DOI 10.51558/2303-5161.2025.13.13.139 Scientific paper

# TASKS IN TORRENT CONTROL AND DETERMINATION OF THE EROSION COEFFICIENT OF THE TURIJA RIVER BASIN

Munir Jahić[1], Amir Mešković[2], Mufid Tokić[3], Omer Kovčić[4]

[1]*PhD Munir Jahić, CE., emeritus, University of Bihac, Faculty of Engineering, tel: +38761183241, e-mail: munirjahic@gmail.com*
[2]*PhD Amir Mešković, full professor, University of Tuzla, Faculty of Mining, Geology and Civil Engineering, tel: +38761280096, e-mail: amir.meskovic@untz.ba*
[3]*Mufid Tokić, CE, "Spreca" Ltd. Tuzla, Aleja Alije Izetbegovića 29/VII, Tuzla, Bosnia and Herzegovina,tel: +38761728428, e-mail: mufid.tokic@gmail.com*
[4]*PhD Omer Kovčić, CE., "Spreca" Ltd. Tuzla, Aleja Alije Izetbegovića 29/VII, Tuzla, Bosnia and Herzegovina,tel: +38761868123, e-mail: omer.kovcic@gmail.com*

## Summary

In a series of exogenous and endogenous processes that cause enormous damage almost all over the world, land erosion and torrential flows occupy a special place. Torrential flows are formed practically unnoticed and represent a mixture of a large amount of eroded material from mountainous and hilly areas, which, together with water, flows down the ravines formed at a high speed into the lower parts. These streams, which in dry weather have very little flow or their beds are completely dry, in a short period of time destroy everything in front of them, from bridges, roads, to other buildings. They fill canals and agricultural land with silt, and often endanger populated areas, often with human casualties. A true example of the above was witnessed in the destruction of settlements in the municipality of Konjic and municipality of Jablanica in October 2024, where torrential rains caused huge human losses and material damage in a few hours.

## 1. INTRODUCTION

Protection against erosion and torrential phenomena is the concern of all countries, as well as the wider international community. In this sense, it is particularly important to point out that at the conference on the Earth, held in Rio de Janeiro in 1992 under the auspices of the UN, the documents on the global plan Agenda 21 (program for the 21st century) were adopted, which, among other things, talks about the protection of land from the spread of erosion and flash floods, within the framework of the strategy of sustainable development and the protection of the human environment [1].

Annual damages in the world from soil erosion and torrential flows are extremely large, exceeding hundreds of millions of dollars. They can be significantly reduced and reduced to a minimum by arranging watersheds and taking the right approach to flood protection. In this case, a realistic assessment of the condition of the flood area, the implementation of efficient and complex anti-flood measures and the formation of expert teams for the prevention of flash floods are especially important [1].

The Turija river basin belongs to the Modrac reservoir basin. The Turija River in its upper and middle course, including its tributaries, is located in a mountainous area. It is characterized by a large drop in the bottom of the natural bed, which results in a high speed of water flow and water power that erodes the banks and carries a huge amount of sediment with its bed to the Modrac reservoir [2].

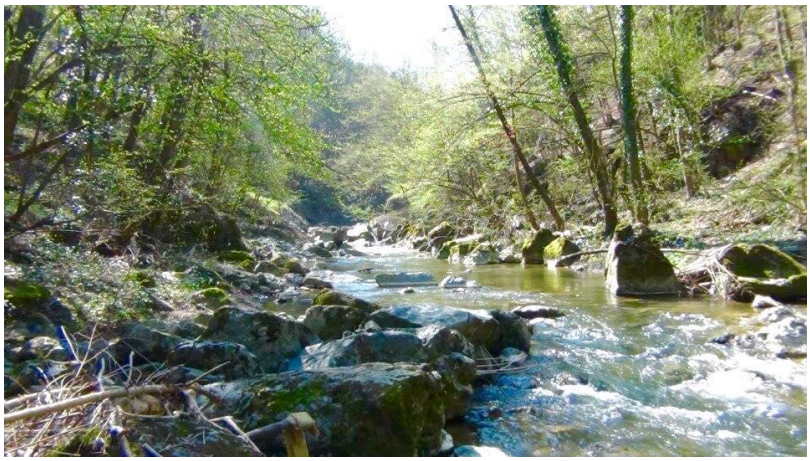

Figure 1. The bed of the Turija River in its middle course

The area of the Turija river basin is about 240.00 km2. It can be said that it belongs to medium watersheds according to the qualification of watersheds in hydrology [2].
In the following Figure 2, the catchment area of the Turija River is shown, taken from https://mghydro.com/watersheds/.

