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POSSIBILITY TO MODEL THE EXPLOITATION OF THE SURDUC RESERVOIR

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Abstract: Reservoirs together with the dams that make them are constructions with a very long lifetime, which require significant investments for construction and exploitation. For this reason, the design, execution and exploitation of these hydrotechnical arrangements must allow the efficiency these types of investments, their economy and safety being the two fundamental elements of which it is attached account for the design, execution, exploitation, but especially for the financing of new investments in the field of water resources management. In order to develop the regulations for the exploitation of the reservoirs, it is possible to use the advanced hydroinformatics tools for modeling the operation of a reservoir. This paper presents such a possibility of modeling the exploitation of Surduc reservoir using MIKE HYDRO Basin tool.

Keywords: reservoir, exploitation, modeling, water resources management.

1. INTRODUCTION

Reservoirs together with the dams that make them are constructions with a very long lifetime, which require significant investments for construction and exploitation. For this reason, the design, execution and exploitation of these hydrotechnical arrangements must allow the efficiency these types of investments, their economy and safety being the two fundamental elements of which it is attached account for the design, execution, exploitation, but especially for the financing of new investments in the field of water resources management.

Therefore, developments of reservoirs exploitation regulations are very important.

Increased attention to the drafting of exploitation regulations for reservoirs must be paid to large reservoirs with complex functions, both for the satisfaction of water users, electricity production and flood mitigation. Exploitation policy is essential for reservoir operation because the impact of the operation on the environment, society and economy is significant.

The regulation for the exploitation of the reservoirs represents the main document of the owner of the reservoir, based on which its water resources and other natural resources must be used, respecting the environmental protection conditions, as well as the fulfillment of the maintenance and repair obligations of the hydrotechnical constructions within the terms provided in the technical book of hydrotechnical constructions, in accordance with the normative acts, based on the observations on the behavior of the constructions in operation. The regulation is part of the technical documentation for the exploitation of the reservoir. [1]

The exploitation regulations are elaborated for the hydrotechnical constructions with functions of regularization and capture of water discharges: dams with permanent accumulation lakes, dams with non-permanent accumulation lakes, polders, water intakes with or without dam, hydrotechnical regulation nodes and water discharges management. [2]

The elaboration of the exploitation regulations is made on the basis of the information and exploitation conditions elaborated by the designers, the information from the technical books of the constructions, equipment's and installations, conclusions and recommendations of the studies regarding the tracking of the behavior in time and of the expertise studies on the technical condition.

Also, must be taken into account the hydrological, hydrogeological and water management studies, as well as the information contained in the orders and technical dispositions of the technical-operative authorities, from the field of activity of the owner of the arrangement and from the field of water resources management. [2]

In order to develop the regulations for the exploitation of the reservoirs, it is possible to use the advanced hydroinformatics tools for modeling the operation of a reservoir.

The results of modeling the exploitation of accumulation lakes with advanced hydroinformatics tools can help the specialists to elaborate efficient exploitation plans, which correspond to the requirements of an integrated and sustainable water resources management.

2. MIKE HYDRO Basin MODEL

Hydroinformatics (or water informatics) result from a combination between modelling tools and

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Information and Communication Technologies (ICT), result a single methodological approach dealing with physical, social and economic aspects of sustainable and integrate water resources management.

One from the most known advanced hydroinformatic tools for reservoirs operation modelling are MIKE HYDRO Basin, developed by DHI – Institute for Water and Environment. MIKE HYDRO Basin is a multi-purpose, map-centric decision support tool for integrated river basin analysis, planning and management. MIKE HYDRO Basin uses a simplified mathematical representation of the river basin, including the configuration of river and reservoir systems, catchment hydrology and water user schemes. [3]

Advantages of use of MIKE HYDRO Basin:

- MIKE HYDRO Basin provides an easy-to-use, map-based modelling framework for water resources management and planning in river basins;
- It includes all model features required in most projects for efficient and accurate water resources modelling;
- Design model layouts using embedded GIS features and functionalities;
- Fast and flexible simulation engine with scripting options;
- Mature and reliable river basin simulations capability obtained from more than a decade long record of project applications;
- Detailed outputs from model features provide an easy overview of scenario results, such as water usage, water allocation deficit, generated power, reservoir releases, water losses and mass balance;
- Comprehensive and effective model components for Integrated Water resources Management applications and decision support systems;
- Options for stakeholder involvement through serious gaming.

