Flood management and lake control

Andreas Inderwildi, Dipl. Ing. ETH[1]; Gian Reto Bezzola, Dr.[1]; Wolfgang Ruf, Dr.[1]

LAKE CONTROL

In Switzerland two thirds of the entire catchment basin of the Aare River (17,600 km²) are controlled by the main perialpine lakes (Jura lakes, Lake Lucerne and Lake Zurich, see Fig. 1). There are mandatory regulations in place specifying the outflows, in order to consider the wide interests of various stakeholders with regard to the water levels and the outflows.

In the case of floods further additional instructions are an inherent part of the existing regulations. In the river systems of the Aare, Reuss and Limmat, the discharge is significantly determined by the unregulated downstream tributaries (Emme, Kleine Emme and Sihl). The lake control is of great importance to the flood management, especially since the densely populated Swiss Plateau has a high damage potential.

The cantons are responsible for the operational regulation of the lakes, the monitoring of the control systems and the establishment of regulations. In accordance with the Federal Act on Hydraulic Engineering, the Federal Office for the Environment FOEN is responsible for the supervision of the lake control. In emergency situations, the FOEN has also a right to say in adapting the outflows of the Jura lakes and the Zurich lake.

FLOOD EVENTS AND ANALYSES

The floods of 1999, 2005 and 2007 caused severe damages in Switzerland. The lakes and large rivers of the Swiss Plateau were especially affected. The analysis of the flood events showed the importance of a coordinated regulation of the large Swiss lakes. As a result, the collaboration between the Con-fe-deration and the cantons in the domain of lake regulation was improved.

FORECAST REGULATION

In case of an emerging flood, the outflow can in principle be adapted to optimise the retention volumes of the lakes by considering the interests of upstream and downstream residents. Furthermore, the outflows from the various lake systems should be coordinated in order to avoid superpositions of downstream high flows.

Subsequent to the floods of 2005 and 2007, for the Jura lakes a prognostic regulation scheme was established in the autumn of 2008. It is based on the 5-day-forecast of the lake inflow and allows to create additional flood retention volume by preventive lake level lowering (see Fig. 2). The forecast regulation requires also institutionalised agreements among the concerned cantons, in order to ensure the necessary decisions quickly and conjointly.

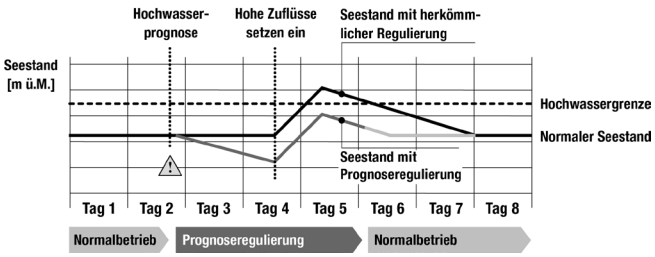

Figure 2. Principle of forecast regulation (Figure Regulatory Office for Water and Waste, Canton of Berne)

The forecast regulation has already been successfully operated during the flood events of May/June 2013 and July 2014.

HYDRODYNAMIC MODEL

In order to improve the regulation of the main perialpine lakes and to assess various outflow scenarios during flood events, the Federal Office for Environment FOEN has set up a comprehensive hydrodynamic model (Inderwildi et al. 2014). This currently includes approximately 270 km of river reaches, 150 km of lakes, between 600 to 1400 cross-sections (depending on the model configuration) as well as 13 river power stations

and 3 control structures for the lake outflows (see Fig. 3).

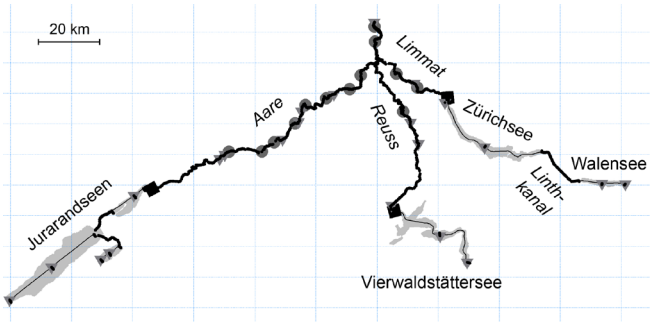

Figure 3. Spatial overview of the hydrodynamic model.

This model has been in use since 2013. The experiences gained with the hydrodynamic model show that the calculations for the lake level forecast with different outflow scenarios provide valuable information for the daily forecast as well as during flood events. The model complements the existing model chain (rainfall - runoff) and permits to predict the impact of lake control in the overall system.