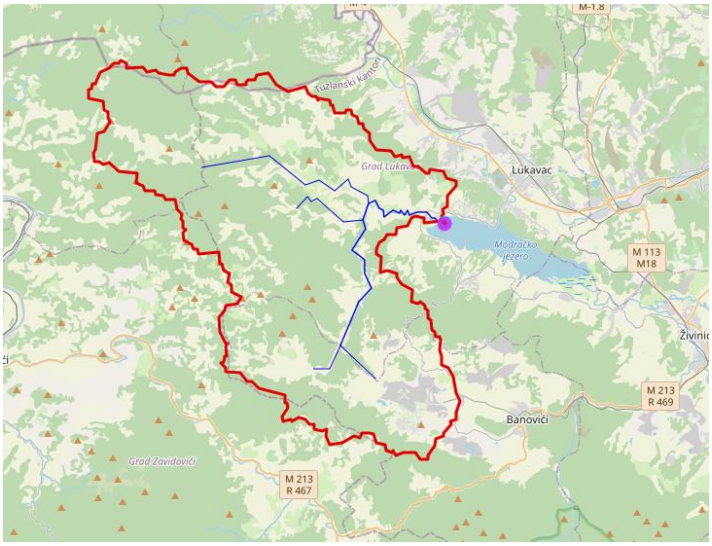


Figure 2. Turija River Basin

## 2. PREVIOUS RESEARCH AND WORKS

In order to prevent excessive backfilling of the Modrac reservoir with hauled sediment, several dams were built on the tributaries of the reservoir. Several such barriers were built on the Turija River, which collapsed after construction, due to poor foundations and insufficient

geomechanical research. The only two dams that still exist today are the dam on the Turija River and the dam on the Brijesnica River, which is a tributary of the Turija River.
The above-mentioned reinforced concrete dams do not perform their function for the simple reason that they are not maintained, that is, that sediment extraction on the upstream side is not carried out. The reason for this is that the dams were built in inaccessible places and the currently available construction machinery does not have access to clean it. It is important to point out that the aforementioned dams have cleaning openings of 40x40 cm size, but they are not large enough to clean the huge amount of sediment behind the dam.

Figure 3. Dam on Turija river

Figure 4. Dam on Brijesnica river

It is important to point out that during the design of the Modrac dam and hydroaccumulation, the harmful consequences of possible erosion and the occurrence of flash floods were not sufficiently investigated. The direct consequence of the above is the accelerated filling of the reservoir and its eutrophication, especially in the last few years when climate changes, uncontrolled cutting of forests, excessive construction of buildings on the basin of the reservoir, etc.

## 3. UNCOMMANDABLE FLOWS AND THEIR REGULATION

A frequent occurrence in practice are the so-called untamed torrents. They occur on very steep mountain slopes and have a relatively short course. Their arrangement requires extremely large and disproportionate resources, and the final effects are uncertain [2].
One of the measures in the case of an uncontrollable torrential flood that endangers the downstream area is the construction of a settling tank. One such solution is shown in the following figure 5.

