

# Management measures for the restoration of degraded ecosystems in order to increase biodiversity conservation in the Târnava Mică catchment area. Case study Bălăușeri section, Târnava Mică River, Romania

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**Abstract.** The paper examines the possibilities of maintaining the longitudinal connectivity of the Târnava Mică R water courses in the context of hydrotechnical works execution. The main reason why the longitudinal connectivity needs to be analysed is that the transverse obstacles may prevent the migration of upstream fish species in order to reproduce the species concerned. In this way, the state of aquatic ecosystems is affected, which the Water Framework Directive aims to protect. The European Commission has launched two infringement procedures against Romania due to the destruction of unique habitats by not ensuring the longitudinal connectivity. The current methodology for the restoration of longitudinal connectivity provides that the longitudinal connectivity of a water body is ensured if there are no transverse obstacles on the river, or if these obstacles meet certain criteria which make the pressure given by them insignificant. In addition, longitudinal connectivity is an important criterion for defining the natural water bodies and heavily modified water bodies. The most widespread measure is the fish scale. The advantage is given by the lowest cost compared to the other variants and the fact that in many cases, it can be applied to the already existing constructions. However, there is a construction height limit for which it is recommended. In the National Administration of Romanian Waters methodology, the height limit is 15 m. The case study in this paper will also present the numerical modelling (1d) for a fish scale at Bălăușeri on the Târnava Mică water stream from the Mureș River catchment area. The purpose of the case study of the longitudinal connectivity of the Târnava Mică River was to restore water connectivity to ensure favourable conditions for aquatic species dependent on riparian habitats.

## 1. Introduction

The analysed works are located in the minor Riverbed of Târnava Mică (Figure 1), in the area of Bălăușeri, on lands that are legally owned by the Romania State and administered by the "Apele Române" National Administration - the Mureș Basin Water Administration-ABAMS (Table 1).



**Table 1.** Târnava Mică River

NAME	LAT	LONG	X_STEREO70	Y_STEREO70	MATERIAL	OWNER
Triple threshold Bălăușeri	46.402854	24.702409	477241	544838	Triple threshold concrete+stone	ABAMS

**Figure 1.** Location map (google earth capture)

Currently, the threshold located in the above section is in an advanced degradation state and is not passable by fish species; therefore, the continuity of the Târnava Mică watercourse is not ensured so as to ensure both the conservation of aquatic flora and fauna and mitigation of floods.

Within the investment, it is proposed to restore the continuity of the watercourse and the passage of the floodplains through hydrotechnical works consisting of the restoration of the existing threshold (Figure 2), the realization of the passage for fish and the consolidation of the bank for the proper transit of the maximum flow, stabilization and prevention of the degradation of the whites compliance with OM 1163/2007 [1] regarding the approval of measures for the improvement of the technical solutions for the design and implementation of the hydrotechnical works for the water courses development and refurbishment, for the achievement of the environmental objectives in the field of water, the Order 1215/2008 [2], the Water Framework Directive 2000 / 60 / EC [3].



**Figure 2.** Existing Situation for the Threshold Bălăușeri

The Târnava Mică River (Table 2) is characterized by the following hydromorphological data according to the water cadaster: length -196 km; slope 5 ‰; coefficient of sinuosity 1.62; river basin surface 2071 km<sup>2</sup>; the average altitude of the receiving basin 530 m; surface forest area 56449 ha [4].

**Table 2.** Hydromorphological data for Târnava Mică River

Nr. crt.	River	F [ km <sup>2</sup> ]	L Spring [km]	Altitude [m]		Sinuosity coefficient	Medium slope [‰]
				upstream	downstream		
1.	Târnava Mică	2071	196	1310	237	1,62	5

The hydrological data of the Târnava Mică River (Table 3), according to INHGA's study, are as follows:

