THE INFLUENCE OF HYDROLOGIC LAKES AND ACCUMULATED MANAGEMENT ON THE PROCESS POURING OF THE LAKE

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Summary: *According to the available existing documentation and various previous studies, the flow of water into the "Modrac" accumulation is not defined directly, by measuring the flows on the main creek Spreca and Turija, but indirectly, over the level and volume of the accumulation, as well as data on the discharge of water from the reservoir.*

In this way, a series of average daily values of inflow into accumulation was obtained for the period from 1980 to 2012. year. Interpretation of these data was done in the form of variation of annual inflows in the observed period, as well as average flow curve curves. By reviewing the previous measurements and surveys, it can be concluded that there is a more pronounced cyclicality of inflows over a longer period of time, with driers of dry and rainy periods.

On the other hand, having in mind the natural correlation between the inflow of water and the spread of the deposit, it is logical to hypothesize that at the time of the hydrological maximum, the input is higher in the accumulation.

Another important indicator of the hydrological regime of the lake is the duration of the inflow into the accumulation "Modrac". This curve points to the vast hydrological regime of the watercourse in the basin of the reservoir. In this regard, it should be noted that all watercourses in Bosnia and Herzegovina and the region, with a basin area of up to 1000 km2, have such a regime. Bearing in mind the similarity of physical and geographical conditions in the region, this analogy is quite logical. The hectic hydrological regime is characterized by a short duration of large waters and a very long duration of small water, as well as a large flow range (Q_{max} / Q_{min}).

Keywords: *hydrological regime, accumulation, inflow, application, curve flow, catchment area*

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1. INTRODUCTION

The "Modrac" dam is a multi-purpose reinforced concrete dam, which according to its technical characteristics and the amount of accumulation belongs to high scores. It consists of ten arches (arches), three of which have overlapping bodies, nine contractions, and two gravitational coastal pillars. The length of the dam on the crown is L = 205,00 m and the highest height is H = 27.50 m. The vaults are different and ranging from 15.60 to 17.00 m. The thickness of the vault is 50 cm high and the bottom to 40 cm at the top of the mentioned dam. The thickness of the deposit is also different, in terms of height and sum of 2.80 to 1.40 m. In the long term, the dam is in some fields stuck with beams. [1]
For the accumulation level management, under normal hydrological conditions, four basic outlets (number: 2, 6, 7 and 8) are provided for the maximum capacity Q = 77 m3 / s (projected state). On the basement exit number 2, the "Modrac" power plant of 2,000 kW was built for the production of electricity by using surplus water available. For the evacuation of large water, in addition to the basic drains, three overflow fields are envisaged, maximum flow rates of about Q = 1,000 m^3/s, ensuring the evacuation of the large springs of the Spreca River ranges from 1/1000. The purpose of the accumulation, in the order of priorities established by the Law on Protection of Reserves "Modrac" (Official Paper of the Canton of Tuzla, No. 15/06), is as follows::

- Providing water for the needs of the population,
- Providing water for industry,
- Provision of the water management minimization for the Spreca watercourse, downstream of the dam,
- Flood protection from downstream slopes,
- production of electricity on small hydro power plants,
- development of tourism, recreation and water sports, in accordance with the said law.

The plant plan has set a minimum working level of 195.00 m.u.s., with a useful volume of accumulation of 64x106 m^3. The drainage mode of accumulation is directly related to maintaining the water level in the reservoir. Therefore, in the spring, when natural paths are larger, more water is discharged from the reservoirs and only in the summer period is only an environmentally acceptable flow determined by the water permit and is Q = 4.7 m^3/s. The ecologically acceptable flow in the dry season of the year with the prescribed Q = 4.7 m^3/s decreases to Q = 1.0 m^3/s, which is slightly above the minimum average monthly flow of the Spreca River 95% Q_{min}.midlle month.95% = 0.824 m^3/s.

