Water budget of an oxbow lake in the Drava River floodplain

Bilan hydrique d'un bras mort dans la plaine d'inondation de la Rivière Drava

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RÉSUMÉ

La partie hongroise du lit majeur de la Drava est autant affectée par les risques d'inondation que de sécheresse. Les risques de sécheresse ont tendance à augmenter car la construction de barrages et les régulations ont changé le débit de la rivière et creusé son lit. Un projet de réhabilitation à grande échelle, le programme « Ancien Drava » a été conçu pour résoudre les problèmes d'une part de gestion de l'eau et du territoire, et d'autre part d'emploi. A l'intérieur de ce projet, a été planifié un renflouement des bras morts qui se ferait indirectement depuis le lit principal à travers d'anciens cours et affluents de la rivière. L'efficacité du projet dépend du succès du plan de renflouement. Afin d'évaluer les avantages du Programme, nous réalisons un contrôle pour établir le bilan hydrologique du bras mort Cún-Szaporca, une importante zone humide du Parc National du Danube-Drava comportant une grande variété de fonctions écosystémiques. Le contrôle couvre virtuellement tous les afflux et écoulements d'eau dans et depuis le lac, grâce à un enregistrement des précipitations, de l'infiltration, du potentiel de rétention d'eau, de la température du sol, de la teneur en humidité du sol, du niveau de la nappe phréatique, et de plusieurs paramètres chimiques indiquant également les mouvements de l'eau.

ABSTRACT

The Hungarian section of the Drava River floodplain is equally affected by flood and drought hazards. Drought hazard shows an increasing trend as damming and regulation has changed the water regime and the river channel gradually incises. A large-scale rehabilitation project, the Ancient Drava Programme, is designed to solve problems of water governance, land management and employment. As part of this project, water replenishment of oxbows is planned indirectly from the main channel utilising old courses and tributaries of the river. The efficiency of the project basically depends on the success of this replenishment scheme. In order to assess the benefits of the Programme, we perform hydrological monitoring to establish the complete water budget of the Cún-Szaporca-oxbow, an important wetland within the Danube-Drava National Park, with a wide range of ecosystem functions. The monitoring covers virtually all the possible water inflows into and outflows out of the lake with recording of precipitation, infiltration, water retention potential, soil temperature, soil moisture content, groundwater level and various chemical parameters also indicating water movement.

KEYWORDS

Floodplain, drought hazard, oxbow, water replenishment, Hungary

1 ENVIRONMENTAL PROBLEMS OF THE DRAVA FLOODPLAIN

The Drava is a border river between Hungary and Croatia with an alluvial plain (morphological floodplain) of up to 15 km width. Beginning with 1750, river channelisation divided the area into an active and a ”protected” floodplain. Floods most commonly occur in June-July (Atlantic influence) and in October-November (Mediterranean influence). After the record flood in the summer of 1827 flood-control measures accelerated. Artificial cutoffs made at numerous sites reducing river length and the construction of hydroelectric plants on upstream sections exacerbated natural channel incision due to the neotectonic subsidence of the Drava graben. Particularly low water levels have dropped significantly. The previously unlimited water availability in the floodplain, disconnected from the river channel, was replaced by the alternation of flood and drought periods – occasionally even within a single year (Lóczy et al. 2014). The conditions for agriculture, the main source of subsistence for the population, became critical. To amend this situation, a large-scale landscape rehabilitation project, the Ancient Drava Programme, launched in 2013 (AQUAPROFIT 2010) is intended to solve problems of water governance, land management and employment.

2 STUDY AREA: THE CÚN-SZAPORCA OXBOW

Floodplain landforms, such as oxbow lakes, play a particularly important part in satisfying ecological and agricultural water demand. For a more detailed examination the Drava oxbow of 257 ha area with with a maximum water depth of 2.4 m and an average water depth of 1.12 m (DDKÖVIZIG 2012) was selected. The oxbow was partially cut off from the new Drava channel during the first stage of channelisation between 1842 and 1846. The water management plan (DDKÖVIZIG 2012) envisions ”ecologically sustainable and cost-effective water supply”, water retention, wetland habitat restoration and recreational development, first of all, through a rise in lake water level from the present 90.15 m above sea level to 91.25 m. Water recharge will be implemented from a reservoir on a minor tributary through a feeder canal of 1.25 km length and only 0.4 $m^3 s^{-1}$ capacity.

3 MONITORING WATER BUDGET

Two monitoring sites have been set up next to the oxbow lake. The monitored parameters cover virtually all the possible water inflows and outflows of the lake. Precipitation, infiltration, water retention potential, soil temperature, soil moisture content are recorded at various depths. Changes in groundwater level and some chemical parameters (indicating water movement) are also observed. The monitoring of groundwater conditions is supplemented with well testing to estimate subsurface communication between the oxbow and the main Drava channel. Soil profile and alluvial sediment analyses are carried out to estimate the conductivity of the different horizons/beds and land use and vegetation dynamics are surveyed by remote sensing. The influence of local rainfall events on the groundwater table is evaluated in the light of precipitation amount and intensity as well as soil temperature and saturation. Since seepage to groundwater is a major type of loss in the water budget of the oxbow, the monitoring of groundwater levels is central to our investigations. Evaporation from open water surface is estimated from climatic parameters (checked from weather in 2013 and 2014) and transpiration from aquatic and riparian vegetation from botanical and forest inventory data (proportions of tree species), resp.

4 RESULTS AND DISCUSSION

The two groundwater monitoring stations are in operation since September 2013. Well testing pointed out that the groundwater table in the immediate environs is dropping with distance from the oxbow. The individual hydrogeological units show highly variable transmissibility values. Comparing the properties (particle composition) of sediments on the lake floor and in the lakeshore zone by laboratory investigations, we identified a clogged zone (accumulation of mud with high organic matter content). The total surface across which seepage from the oxbow lake can take place was calculated to be 26,000 m^2. The analyses indicated that a ca 0.5 m water table drop probably takes 15 days. This provides a basis for the calculation of the necessary rate of water recharge through the feeder canal. In the hot summer season evapotranspiration significantly reduces water reserves and calls for higher rates of recharge.

5 CONCLUSIONS

It is too early to answer the question how efficiently the oxbow with artificially raised water level would

recharge groundwater reserves in adjacent areas and thus ensure water availability for the entire floodplain. The requirement of an ecologically optimal lake level, however, contradicts the need for floodwater retention in the oxbow – at least during the early summer flood period. Some natural groundwater replenishment seems possible from precipitation falling on the higher-lying terrain in the north. Although further investigations are needed, it is probable that the capacity of the feeder canal will prove barely adequate to maintain the desired water level in the lake. Water recharge would also involve land use conflicts, which will be difficult to resolve on a strictly scientific basis.

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