**Table 3.** hydrological data of the Târnava Mică River

No crt.	River/ cadaster code	Section/coordinate STEREO 70 (m)	F (km <sup>2</sup> )	H <sub>med</sub> (m)	Q <sub>med</sub> multiannual (m <sup>3</sup> /s)	Q Servitude salubrious (m <sup>3</sup> /s)	Q <sub>max p%</sub> (m <sup>3</sup> /s)	
							1%	5%
5	Târnava Mică/ IV-1.96.52	Loc. Bălăușeri/ X=544838, Y=477241	1065	663	8,63	2,49	375	214
							510	290
							430	245

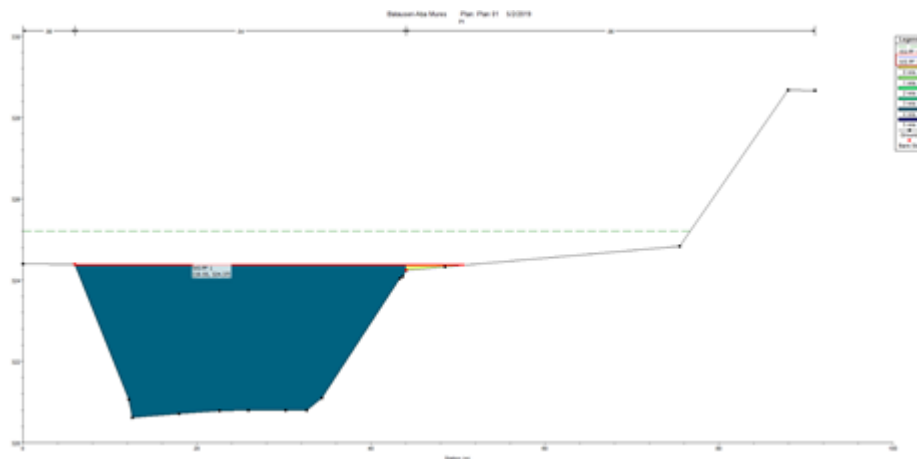
Floods in recent years have highlighted the increased degree of degradation of existing lakes, some of which have been destroyed at around 50%. This threshold in the existing situation does not allow achieving a longitudinal connectivity, not viable by the fish species.

Besides the degradation of the existing threshold, there is also a degradation of the banks in the area, with active erosions, clogging and abundant vegetation being identified.

## 2. Presentation of the technical solution to restore the degraded ecosystem

### 2.1 Flooding Study

The implementation of the project proposed in this study aims to prevent and minimize the risk for floods in the medium and long term, so the hydrotechnical works were dimensioned at the maximum flow with the probability of exceedance of  $Q_{1\%} = 72.9 \text{ m}^3/\text{s}$ , according to chapter. 5 - Strategy and main actions for its implementation - from the G.D. No 846/2010 [5] and the avoidance of potential damage, are in line with national and European practices and policies. In addition, the restoration of degraded ecosystems and the conservation of aquatic flora and fauna are also being pursued. In order to determine the hydraulic characteristics of the cross sections of the Târnavă Mică watercourse in the analysed section, after the topographic elevation, the cross sections were introduced, which were introduced into the Hec Ras hydrodynamic calculation program. Hydraulic calculations were performed to determine the maximum water flow rate at 1% assurance =  $430 \text{ m}^3/\text{s}$  (Figure 3).

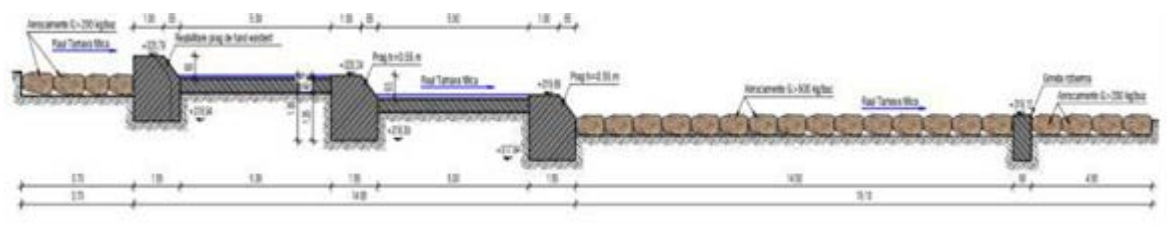


**Figure 3.** Transverse profile in the analysed section

After the hydraulic calculations, it is found that the maximum water level at the 1% assurance rate =  $430 \text{ m}^3/\text{s}$  is within the limit of the minor bed, the share of 324.37 mdMN. Thus, it was proposed to carry out a reshaping in this area together with the other works considered as necessary up to this moment.

