskie province, the largest part of the Uroczysko district is located in the Miłosław commune (the Września county), only the eastern part is located in the Żerków commune (the Jarocin county).

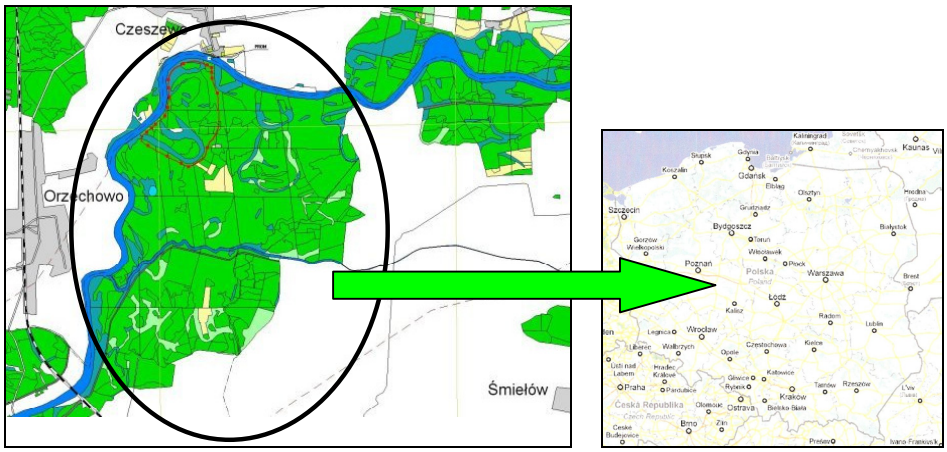

Figure 1. Location of the Uroczysko Warta district

Figure 2. Flood plain forests in the Uroczysko Warta district

The Jarocin Forest Division administers the area. The area of the entire complex is 772.44 ha, of which forests comprise 634.99 ha, while the other part is composed of forest meadows, oxbow lakes and marshes. Soils are mainly alluvial soils (82.2%), brown podzolic soils (9.3%) and grey brown podzolic soils (5.7%). Brown podzolic soils and grey brown podzolic soils were formed in areas located outside the flooding areas. Moreover, ground gley soils, brown soils, gley soils, podzolic epigleic soils, alluvial muck soils, forest black earths and weakly developed soils are also found in small amounts [Pawlaczyk et al. 2002].

Climatic conditions found in the analyzed area, as well as the entire catchment of the Warta River from the hydrological point of view, are not advantageous. It results from two reasons: relatively low precipitation in comparison with the neighbouring areas and high evapotranspiration.

Mean precipitation total from the years 1951–2000 at the water gauging station in Nowa Wieś Podgórna, located nearest to the investigated area, was 546 mm. Variation in annual precipitation total in individual years may be very high: once every 10 years precipitation totals may drop to approx. 380 mm, a cyclicity may be observed in the occurrence of wet and dry years [Kowalczak et al. 2006].

In this part of the forest there are 10 oxbow lakes of the Warta River (starting from the east: Musiółka, Czaple, Szaniec, Łojewo, Mała Starucha, Wielkie, Zaskrzęcie, Długie Zaskrzęcie, Dębiński Rów, Podkowa), as well as several overgrown troughs remaining after former oxbow lakes. In the eastern part of the Uroczysko, the Czeszewski Las Nature Reserve of 222.62 ha is located (fig. 3). The entire object lies within the Żerkowsko-Czeszewski Landscape Park of 15640 ha [Nadleśnictwo Jarocin 2009].

The Uroczysko Warta forest area is a complex of oak-hornbeam forests and ash-elm riparian forests, with a high proportion of old stands, located on the lowest terrace of the Warta River, with the preserved oxbow lakes and typical vegetation. In the forest part there are also phytocenoses of reed canary grass, wood sweet grass, iris and sedge rushes, as well as fragments of meadows related in terms of their floristic composition to cnidium meadows typical of valleys of big rivers. A part of the reserve is regularly flooded by the Warta waters during the early spring high water stages. Flood plain forests in the Czeszewo forest area, together with forests extending along the Warta River below Czeszewo (to the Dębno reserve) constitute the biggest and best preserved complex of flood plain forests in the Wielkopolska region and probably also in Europe. Field maple is found in abundance in the stands. The population of grey poplar is also numerous, and the native black poplar is also found in that area. Cork-forming elms and field maples are also found. A characteristic feature of this object is the proportion of old oak stands (age classes VIII and IX, i.e. 140-180 years) as well as a high number of ash stands of age class IV (60-80 years).

The area of this forest section is also rich in old and impressive trees. In the course of this study a total 77 monument trees were inventoried, of which the most numerous group comprises 39 common oaks, with the thickest being of 620 cm in circumference [Nadleśnictwo Jarocin 2009].

