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THE COMPLETION OF THE DAM LEIBIS/LICHTE: THE USE OF NATURAL PROCESSES AND OF ENGINEERING POTENTIALS FOR THE SUPPLY OF HIGH VALUE DRINKING WATER

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1. SUMMARY

In 2010 the construction and test operation of the Leibis/Lichte-dam in the Free State of Thuringia (Germany) were completed. This ensures the supply of drinking water for the eastern part of Thuringia. Considerable technical equipment and a comparable big water volume allow a specific control to the whole ecosystem in the reservoir and also in the underflow. The fast availability of physical, chemical and biological data allow the development of long time control strategies and also operative control concepts, respectively. The support of natural processes within the water is of high importance for a high level of water quality for drinking water supply. To control already the raw water resources is a safe way to reduce risks, caused by contamination or climate conditioned events and consequently, to minimize also the effort for water treatment. First results since the dam up in 2005 let us realize that this broad discussed decision to complete this dam system has been the right decision.

2. INTRODUCTION

The dam Leibis /Lichte is used for drinking water supply and flood control. The operations of the dam should not affect the ecosystem downstream.

Technical data of the Leibis/Lichte dam

Gross capacity 39,2 10^3m^3
Mean annual discharge 31,5 10^3m^3
Flood storage capacity 5,6 10^3m^3
Capacity to ensure water quality: 6,8 10^3m^3
Theoretic water retention time: 1,2 a
Water depth (max. in normal operation): 90 m
Discharge pipes: 5, continuously variable
automatic measurement of water quality at various depths

From 1992 to 2005, the water supply was from the pre-dam. Since the completion of the dam in 2005, a filling was done with tests. These tests were completed in 2010 with the achievement of the highest level (Figure 1).

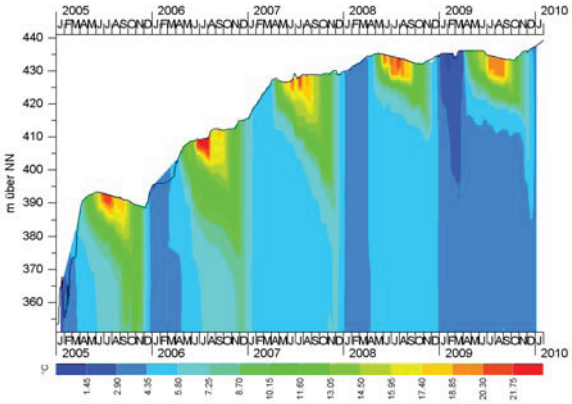

Figure 1 Water temperature and level of water of the Leibis/Lichte reservoir

In contrast to natural lakes, reservoirs consist in the ability of target management of the water body (shorter retention time). Important is also the proportion of deep water in large reservoirs.

3. WATER QUALITY CONTROL

The basis for a high water quality is the protection of the water. A modern management of the reservoir provides a high quality of raw water, before further steps to be done to improve the water quality in the water treatment plant (figure 2).

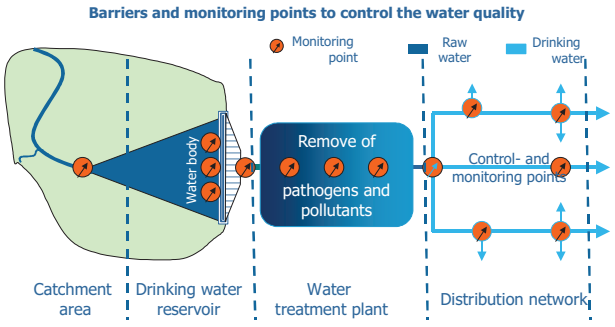

Figure 2 Schematic view of multi-system barriers to protect drinking water

Measures for the improvement of water quality have the following main objectives:

- Reduction of nutrient and algal growth
- Protection against the entry of pathogens
- Protection against the entry of pollutants

3.1. Catchment area

For the complete catchment area of the reservoir there is an ordinance to protect this area against contamination. This area is mostly forested, although there is also some agriculture. The responsible water supply company (Thüringer Fernwasserversorgung) pays compensation for restrictions on agriculture. Another quality assurance element is a sewage pipe along the reservoir where the waste water can be discharged from the catchment and the reservoir.

All actions require a good information base. Online results and laboratory tests are processed in a database for decision making.

To achieve these objectives (best raw water quality) in the reservoir itself, there exists the following ways:

3.2. Short term operating of the reservoir

Especially in the summer, the body of water is divided into different layers (upper warm, bottom cold, Figure 1). Therefore, the concentration of substances varies at different depths. To always provide the best water, is adjusted accordingly based on the online measurements, the discharge depth (figure 3). At the same time from different horizons, polluted water can be derived by an other pipe. This control is of importance in case of floods or algal blooms. At the bottom of the reservoir is also a pipe through which contaminated water is passed from the pre-dam and can be delivered to the lower river.

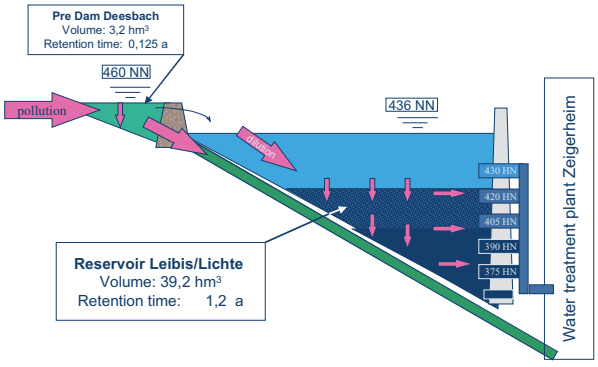

Figure 3 Control options of the Leibis/Lichte reservoir

3.3. Strategic management

Strategic water quality management focused on a large volume of the lower water body (hypolimnion). There the temperature and the external influences are low. Based on the inflows and outflows in the reservoir, the development of this deep water storage is calculated. Therefore at the end of the summer (low inflow), the total content may not be less than 6.8 million m^3.(operating definition [1]).