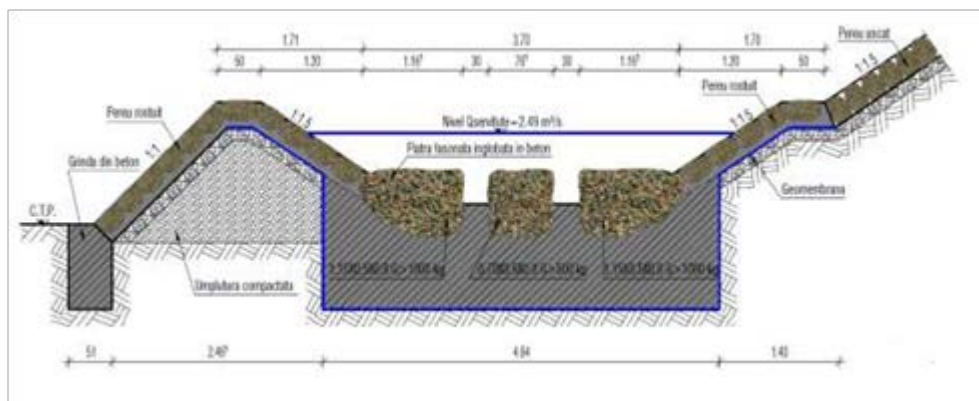
### 2.2. Technically, constructively, functionally architectural and technological description

The triple Bălăușeri threshold is located in Bălăușeri, on the River Târnavă Mică, at approx. 200 m downstream of the DN 13 Bridge (Figure 4). It is proposed to restore this triple threshold, thus making three 55 cm drops, connected downstream with a rhyme that will be stabilized downstream with a rhinestone beam.

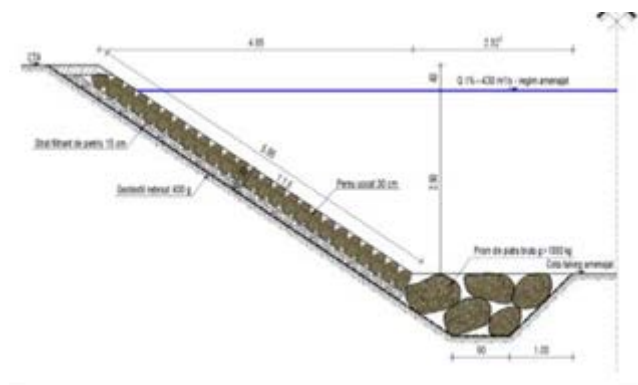


**Figure 4.** The triple Bălăușeri threshold

At the existing threshold, it is proposed to consolidate the banks, continuing the existing consolidations. New consolidation will be done with a 30 cm dry pear, placed on a 15 cm gravel filter layer, placed on a non-woven geotextile layer with  $G > 400 \text{ g/m}^2$ . The foundation of the pear will be made of a prismatic prism. In order to achieve the connectivity of the watercourse, a passage for the ihtyofauna was provided. It is located on the right bank of the Târnava Mică watercourse, it has a longitudinal slope  $I = 5\%$  and is dimensioned for transiting the service flow  $Q_s = 2.49 \text{ m}^3/\text{s}$ . The passageway has a trapezoidal cross section with slope 1:1.5, these are made of 30 cm thick grooved pear (Figure 5, 6). The redesigns are made of rough stone embedded in concrete. In order to prevent water infiltration under the passage, a geomembrane was located.