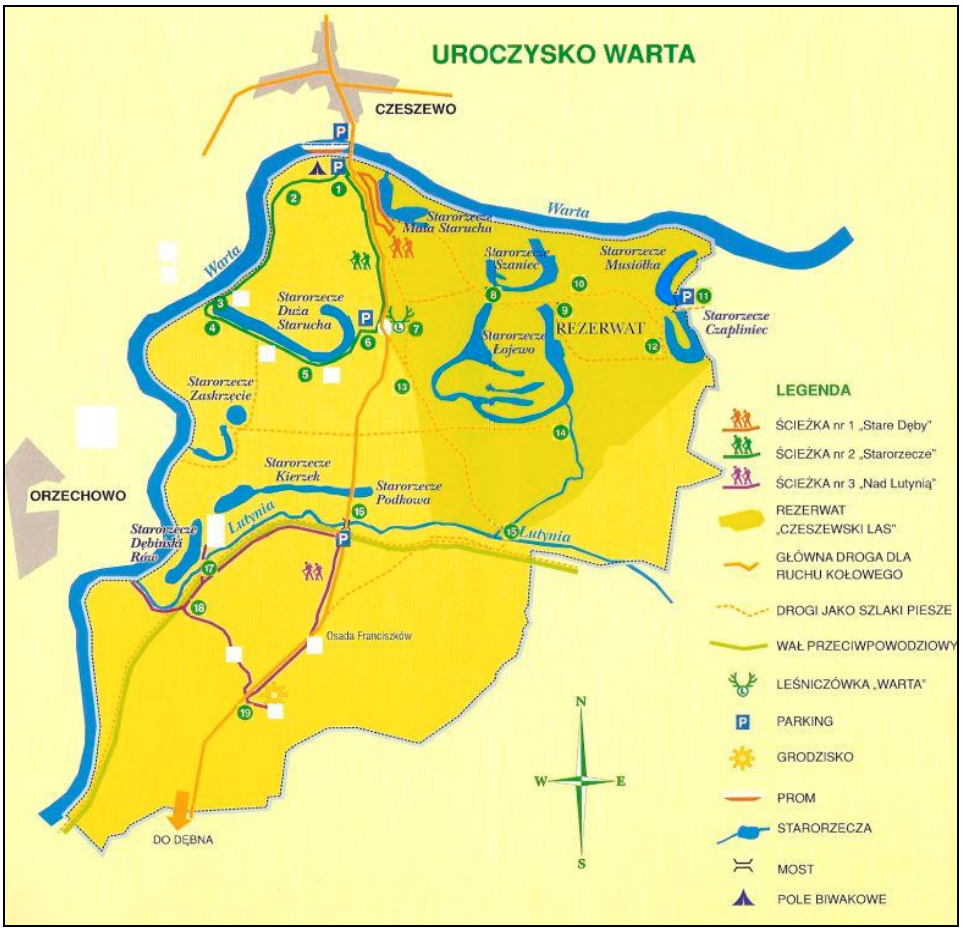

Figure 3. Oxbow lakes of Uroczysko Warta

A very rich flora of vascular plants, including valuable species and comprising over 600 taxa, is found in the Czeszewski Las reserve. It is a typical, well-preserved flora of flood plain forests, oxbow lakes and river banks. In the Czeszewo forest section a total of 75 species of nesting birds or probable nesting birds were recorded [Bednorz et al. 2000]. Taking into consideration the small area of the investigated location (5 km^2) this amount needs to be considered as very high.

The insect fauna is also rich and it comprises numerous species connected with complexes of old forests. Moreover, one quarter of the recorded taxa of long-horn beetles (*Cerambycidae*) includes species connected with old forest and primeval forests, requiring for their development the presence of thick, old trees and a unique microclimate formed by mature plant commies.

The former forest management plan for the Czeszewo forest reserve was binding in the period from 1 January 1989 to 31 December 1998. The Czeszewo reserve at that time covered a fragment of flood plain forest with natural characteristics and area of 27.61 ha. It is an old stand with the dominating common oak aged 150 - 180 years with an admixture of ash, lime, hornbeam and maple of different ages, generally described as the community of elm-ash riparian forest (*Ficario-Ulmetum campestris*). The description of the condition of the object indicated adverse changes taking place in that site, consisting in the thinning of the stand as a result of dying out of elms and ashes, i.e. the main forest forming species in this community.

The current protection plan for the Czeszewski Las reserve, enlarged to the area of 222.62 ha and covering, among other things, the already described, entire Czeszewo reserve, has been in force since 2004. The objective of the reserve protection was to preserve the complex of natural forests and oxbow lakes in the inundation area of the Warta. Special emphasis in the plan was placed on the maintenance of site conditions and flooding with river waters thanks to the inhibition of their flow with the simultaneous preservation of meadow patches significant for the diversity of flora and fauna.