2. HIDROLOGICAL CHARACTERISTICS OF RESERVOIR MODRAC

The drop of water in the reservoir Modrac, as stated above, is not defined directly, by measuring the pressure on the main tributaries of Spreca and Turija, but indirectly, over the level and volume of reservoirs of hydrophobic discharges of water from the lake. In this way, a series of mean daily intakes in the lake was obtained for the period 1980-2012. Interpretation of these data was made in the form of variations of the annual inflows into the period considered, as well as the average wrong flow time. From the diagram of the variation of the annual flow into the accumulation (Figure 1) it can be concluded that it

has penetrated in the range of 220-860 million m^3, with an average of 300-400 million m^3.[3]

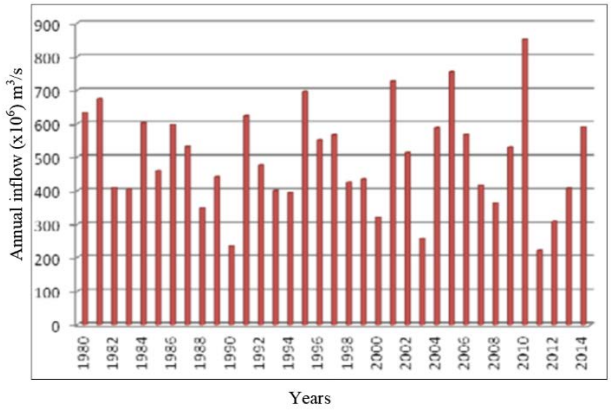

Figure 1. Variation of annual inflow into the Modrac reservoir period 1980 - 2014

This diagram does not indicate a more pronounced inlet cyclicality over a long period of time, with dry and water remainder. On the other hand, bearing in mind the natural correlation between the flow of water and the nanoparticle, it is a logical hypothesis that in the water years there was a greater incidence of deposition in the accumulation. Another important indicator of the hydrological regime of the lake is the fault of the flow into the reservoir "Modrac", (Figure 2). This fault indicates the hydrological regime of watercourses in the reservoir. In this regard, it should be noted that all watercourses in the region, with a surface area of up to 1000 km^2, have such a regime. Bearing in mind the similarity of the physical geographic conditions in the region, this analogy is quite logical. The hydrological regime is characterized by a short duration of large water and a very long duration of small water as well as a large range of flow (Q_{max} / Q_{min}). [3]

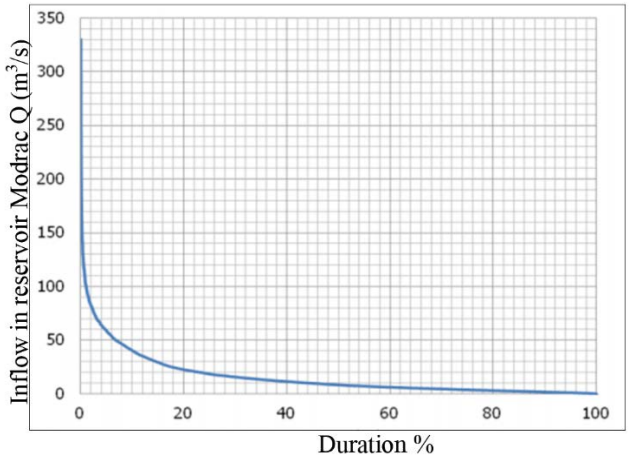

Figure 2. Injury of the Modrac accumulation

According to the latest hydrological measurements (data from the Spatial Plan of the Tuzla Canton Water Management Study, Institute of Hydrotechnical Engineering Sarajevo, September 2007), the average annual average flow rates of the main tributaries of Modrac are: for the Savings Order: Q_{mid} = 13.22 m^3/s, and River Turija: Qmid = 3.08 m^3/s. Based on the data provided, it was concluded that over these tributaries in the Modrac reservoir reached about 515,000,000 m^3/year, which enables Modrac to accumulate water 5 to 6 times during the year. Accumulation monitoring measures the quantities delivered, discharged (drainage and pouring) and wastewater (evaporation) and on the basis of this data and the level changes define the inflow accumulation. Data from Public company "Spreca" were obtained on a daily basis for the period of 1980. By analyzing the data, the following conclusions were reached:

- The average annual flow in the reservoir is about 15.63 m^3/s (Figure 3),
- There is a strong lack of mood of touches, indicating turbulent flow character watercourse,
- Months July, August, September and October usually have medium monthly flows between 4 and 6.7 m^3/s,
- It is the most average month of March, but in June it is the maximum average monthly flow in the synthesis year (period 1980-2013)