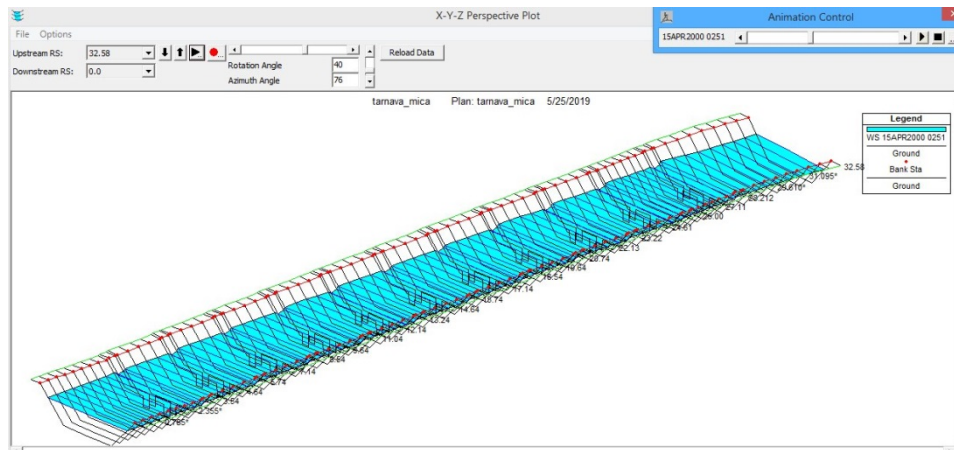
**Figure 5.** Cross section through the projected passage



**Figure 6.** Cross section through dry pear

### 2.3 Numeric model (1d) for a Fish Scale. Case study Bălăușeri, Târnava Mică

The hydraulic calculations on the River Târnava Mică, in the Bălăușeri section, were carried out with the HEC-RAS software, which reproduces the propagation of the flood waves in a natural and arranged regime, highlighting the hydraulic characteristics of the bed and the effects of the studied hydrotechnical works. The calculation model can determine the characteristic flow data of non-permanent and permanent water in a uniform or progressively variable hydraulic regime for naturally or arranged hydrological rivers (according to the works included in the design schemes or projected) with unifiers, but also for dendritic and annular whites. In order to numerically translate the flow of servitude, a scale of fish was made according to the proposed geometry, geometry represented graphically in the figure below (Figure 7).