PROTECTION OF FLOOD PLAIN FOREST SITES

In order to save the Uroczysko Warta forest district and its natural value a system of structures ameliorating water relations in the forest district interior has been constructed. In the years 2004–2005, within the framework of the realized project, co-financed by the EkoFundusz foundation as the "Comprehensive protection of biodiversity in Uroczysko Warta in the Żerkowsko-Czeszewski Landscape Park", the following structures were formed: a sill damming waters on the Lutynia River, 4 culverts with flap check valves making it possible for the rising and dammed waters to flow into oxbow lakes and preventing their return to the river, 2 log stop gates, making it possible to control manually water levels in oxbow lakes of Szaniec and Łojewo, a new bridge on the Lutynia River and a macadam road from the Warta forester's lodge to the Franciszków forest district in order to transfer the local traffic from the present road leading to the temporary small bridge on the Lutynia and the areas of the highest natural value (fig. 4).

In 2006 work was initiated on the concept for the attempted preservation of flood plain forests and the Institute of Meteorology and Water Management was commissioned to prepare an expert opinion concerning the optimal solution for water supplementation and retention in oxbow lakes in the Uroczysko Warta

in the Lasy Czeszewskie forest area. On the basis of this report another motion was filed to the EkoFundusz foundation for the realization of an extended natural intervention in the forest district. This motion was entitled "Protection of flood plain forest ecosystems in Uroczysko Warta in the Żerkowsko-Czeszewski Landscape Park - the second stage". This stage is to be realized in the years 2009–2010 and assumes the natural intervention is to be expanded (active nature protection measures) into the area of the neighbouring forests, i.e., Dębno and Nowe Miasto.

Figure 4. A damming sill (A), a culvert with a flap check valve (B), a log stop gate (C), a bridge on the Lutynia River (D)

The area of impact of the engineering infrastructure in the three forest districts is over 1 500 ha. Work on the following structures was planned: the construction of new culverts with flaps, conversion of 3 flap culverts by building up of log stop gates on overflow weirs, the construction of 2 damming sills on the Lutynia River and the reconstruction of a sill constructed in 2005, extension and strengthening of a series of depressions along the so-called Przerwica, the construction of a ditch with a regulating gate, supplying the Piżmaczysko oxbow lake.

THE EFFECT OF THE JEZIORSKO RESERVOIR ON FLOWS IN THE WARTA RIVER

A gauging station in Poznań is located at 244 km of the Warta River (catchment area of approx. 25 thousand km^2). The artificial reservoir of Jeziorsko, located in the middle course of the river, with the total capacity of 203 million m^3 (put into operation in 1987) has a considerable effect on the Warta River flows. The evaluation of this impact was based on the diurnal values of flows in the Warta River at Poznań in the years 1822–1997.

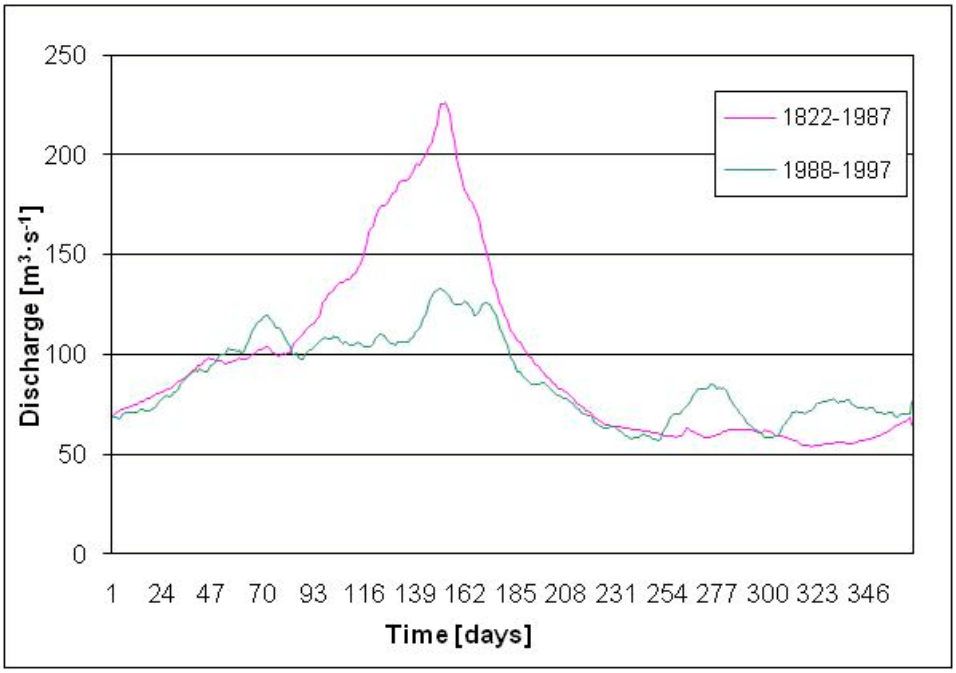

Figure 5. Time series for periods: 1822-1987 and 1988-1997 of the Warta river discharges at Poznań, averaged for individual days