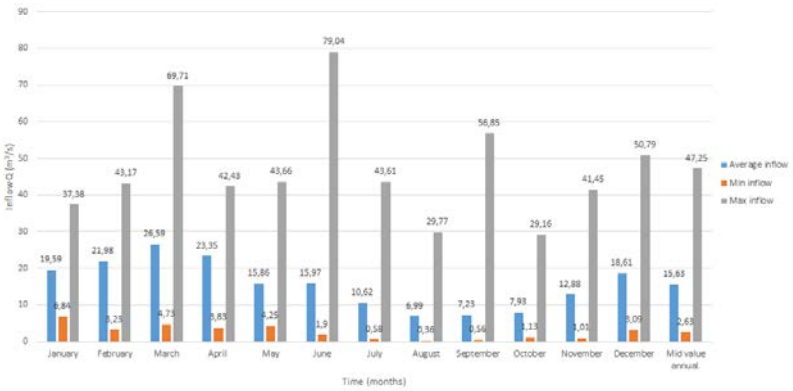

Figure 3. Histogram of minimal, maximal and medium contact in Modrac accumulation

The following figure (Figure 4) shows the water flow curve in the Modrac reservoir measured in 2012. This year is characterized by a very wide range of minimal and maximum touches, as can be seen in the following figure.

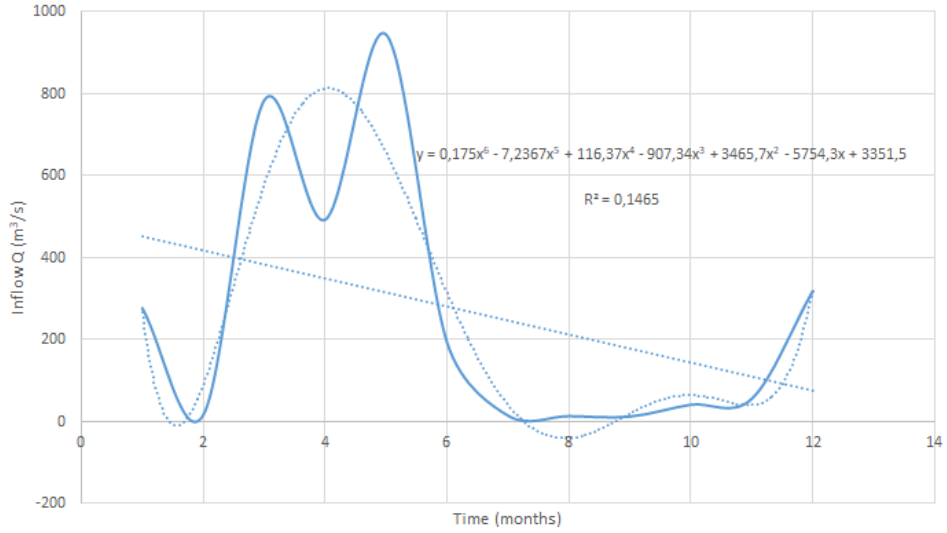

Figure 4. Diagram of touches to accumulationModrac in 2012

3. THE PROBLEM OF OVERWHELM RESERVOIR MODRAC

Considering the problem of overwhelm reservoirs, it also requires the analysis of the influence of the hydrological regime on this phenomenon, that is to say, the conditions of the reservoir regime management, with which the minimum slip is achieved. However, the realization of minimum suction strain conditions is only possible if there are no other limiting factors for the lake regime.

In the period from the construction of the Modrac dam and the artificial reservoirs (1964) to 2012, the total mass of the pre-stretched application amounts to a maximum of 15.000.000 cubic meters, and it can be concluded that the moderate intensity of squeezing by the application. Reduction of total vapor pressure, over a period of almost 50 years, is less than 15%, so it can be concluded that shortening of the age of accumulation is practically negligible. The impact of mining activities on the accumulation of accumulation of analyzes and works carried out in the present period is defined at about 4.510.000 cubic meters of suspended sediment, predominantly of coal particles. [3][4]

By controlling the Modrac reservoir, the operator has been obliged to perform additional cracks in the water reservoir, because the impact of the bulb is much more pronounced than the water supply requirements, rather than the acceptance and transformation of the floodwaters. [5]

In order to protect the reservoir "Modrac" from the introduction of the reservoir, which reduces the volume of accumulation, on the river Turija and Brijesnica on one side and the river Oskova on the other, a series of hydrotechnical objects (stopping dams, overflows, flaps, dr.) whose function is to prevent erosion and pronouncement of materials in the Modrac reservoir. The basic task of these bulkheads is to create accumulation on the said retention rivers and to regulate this river flow as regards the movement of the

netting. The aforementioned buoyancy bulkheads for a number of years are not in operation because they are not cleaned and are covered with dirt, garbage, etc.
In 2012, measurements of the recording of the deposition in the Modrac reservoir were performed, and quantities were measured by the amount of water in the reservoir. The amount of nanoparticles is shown in the following figure (Figure 5). [6][7]