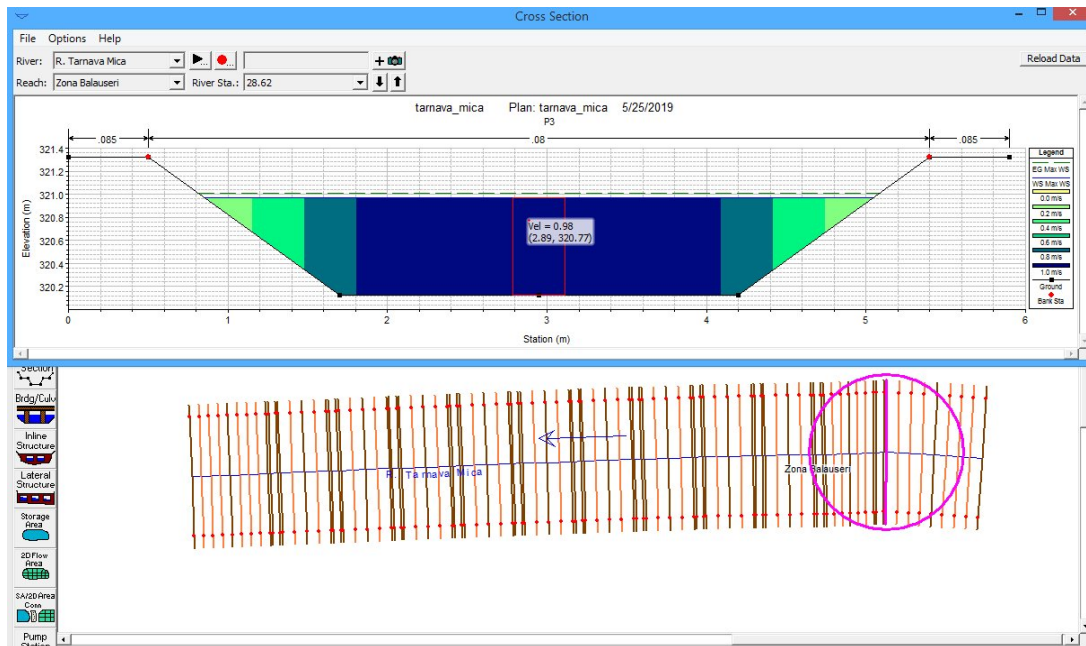
**Figure 7.** Fish Scale. 3D Overview

At the generation of the transit liquid hydrograph, a synthetic configuration was used in the HEC-RAS software package vers.5.03/3/, resulting in a flood wave, which will reach the max. Service flow  $Q$  served =  $2.49 \text{ m}^3/\text{s}$ . The geometric model proposed for the Fish Scale (mean slope of about 5 %) represents a channel with a trapezoidal section with the geometrical elements:  $b = 3,70 \text{ m}$ ,  $m = 1,5$ ,  $H = 0,80 \text{ m}$ , divided into 11 compartments made of cut stone embedded in concrete with 30 cm slots. The figure above shows the geometric projection in the plane and the water flow through the Fish Scale. This layout is required for 1D numerical modelling with the HEC-RAS software package vers.5.03.

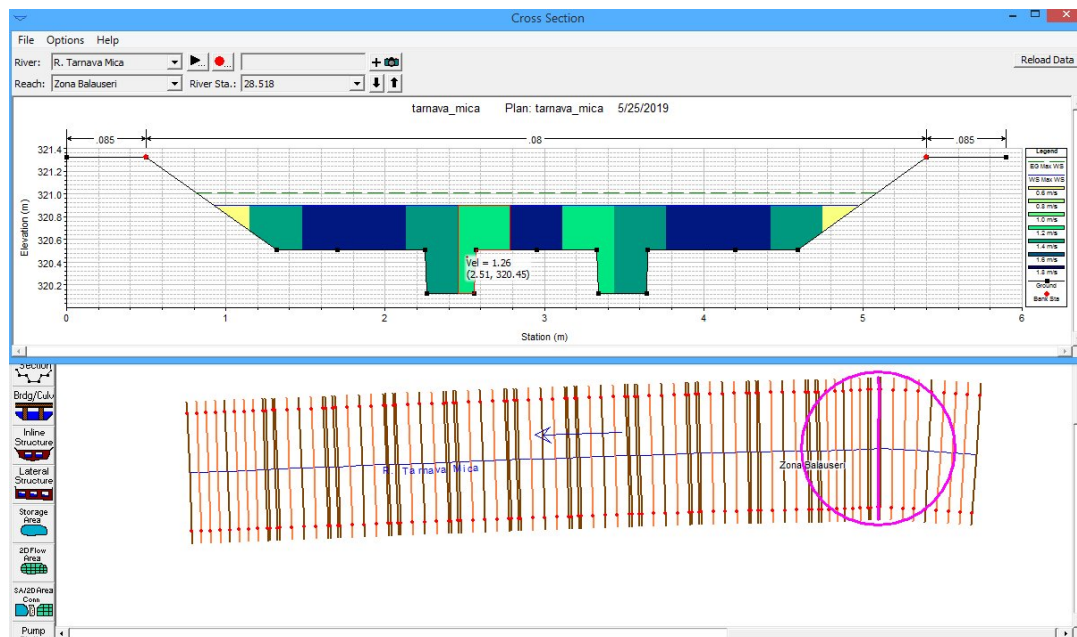
For the numerical modelling of the Fish Scale geometry, from the graphical representations, a database was created in 3D, resulting in: a situation plan (geometric representation in AutoCAD of the geometric structure and average slope at the radius of about 5 %), 9 cross-sectional profiles (along the entire flow path) in which the shape of the channel geometry, respectively the roughness of the walls and bottom of the channel, are emphasized.