Runoffs of the Warta also exhibit relatively high stationary nature in relation to mean annual values. In the analyzed period of the reservoir operation (under average meteorological conditions except for the year 1997) the variation in daily flows, and as a consequence also the maximum values of flows, were significantly reduced. Mean standard deviation of daily flows in a year in case of the multiannual period of 1822–1987 (166 years) was 75.3 m^3·s^{-1}, while the respective standard deviation in the analyzed 10-year period of reservoir operation for the Jeziorsko reservoir was only 38.8 m^3·s^{-1}. Moreover, the mean low flow

increased from 32.1 to 39.5 $m^3 \cdot s^{-1}$ and the mean high flow decreased from 449 to 201 $m^3 \cdot s^{-1}$ (obviously all the above changes are significant at α=0.05). The above changes in flows, before and after the Jeziorsko reservoir was put into operation, are presented in fig. 5, where the effects of changes in flows at the Poznań cross-section resulting from the filling and emptying of the reservoir may be clearly observed. Storage capacity of the Jeziorsko reservoir has a highly significant effect on the alleviation of the impact (countermeasure) of floods in Poznań, as evidenced by the summer water rising in 1997 [Miler 1999].

MONITORING OF WATERS IN THE FOREST DISTRICT

In the Uroczysko Warta forest district in 2008 the system of monitoring was created for surface and underground waters. A total of 26 drillings, ranging in depth from 4 to 26 m under the ground level, were performed (fig. 6). In the sites of drillings piezometers were placed, in which in the beginning of 2009 devices automatically recording underground water levels were installed. The measuring system is supplemented with 7 staff gauges at oxbow lakes and the Lutynia River. Depth to the static water tables in piezometers ranges from 1.13 to 4.21 m under the ground level [Zieliński, Niemczyński D. 2008].

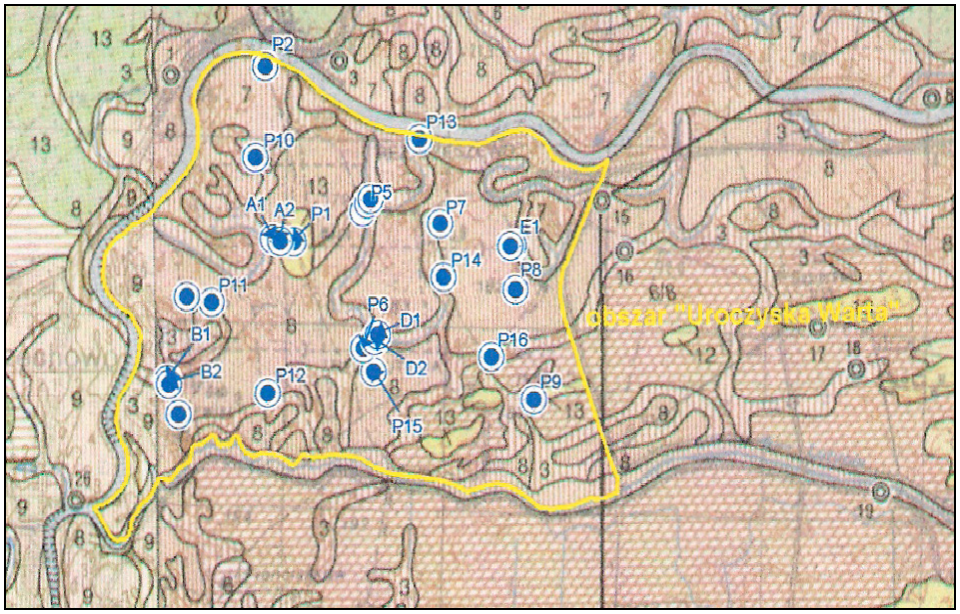

Figure 6. Prepared sight-holes - piezometers

CONCLUSIONS

The evaluation of effectiveness of the adopted concept for the protection of flood plain forests in the Uroczysko Warta forest district requires permanent monitoring of processes, occurring over periods of many years in forest ecosystems (e.g. formation of snag, formation of oak-hornbeam forests, annual increments in the oldest trees).

For example in the period of 1991-2007 it was observed that a reduction of number of days of oxbow lake filling is inversely proportionally correlated with the mass of the formed dead trees.

The period of groundwater monitoring to date, being short (1 year), does not make it possible to evaluate the effectiveness of buffer filling of oxbow lakes, with the use of technical infrastructure described in this study.

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