

Water management measures in the Central Biebrza basin, Poland

E. P. QUERNER

Alterra, PO Box 47, 6700 AA Wageningen, The Netherlands
e-mail: e.p.querner@alterra.wag-ur.nl

A. SLESICKA & W. MIODUSZEWSKI

Institute for Land Reclamation and Grassland Farming (IMUZ), Falenty, Poland

Abstract The Biebrza National Park (BNP), situated in northeast Poland, represents a unique environment of wetland with meso- and eutrophic peat ecosystems. One of the dangers for the park wetland is the over-drying of the soil caused by the drainage works carried out in the past. To counterbalance the negative effects, the Biebrza National Park aims to restore the hydrology. However, farmers owning land along the rivers may experience negative effects on their farmland resulting from these measures. The physically-based groundwater and surface water model SIMGRO was used to predict the effect of raising the water levels. It was found that reduction of the discharge in the drainage canals to about 5% of the present flow, with the remaining water flowing via the rivers, leads to a considerable rewetting of the wetland area but unavoidably also leads to higher water levels in part of the agricultural area.

Key words Biebrza (Poland); drainage; groundwater; hydrological degradation; river discharge; surface water

INTRODUCTION

The Biebrza National Park (BNP), situated in northeast Poland (Fig. 1), is a unique environment of wetland with meso- and eutrophic peat ecosystems. One of the threats for the park is the hydrological degradation (over-drying) of the soil, caused by drainage works carried out in the past. The National Park is situated along the Biebrza River covering some 60 000 ha. Land use is predominantly grassland for meadows, pasture and woodland. The Biebrza River has a length of 165 km, and is located in a gently sloping landscape, surrounded by peat fens and hay meadows. The discharge of the river fluctuates during the year. In summer the discharge is about $10\text{--}20\text{ m}^3\text{ s}^{-1}$, but in early spring when the snow melts, the discharge increases to more than $100\text{ m}^3\text{ s}^{-1}$.

SCOPE OF RESEARCH

The research focused on the water management problems in the Central Biebrza basin. This part of the basin was drained in the nineteenth century, causing severe drying of the peat soil in summer, enhanced mineralization of organic matter and subsequent degradation of the vegetation. In particular, the digging of the Rudzki and Woznawiejski Canals resulted in lowering of the water levels in the Jegrznia and Elk rivers and a decrease in the duration and frequency of inundation of the adjacent land. Another consequence has been a gradual lowering of groundwater levels.



Fig. 1 Poland and the location of the Biebrza National Park.

To counterbalance these negative effects the Biebrza National Park aims to restore the historic hydrological regime. However, farmers owning land along the rivers Jędrzonia and Elk may experience negative effects on their farmland resulting from rewetting measures in the park. The physically-based groundwater and surface water model SIMGRO was used to simulate the effect of these measures (Fig. 2). The model simulates the water movement in the unsaturated zone, the saturated zone and the surface water in an integrated manner. The unsaturated zone is modelled as pseudo-steady state using time steps of one day. The finite element method is used to describe the regional groundwater flow in the saturated zone. The surface water is represented in the model by a network of reservoirs; the outflow from one reservoir is the incoming flow to the next reservoir. The overall model is robust in terms of numerical stability and, for regional studies, does not require too much input data. A detailed description of the model is given elsewhere (Querner, 1997).

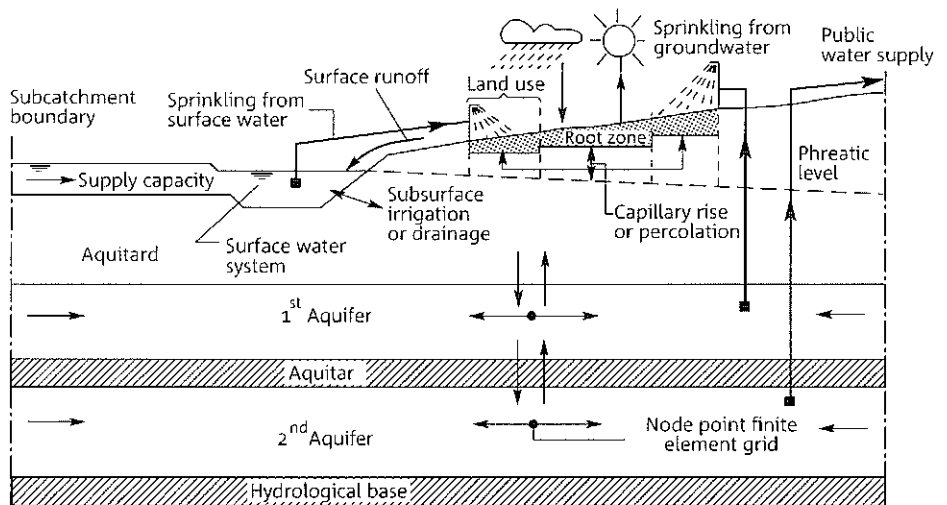


Fig. 2 Schematization of the hydrological system for a subregion in the SIMGRO model (Querner, 1997).

SCHEMATIZATION AND CALIBRATION

The Central Biebrza basin has been modelled by SIMGRO. The finite element network of 1500 nodes spaced about 500 m apart and 110 subregions (shown in Fig. 4). The saturated zone is divided into two layers: a peat layer on top and a sandy soil below. The peat layer is considered as an aquitard ranging in thickness of 1–3 m, the aquifer below has a thickness of about 20 m and a transmissivity of about $200 \text{ m}^2 \text{ day}^{-1}$ (Slesicka & Querner, 2000).