MIKE HYDRO Basin is the ideal software for:

- Multisector solution alternatives to water allocation and water shortage problems;
- Climate change impact assessments on water resources availability and quality;
- Exploration of conjunctive groundwater and surface water usage;
- Optimisation of reservoir and hydropower operations;
- Evaluation and improvement of irrigation scheme performance;
- Integrated water resources management (IWRM) studies. [3]

The Basin module support three routing options:

1. Linear reservoir routing - distributes flow leaving the river node over all time steps; delay parameter K (the linear routing time lag), must be specified. The delay parameter K specifies the time for the incremental flood wave to traverse the river between the selected river node and the next downstream node. Its value estimated as the observed travel time of the flood peak between the nodes. For a pulse inflow, outflow peaks after a specified time given by the time lag, and then decays exponentially.

2. Muskingum method - is a commonly used hydrologic routing method for handling a variable discharge-storage relationship. This method models the storage volume of flooding in a river channel by a combination of wedge and prism storage. During the advance of a flood wave, inflow exceeds outflow, producing a wedge of storage. During the recession, outflow exceeds inflow, resulting in a negative wedge.

3. Wave translation algorithm - uses a cyclical buffer with ‘slots’ for every time step. The inflow at a time step put into the current slot, and the corresponding earlier inflow that was stored in that slot pulled out. The index of the current slot cycles within the buffer, such that a new inflow always replaces the ‘oldest’ previous inflow. The number of slots in the buffer is equal to the number of time steps that a flow delayed. The number of slots is computed as floor dt/K, where K can vary among reaches, and dt [time] is the simulation time step. The latter must be constant during a simulation; for months, a standard month length (30 days) assumed. A good estimate of K can be the travel time of a distinct hydrograph peak between the selected river node and the next downstream node.

MIKE HYDRO Basin module used only to calculate flows, not water levels, because module is not a hydraulic model and thus cannot use for proper flood modelling. [3]

The input data in MIKE HYDRO Basin are:

- river network - river nodes;
- location and characteristics of reservoirs and water user;
- river branches catchments characteristics (area, land use);
- time series of precipitation, evaporations from reservoirs, water demand.

3. STUDY CASE

To exemplify the potential of using advanced hydroinformatic tools (MIKE HYDRO Basin) to modeling exploitation of reservoirs was elected a study on Surduc reservoir (Figure 1).

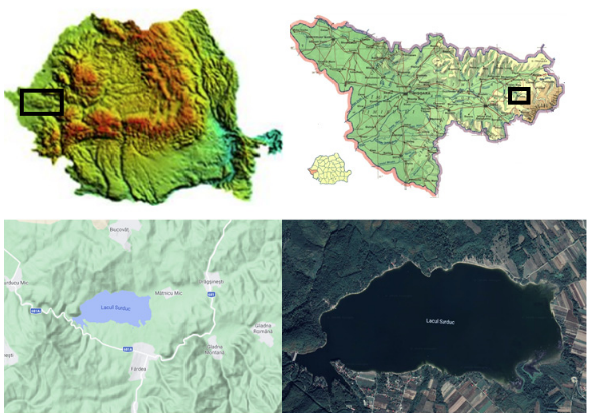

Figure 1. Geographic location of studied reservoir (plan view, aerial view)

Surduc reservoir is part of the ensemble of hydrotechnical works of the Timis - Bega basin and is located on the Gladna river, a left tributary of the Bega river. The Gladna river has a length of approximately 34 km and a hydrographical basin of 173 km^2 of which 7491 ha of forest. The river basin has an average altitude of 282 mdM (between 820 and 119 mdM), with an average slope of 2.1%.