### 3. Numerical simulation and presentation of results

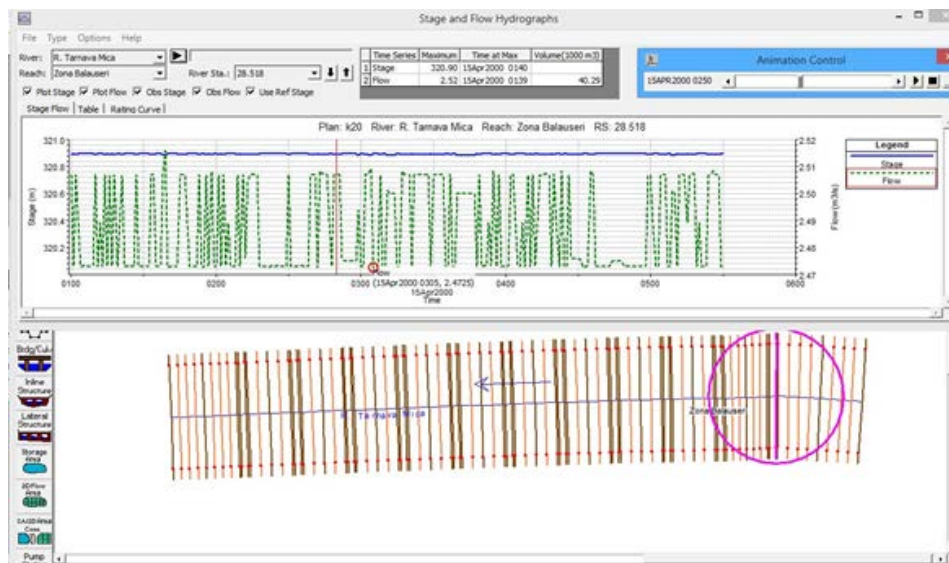
Under the program, a milestone standard counting (on this particular route called metric) is used to identify the profiles, and this denomination is a numeric value and represents a real number [6], [7] and [8]. This method is very useful in generating new interleaved sections (automatic interpolation sections) or fusing them through various linear interpolation methods between two consecutive transverse sections, known sections from topographic elevations or technical representations. Following the geometric element insertion operations in the database and then geometric interpolation with intermediate sections on the route, the graphical representations in the following figures were obtained. The passage has a trapezoidal cross-section with a sloping slope of 2: 3, these are made of 30 cm thick grooved pear. The redesigns are made of rough brick embedded in concrete and are dimensioned to pass through the service rate  $Q_s = 2,49 \text{ m}^3/\text{s}$  (Figure 8-10).



**Figure 8.** The distribution of water flow rates and water level in the P3 cross section



**Figure 9.** Distribution of water flow velocities and water level in the intermediate transverse profile P3 ÷ P17



**Figure 10.** The variation of the Service Flow between the values 2,46-2,49 m<sup>3</sup> / s and the water level  $H = 320,9$  mdMN, due to the fish scale configuration for  $L = 0 + 28,518$  m

#### 4. Conclusions

In all sections, there are currents that collide and dissipate the hydraulic energy in the downstream successive downfall. The way the hydraulic energy dissipation results, as it can be seen, lead to the idea that the Fish Scale is properly sized for the fish species that can overcome the water speed of 1.70 m/s and the water levels within it do not exceed delimiting walls. In conclusion, from the analysis of the data resulting from the numerical simulations, the maximum flow rate  $Q_{\text{servitude}} = 2,49$  m<sup>3</sup>/s is reached, resulting in optimal geometry of the Fish Scale structure, which is also evidenced by the velocity regime of the flow rate along its length. The flow analysis was performed only on the fish scale section, at values close to the serving Flow, in which case the spill threshold does not go into operation. For flows higher than this service flow, it is necessary to analyse the correlated flow through both the fish scale and the overflow threshold, the hydraulic model considered to require its expansion.

#### References

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