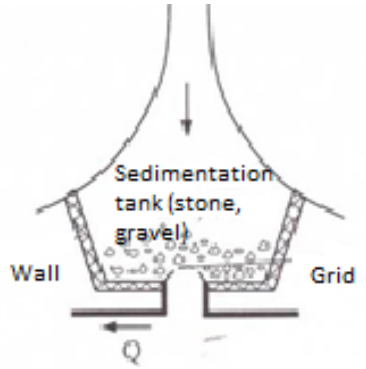


Figure 5. Sediment settling tank for uncontrollable torrential rain

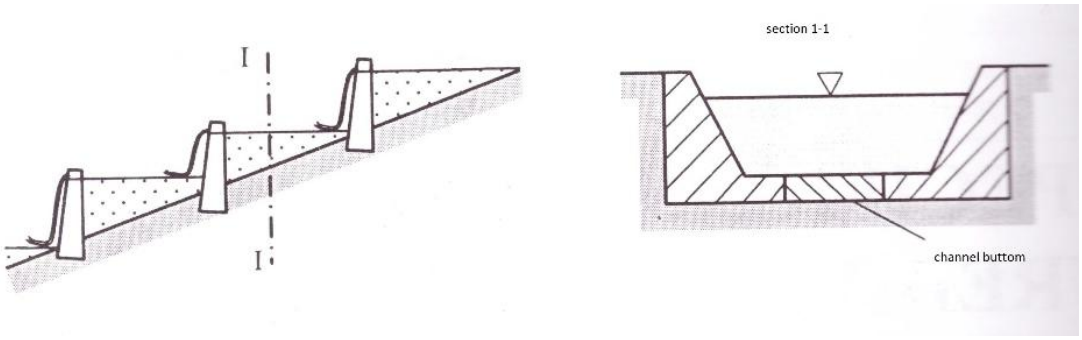


Figure 6. Regulation of an unruly torrent undermining with a trough in the form of a kinete and a series of cascades

## 5. LANDSLIDES AND THEIR REMEDY

In order to rehabilitate landslides, which is a common task in flood management, it is first necessary to determine the cause of the landslide. Most often, the sample is the abundance of surface and underground water, and the loose material of the slope [3].
Determining the cause of the slide is done by studying the conditions on the ground and the conditions that are present through reconnaissance, expeditionary and stationary research [3].
Basic works in landslide rehabilitation can be threefold [1]:

- regulation of surface water runoff,
- regulation of the underground water regime i
- formation of support in the lower part of the unstable slope.

If it is a flood of underminers on the side of which a landslide appeared (Figure 7). As a remedial measure, a transverse building (Figure 8) is considered, which should be used to establish the equalization drop.

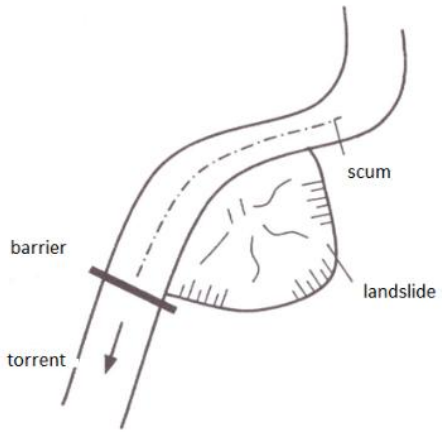


Figure 7. Landslides during torrential rain

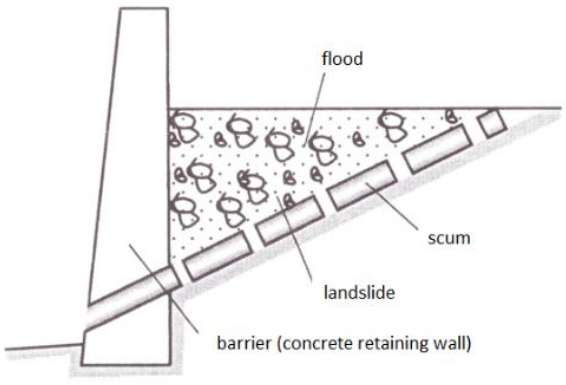


Figure 8. Remediation of landslides within the framework of flood control by means of a flood barrier

If it is a deep landslide, its rehabilitation requires a huge investment with a rather uncertain construction effect. In this case, the solution is often to cut a new torrent bed (Figure 9) or even tunnel it (Figure 10) [1].