The reservoir is located at km 12 + 700 upstream of the confluence of Gladna river with Bega river, between Surducu Mic and Firdea localities, Timis county.

The barred section controls 135 km^2 from a total of 173 km^2 of the Gladna river hydrographical basin area. [4]

The Surduc accumulation dam is of frontal type, of weight, made of rocks with reinforced concrete mask, being provided with a large water drain located on the right slope, two bottom drain pipes, the energy sink basin and the risberma (Figure 2). The hydroelectric plant is located 2 km downstream of the dam. [4], [5], [6]

Figure 2. Surduc reservoir and dam

The reservoir functions are:

- drinking and industrial water supply by supplementing the discharges on the Bega river with 6.70 m^3/s;
- irrigation with 80% insurance: 28700 ha, of which 11900 ha upstream of Timisoara;
- fish farming with 80% insurance: 362 ha in reservoir and 80 ha upstream of Timisoara;
- electricity by machining in MHC Surduc with installed capacity of 2 MW;
- the flood attenuation ensured by a volume of 28.375 million m^3 between the quota 192.00 NNR and the quota 198.00 NNR, corresponding to the ridge of the spillway as well as by the volume of the spill blade;
- recreation (water bike rowing, sport fishing etc.). [4]

The scenario considered is:

- modeling scheme (Figure 3)
- 3 water users - total 12.80 m^3/s
- catchment runoff time series (Figure 4)
- simulation period 01.01.2019 – 31.12.2019.

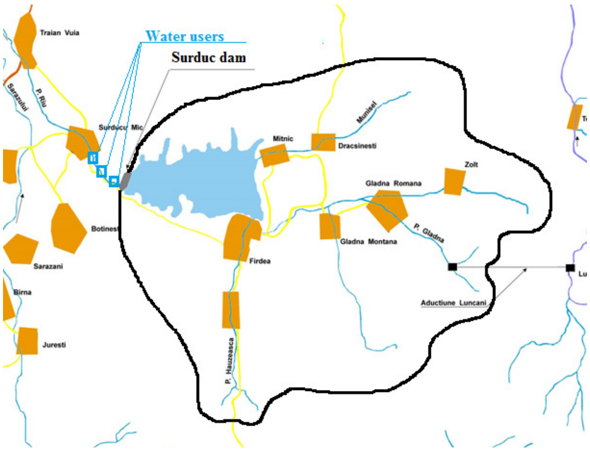

Figure 3. Scheme for modeling

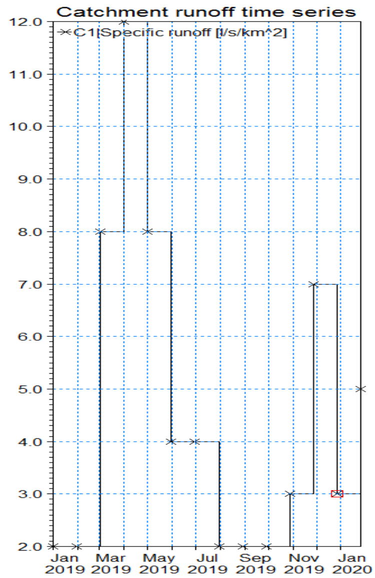

Figure 4. Catchment runoff time series

4. RESULTS AND DISCUSSION

The results of simulation can see in Figures 5, 6, 7 and 8.