The model was calibrated for the hydrological conditions of 1995 and 1996, using the Biebrza River discharge, surface water levels and groundwater levels. In Fig. 3 the calculated and observed discharges of the Biebrza River and groundwater levels for 1995 and 1996 are shown. The calculated and observed discharges compare well, but small differences occur during periods of low flow. The response of the calculated groundwater levels is of the same order as measured. The standard deviation is less than 0.3 m.

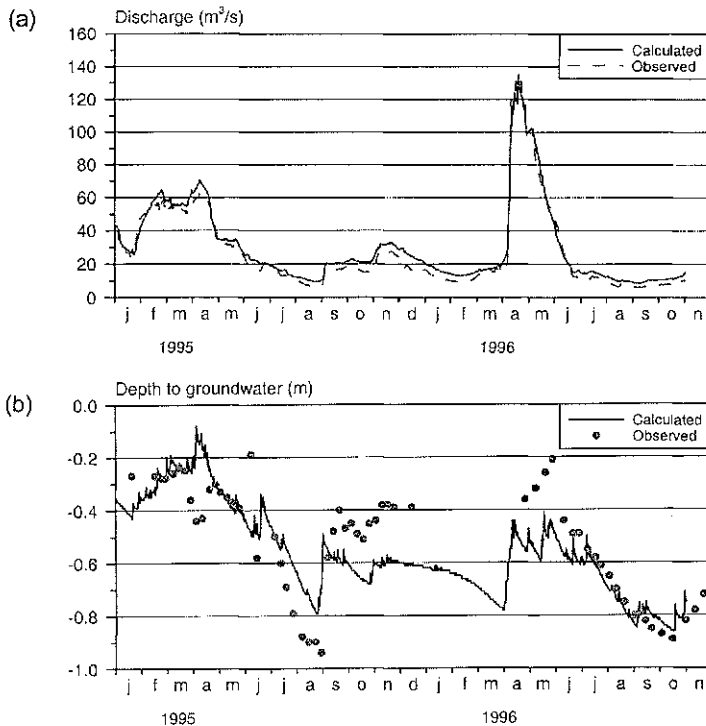


Fig. 3 Comparison of calculated and observed discharges of the Biebrza River and groundwater levels for 1995 and 1996. (a) Discharge of Biebrza at Osowiec gauging station. (b) Groundwater levels at node 687.

RESULTS AND CONCLUSION

Various scenarios have been defined to represent the possible methods for restoring the hydrology of the area. The scenarios focused on raising the water levels in the canals by a redistribution of the discharge over the drainage channels and rivers. It was found

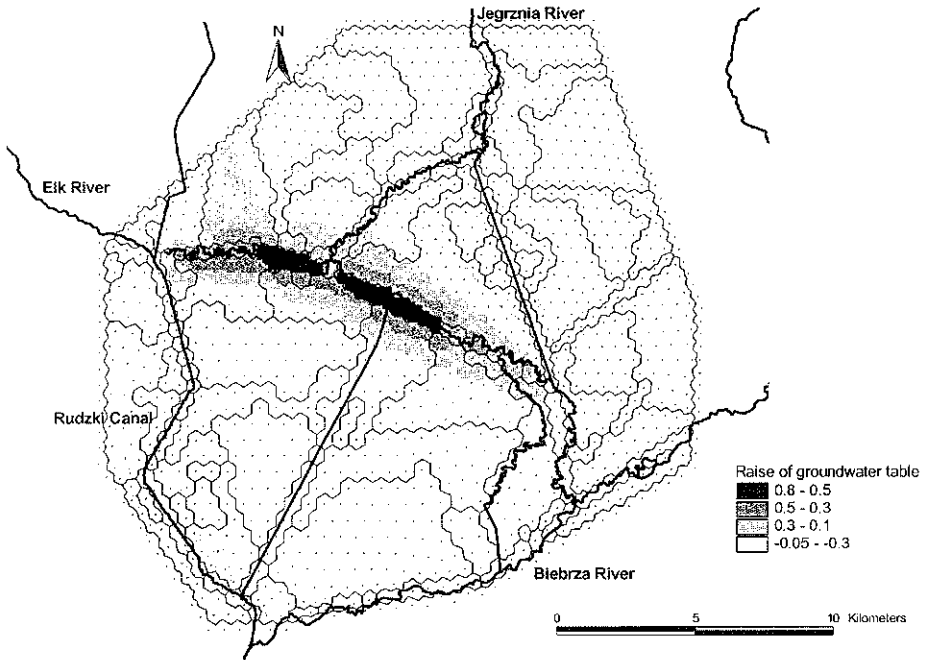


Fig. 4 Change in groundwater table for September 1996: scenario in which flow regime via drainage canals is reduced to 5% of the present flow.

that reducing the discharge in both the Woznawiejski Canal and the Rudzki Canal to about 5% of the present flow, with the remaining water flowing via the rivers Jegrznia and Old Elk, will have the most substantial effect on groundwater levels. This scenario almost resembles the original hydrological situation, i.e. before the construction of the canals, and leads to a considerable rewetting, especially in the zone along the Elk River (Fig. 4). Rewetting of the natural wetland area is feasible but unavoidably these measures also lead to higher water levels in parts of the agricultural area.

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