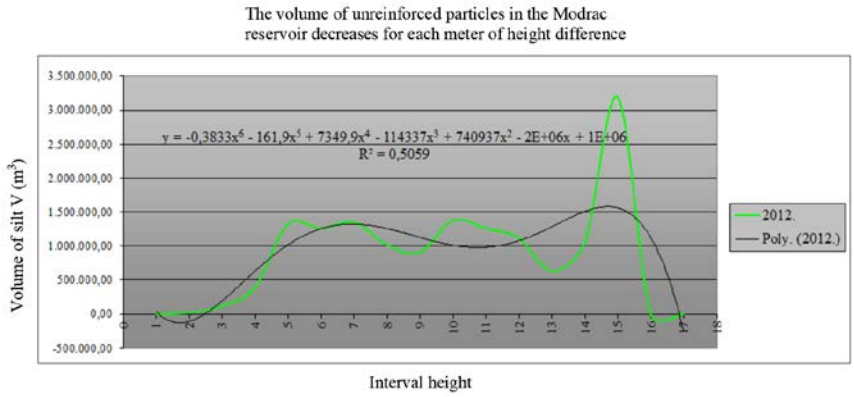

Figure 5. Diagram of silt in reservoir Modrac in period 1964 – 2012

The Modrac hydrographic measurement function equation for 2012 is calculated and displayed in the Microsoft Office Excel program package and amounts:
$y = 0{,}69758x^2-263{,}08845x+24804.38352.$ ($x10^6$ m^3).

4. CONCLUSION

By analyzing the data obtained from these surveys, the following conclusions were reached:

- The average annual flow in the reservoir is about 15.6 m^3/s (Figure 3),
- There is a strong lack of mood of touches, indicating a bulgarian character watercourse,
- Months July, August, September and October usually have medium monthly flows between 4 and 6.7 m^3/s,
- It is the most average month of March, but in June it is the maximum average monthly flow in the synthesis year (period 1980-2013)

Exact data show that in the period from the construction of the dam Modrac and artificial accumulation (1964) to 2012, the total mass of the pre-deposited application is max. 15.000.000 m^3, and it can be concluded that the moderate intensity of squeezing by the application. Reducing the total volume, over a period of almost 50 years, is less than 15%, so it can be concluded that shortening the lifespan of accumulation is practically negligible.
By controlling the Modrac reservoir, the operator has been obliged to perform additional cracks in the water reservoir, because the impact of the bulb is much more pronounced

than the water supply requirements, rather than the acceptance and transformation of the floodwaters.
Research in this paper can serve as a good basis for further research in this area.

REFERENCES

[1] Kovčić, O. (2017). "Management of multi-purpose reservoirs with a case study of Lake Modrac", University of Tuzla, Faculty of Mining – Geology – Civil Engineering, PhD Thesis.
[2] Kupusović, T., Suljić, N., Zigic, I., Kovčić O. (2014). Trend and possible causes of flood waves at the dam profile of multipurpose reservoir "Modrac", Bosnia and Herzegovina, Milankovitch Anniversary Symposium UNESCO Water Management in Transition Countries as Impacted by Climate and Other Global Changes, Lessons from Paleoclimate, and Regional Issues, pp. 120-124.
[3] Influence of mining works on lake Modrac - Tuzla Canton (2014). Institute for Water Management "Jaroslav Cerni" Belgrade
[4] "Geodesic - hydrographic survey of the bottom of the lake is the reservoir shoreline to the processing of the measured data," MIG Ltd. Slavonski Brod, 2012.
[5] Kupusović, T.; Vučijak, B.; Kovčić, O. (2015). Reservoir Modrac and its functioning during floods in May 2014., Hrvatske vode 23 91, pages 19-28, UDK 556.166(497.6)
[6] Kovčić, O. (2011). Analysis of flow waves on the profile of reservoir "Modrac" in terms of throughput capacity of dam, University of Tuzla, Faculty of Mining – Geology – Civil Engineering, Master Thesis
[7] Suljic, N., Kovcic O. (2018). Analysis of time oscillations of water on lake Modrac as a multi-purpose reservoir, Archives for Technical Sciences, Bijeljina, Year X, No. 18, pp. 31-40, ESCI Indexed.