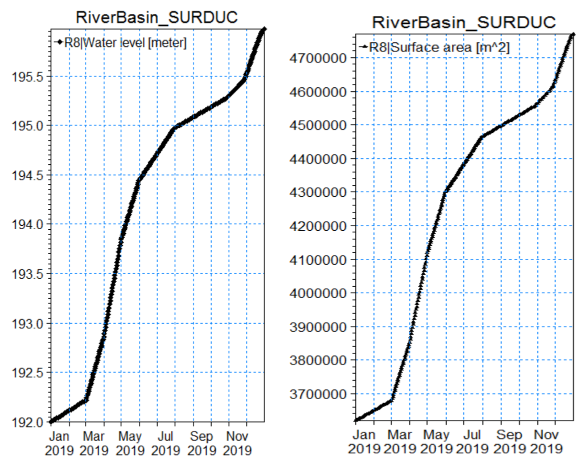

Figure 5. Variation of water level and surface area of reservoir

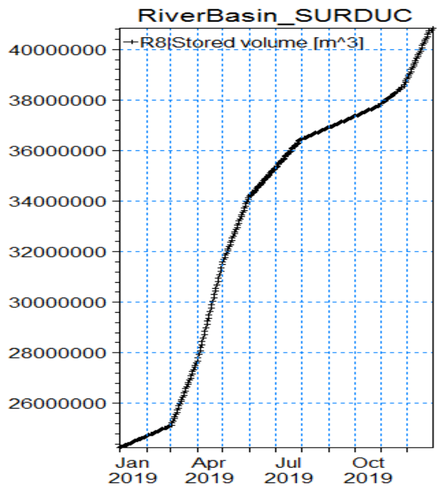

Figure 6. Variation of stored volume in reservoir

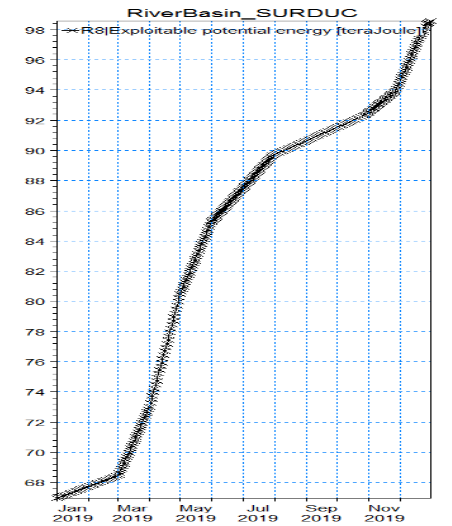

Figure 7. Exploitable potential energy

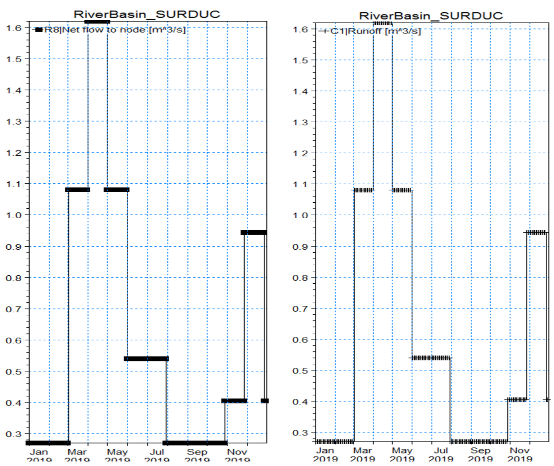

Figure 8. Runoff and net flow in reservoir variation

By modeling, the water level in the reservoir and the stored water volume can be estimated at any moment. This is useful when forecasting a flood and seeing if it is necessary to pre-emptying an accumulation trance to retain / attenuate the flood wave, or if water volumes do not meet the water requirement for use, restrictions may be introduced.

5. CONCLUSIONS

Advanced hydroinformatics tools are useful for water management specialists, in order to draw up water resources management plans in a river basin. In the case of complex arrangements of river basins, with several accumulations, complex models can be built that successfully complete the dispatcher graphics for each accumulation. Thus, a coordinated exploitation of all hydrotechnical works can be achieved, in view of the sustainable and integrated management of water resources.

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