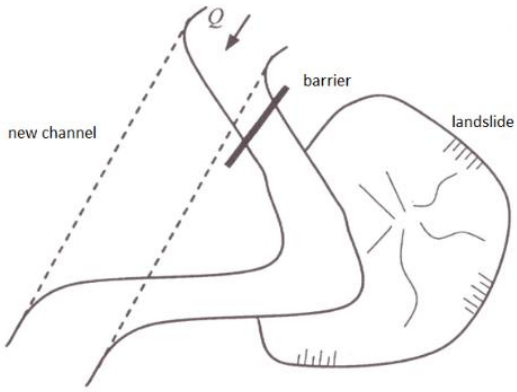


Figure 9. Avoiding landslides by building a new torrential riverbed

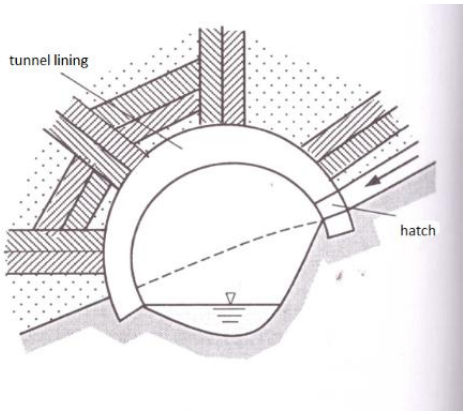


Figure 10. Tunnel method of breaking through a new torrent bed

## 6. MICRO ACCUMULATION AND RETENTION

Micro accumulations and retentions are very important hydrotechnical objects in the integral arrangement of the water regime, and therefore very important in the fight against erosion, flash floods and drought [4].

Small reservoirs can, in addition to being single-purpose, also serve the needs of irrigation, fishing, tourism and the like when they have a multi-purpose character.

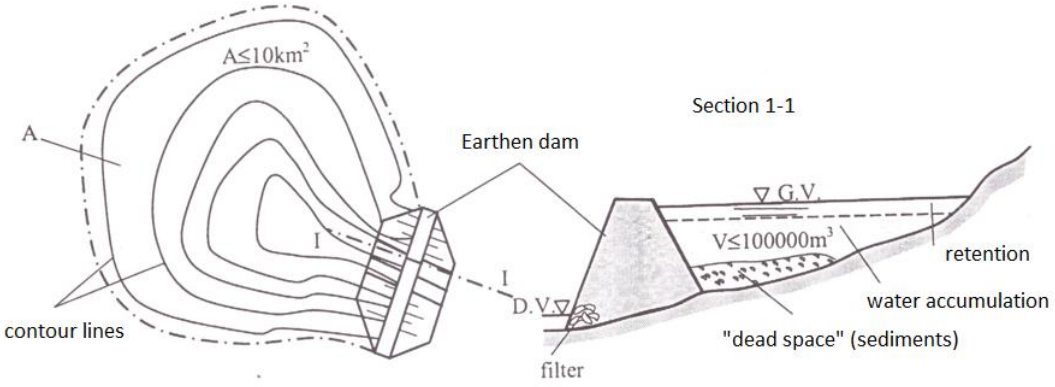


Figure 11. Presentation of one micro accumulation and characteristic parts of the volume on the upstream part of the dam

It is also important to point out an efficient solution with embanked dams, which are actually strong embankments that are maintained by gravity against external forces [4].

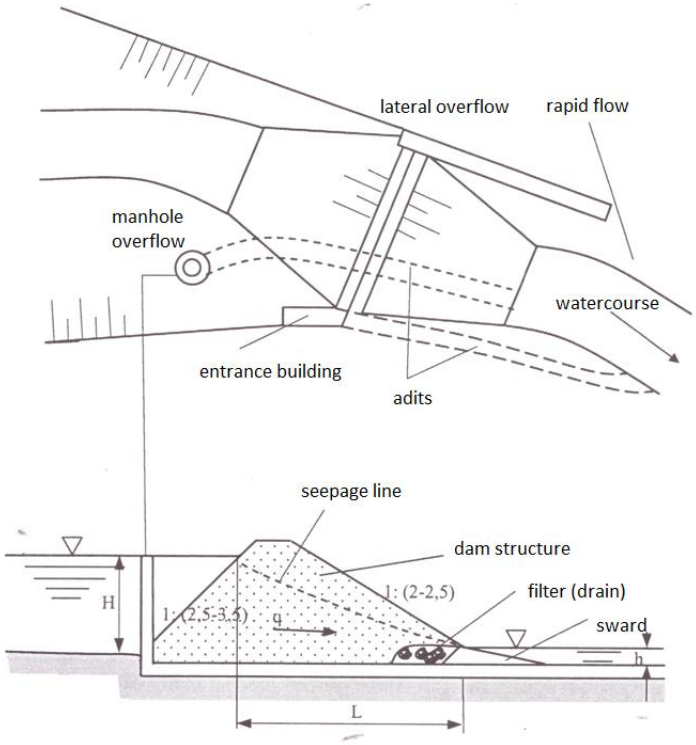


Figure 12. View of an embanked dam with evacuation (overflow) facilities for large waters