The model also allows for detailed analysis of flood events, with the aim of optimising the lake control. Since it was possible to test and optimise the model over the past 3 years, it will now be further developed and expanded in 2016.

REFERENCE

Inderwildi A., Ruf W., Bezzola G.R. (2014): Hochwassermanagement und Seeregulierungen. Internationales Symposium Wasser- und Flussbau im Alpenraum, 25.-27. Juni 2014, Zürich. Mitteilung Nr. 228 der Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie der Eidgenössischen Technischen Hochschule Zürich, 565-575

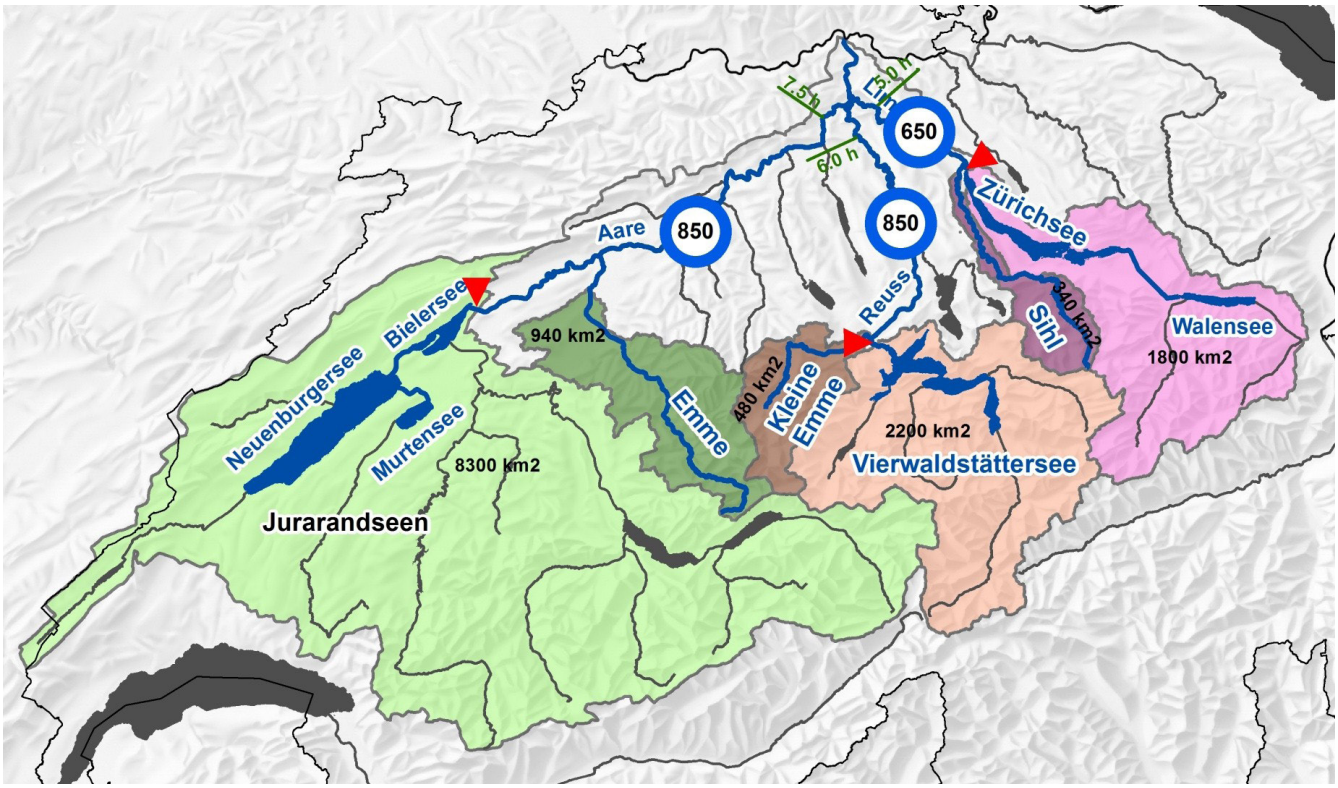

Figure 1. Overview of the catchment basin of the Aare river and its sub basins

KEYWORDS

lake control; flood management; hydrodynamic model; forecast regulation

1 FOEN (BAFU) Switzerland, Ittigen, SWITZERLAND, andreas.inderwildi@bafu.admin.ch