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Management of the Storage Reservoir Influencing the Protected Natural Environment – Upper Narew River System Case Study

Preface

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One of the aims of the recently introduced Framework Water Directive (Directive 2000/60/WE) is the protection of the natural environment from further degradation. In the case of catchment systems, in which water retention reservoirs play an important role, maintenance of the desirable status of the natural environment under protection requires not only securing higher flows during periods of vegetation growth, but also introducing or keeping the flood impulse.

River floods are commonly considered as natural phenomena with threats to life and health and loss of property. However, in some situations they are a positive occurrence, helping to preserve the natural features of a particular region. This is true for the Narew valley, in particular the area within the borders of the Narew National Park (NNP), where spring floods not only cause no material damage, but also bring positive effects for preserving the natural qualities of the region.

The Narew National Park was formed in order to maintain the hydrographic system of the anastomosing river and water-peat ecosystem, which is unique at the European scale. Unfortunately, at present, the natural vegetation of the park is endangered by the on-going delapidation of the valley and postponement of the agricultural use of the meadows. Settlement changes in the lower reach of the River Narew follow the regulation of its channel and are also due to natural causes. A new river channel was built during drainage works. It is wider, deeper, and straighter than the former channel, causing the lowering of water levels in the river and decreasing and shortening surface flooding, as well as increasing groundwater levels in the valley. Drying of the whole valley is also enhanced by the weather conditions. Mild winters, small snowfall and, in part, the decrease in rainfall, influence the decrease of river flooding and groundwater resources.

To maintain the required status of riverine wetlands with fluvial-glacial feed, it is necessary to retain, during the river's vegetation growth period, higher than minimum flows according to a hydro-biological criterion and also to keep or introduce a flood impulse. The concept of flood impulse was introduced by Junk *et al*. (1989) for tropical rivers and was further developed by Tockner *et al*. (2000) for rivers situated in intermediate climate zones. Nowadays ecologists claim that it is a key paradigm for the ecology of running waters. According to this concept, the flood impulse should help sustain high-level biodiversity in the flooded river terraces as an integral part of the feed for fluvial-glacial wetlands (Okruszko *et al*. 1996).

In many cases people cause the deterioration of their habitat through ignorance, organizational inefficiency and lack of information. Hence, it seems desirable to begin actions leading to the intensification of research on the improvement of the whole system of environmental protection, and in particular, on the management of the river systems containing water storage reservoirs that influence the natural environment. Therefore, an intensification of the study of various aspects of the above mentioned problems is a must and is challenging not only for the scientific community but also for decision makers at both local and state levels.

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The goal of the project was the development of control techniques that would help in re-establishing the appropriate water conditions in the Narew National Park by the management of the flood impulse in the section between the Siemianówka storage reservoir and the Narew National Park.

In this monograph, the first details of the GPS measurement programme in the Narew National Park are presented. However, the project team performed over fifty measurements of selected cross-sections of the riverbed and the valley, undertook hydrometric measurements, and assessed the decline of water level in the section from the Siemianówka reservoir to Rzędziany. Measurements covered most of commonly used topographic and hydraulic characteristics. The resulting cross-sections were used to build a numerical model of the area and for hydraulic calculations.

We further present two approaches to specifying an appropriate hydrological regime within a wetland, necessary for maintaining goods and services. This regime is related to the source of water, which varies with the type of wetland.

The next problem addressed in this monograph is the selection of a proper rainfall-flow/flow-routing model of the upper River Narew catchment and the river reach between Bondary and Suraż. Solution of the flood management problem in the reservoir system requires the repeated solving of unsteady flow equations for successively generated operation scenarios. Thus the solution algorithms applied in such cases should be maximally efficient, not only with respect to the computer capability requirements, but – particularly important in this case – time of computation required to obtain the solution. Within the project, simulation research was undertaken that resulted in an

estimation of the effectiveness and applicability of numerical solutions of the inverse problem of flow equations.

Finally, a computer-based analysis and control mechanisms for the control of a flood impulse in the system are presented. An uncertainty analysis of the predictions obtained is performed, and an influence of the uncertainty of model structure and observations on the reservoir control performance is analysed. The study is based on the Global Sensitivity Analysis (GSA) and Generalised Likelihood Uncertainty Estimation (GLUE) techniques. Additionally, these techniques were applied to study transport processes in the NNP reach of the River Narew.

The predictions of flood extent will undoubtedly play an important role in water management best practice, following the principles of sustainable development in the Narew National Park and an adequate control of the Siemianówka storage reservoir.

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