## 7. ANALYSIS OF THE EROSION COEFFICIENT OF THE TURIJA RIVER BASIN

In order to take preventive action and prevent the occurrence of erosion and flash floods, it is necessary to analyze and determine the coefficient of erosion of the catchment area in question with sufficient precision. If the erosion coefficient is known, other parameters can be managed more easily.
In practice, the formula of S. Gavrilović is often used for this method of calculation [7]:

$$W_{annual} = T \times H_{annual} \times \pi \times \sqrt{Z^3} \times A \qquad (1)$$

where:
$W_{annual}$ – the total amount of production of erosion sediment ($m^3$/god)
T – area temperature coefficient
$H_{annual}$ – average annual precipitation (mm)
Z – basin erosion coefficient
A – catchment area ($km^2$)

The temperature coefficient is calculated according to the formula:

$$T = \sqrt{\frac{t_0}{10}} + 0.10 \qquad (2)$$

where:
$t_0$ – average annual air temperature (°C)

For the results obtained for the period 2014 - 2021, the amount of sediment produced in the Turija river basin and introduced into the Modrac reservoir is shown in the following table 1. [8].

Table 1. Tabular presentation of the amount of deposition for the period 2014 - 2021 [9]

| Year | Average annual precipitation (mm) | Amount of sediment (deposit) $m^3$/god |
|---|---|---|
| 2014 | 1430,20 | 190,30 |
| 2015 | 870,80 | 28,01 |
| 2016 | 989,20 | 29,04 |
| 2017 | 982,90 | 34,77 |
| 2018 | 966,50 | 28,85 |
| 2019 | 896,90 | 24,86 |
| 2020 | 915,60 | 32,79 |
| 2021 | 814,00 | 17,20 |

If the most unfavorable case is taken in order to determine the maximum force of erosion processes in the Turija river basin, for the year 2014, with the temperature coefficient T=1.07 (empirical pattern 2), the result of the erosion coefficient is obtained, which is Z=0.68 [1].

## 4. CONCLUSION

This paper presents the tasks and measures that must be adopted and acted upon in accordance with the adopted measures in order to mitigate the effect of the erosion processes of the catchment area and the formation of torrents. It is necessary to come up with a strategy and hire an expert team that would actively work on planning documents, and with the available mechanization, carry out work on the ground, that is, in the catchment area and riverbeds that are torrential in nature.
Also, the goal of this work was to analyze and calculate as precisely as possible the erosion coefficient of the Turija river basin, using the available input data, and ultimately, based on it, define the ranking of the basin's vulnerability to erosion processes. Given that, according to literature data, the erosion coefficient ranges from 0.1 to 1.50, it can be concluded that the Turija river basin belongs to the basins that are moderately subject to erosion and the formation of torrents.

## REFERENCE

[1] Jahić, M. (2008). „Arrangement of torrents", University of Sarajevo, Faculty of Forestry
[2] Kovčić, O. (2017). "Management of multipurpose reservoirs with a case study of Lake Modrac", University of Tuzla, Department of Mining - Geology - Civil Engineering, Doctoral Dissertation.

[3] Carić D. (1952) "Technical Hydraulics", Sarajevo
[4] Jahić, M. (2003). „Methods of investigating torrential watercourses", University of Sarajevo, Faculty of Forestry - Proceedings
[5] Jahić, M. Bajrić, M. (2003) "Forecasting floods for the purpose of environmental protection" University of Sarajevo, Faculty of Forestry - Proceedings.
[6] Vukadinović, V. (2018) "Land Resources", Faculty of Agriculture in Osijek
[7] Gavrilović, S. (1972). "Engineering on torrential flows and erosion", "Izgradnja", Belgrade
[8] Neitsch SL, Arnold JG, Kiniry JR, Williams JR (2011) „Soil and water assessment tool theoretical documentation version 2009.“ Texas Water Resources Institute, College Station
[9] Arnold JG, Srinivasan R, Muttiah RS, Williams JR. (1998) „Large area hydrologic modeling and assessment. Part I: model development.“ J Am Water Resour Assoc 34(1):73–89
[10] Jahić M. (2004) „Spatial planning and environmental protection", University of Bihac, Technical Faculty Bihac
[11] Jahić M. (2009) „Hydrology“, University of Bihac, Technical Faculty Bihac
[12] Jahić M. (2007) „Hydrotechnics“, University of Bihac, Technical Faculty Bihac.