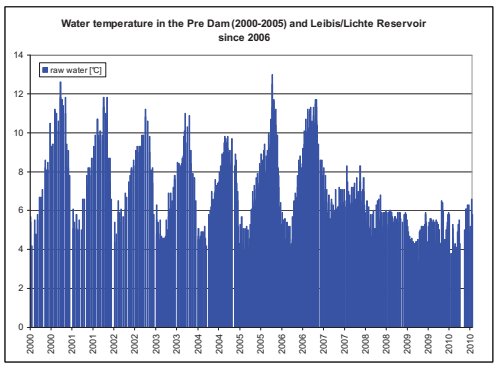

Figure 4: low water temperature since the use of hypolimnic water of the Leibis/Lichte reservoir 2006

Further effects of a large hypolimnion are:

- Low influence of the sediment
- Enough choice in the discharge level of water
- Good dilution of external inflow and its substances

3.4. Biological self purification

A major problem of water supply from surface water are microscopic algaes. In addition to the limitation of nutrients, it is possible to reduce the algae itself in the reservoirs. However, there are small crustaceans (water fleas) that eat algae. This filtration is supported by biomanipulation [2]. Predators of these water fleas are small fish and predators of the small fish are large predators like trout. The concept of biomanipulation (food web management) is based on the promotion of predators, which suppress the small fish (figure 5). In the reservoir Leibis /Lichte, therefore a large stock of Lake Trout (*Salmo trutta lacustris*) is being established [3]. The transparency of the water becomes better and the turbidity decreases (figure 5).

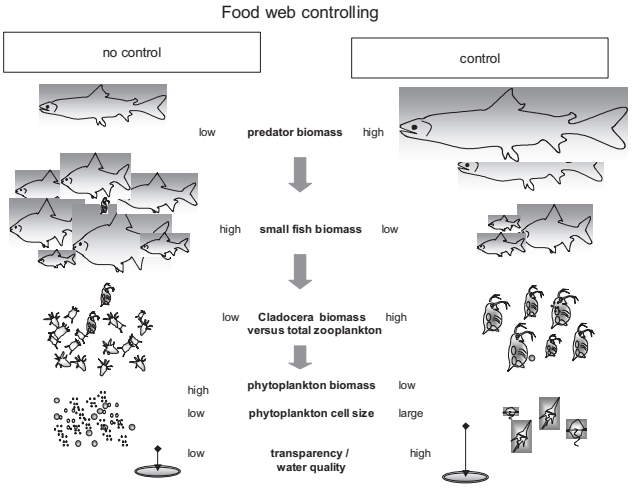

Figure 5 Food web control to improve the water quality

3.5. Temporary measure to ensure water quality

The first filling of the reservoir with water leads to the degradation of the vegetation what is not completely removed at the bottom of the lake. This results in a demand for oxygen and amount of undesirable substances like manganese and ammonia. To avoid this, pure oxygen is bubbled into the deep waters of the reservoir. This measure is necessary in the summer. In this time the water body is stratified (figure 1) and there is no natural oxygen supply.

4. ECOLOGICAL REQUIREMENTS

The construction of this dam and the management of the new reservoir will implicate serious changes of the environment. This is why an impact study was done in order to estimate all possible environmental changes all round of the planned reservoir.

Appreciable main damages would result from flooding and from the "barrier effect" of the dam:

Essential prejudice: Wastage of terrestrial ecosystems in the planned reservoir area
Barrier effect: Runnels and little rivers
Moderate ore low effect: Ecosystem downstream of the dam

Beside these effects, the environmental authority was afraid of a negative impact on a protection zone recommended by European Union [4], located in the downstream of the reservoir. The approval to complete the reservoir system by a dam is connected with compensation measures for all environmental impacts [5]. One project of this compensation plan is the preparation of guidelines for an ecological water management of the reservoir in order to reduce the negative influence on the ecosystem downstream.

The following steps have been done:

- Elaboration of a water management model
- Calculation of hydrological conditions which are
- necessary to conserve the temporary ecological status of the river "Schwarza" downstream of the dam.
  - Determination of concrete requirements on the water management

Significant are very high and very low flows. Therefore, the outflow of the reservoir control as follows:

low inflow = low outflow
high inflow = high outflow

The storage of water takes place only at medium inflow (Figure 6) [6].

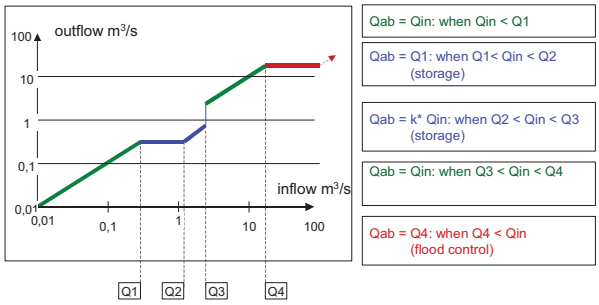

Figure 6 Ecological reservoir management: Control of outflow as function of inflow

5. NEXT STEPS

The final reports to the test filling of the dam Leibis/Lichte dam will presented on 29th September 2010. In Mai 2010 the water treatment plant was successful tested with a maximum capacity. The water distribution will be completed and optimized by 2012. In 2012, the supply of Eastern Thuringia will be completely out of the Leibis/Lichte reservoir.

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