Lakes, reservoirs and ponds, vol. 10(2): 126-138, 2016
©Romanian Limnogeographical Association

Suggestions of scenarios for restoring longitudinal connectivity to sustain fish fauna migration upstream and downstream of Apahida bottom sill

Răzvan VOICU[1], Doru BĂNĂDUC[2]

[1] National Institute of Hydrology and Water Management, Sos. Bucuresti-Ploiesti 97, Bucuresti, 013686, România, Tel.: +40-21-3181115, Email: getiiliberi@gmail.com

[2] Lucian Blaga" University of Sibiu, Applied Ecology Research Center, Dr. Ion Raţiu Street 5-7, Sibiu, Sibiu County, Romania, RO-550012, ad.banaduc@yahoo.com

Abstract

Rivers and their corridors form complex ecosystems that include adjacent land, flora and fauna and the actual courses of water. Given the *ecological criteria for prioritizing* the rehabilitation of longitudinal continuity of watercourses recommended by the International Commission for Protection of the Danube River (ICPDR) (Appendix 1) and starting from the analysis of the Management Plan to ensure longitudinal continuity of watercourses in Someș-Tisa River Area (Annex 9.17.a in BMP – Basin Management Plan) there have been proposed several scenarios in order to facilitate fish species migration above the bottom sill from Apahida. The selected case study is focused on the mentioned discharge or bottom sill in Apahida town (hm 985) located 45 m downstream of the bridge located at the intersection of two streets; this bottom sill is 0.8 m high and was built in order to correct the slope, to reduce erosion and to enhance water oxygenation. Currently the bottom sill is supervised by Someș-Tisa River Basin Water Administration, Cluj SGA. One of the important migratory fish species in the study area is the Common Nase (Chondrostoma nasus) protected by Bern Convention (Appendix III); barbel (Barbus barbus)- rare species, protected Habitats Directive (Annex V),annex 4A of Low nr.462 and Red List of RBDD; bream (Abramis brama) bream (Abramis brama) - IUCN Red List of Threatened Species. The water catchment area of the Apahida commune in Cluj County blocks migration of various species of migratory fish such as: Common Nase (Chondrostoma nasus) protected by the Bern Convention (Appendix III); Barbel (Barbus barbus) - rare species, protected Habitats Directive (Annex V), Annex 4A of Low No 462 and Red List of RBDD; Bream (Abramis brama) Bream (Abramis brama) - IUCN Red List of Threatened Species. To help the three species of fish come the solutions proposed in this article.

Keywords: fish migration, ecobiome's functionality, Somesul Mic River, longitudinal connectivity, dam.

1. INTRODUCTION

Pringle (2001) defined ***hydrological connectivity*** *stating that "when water runs there is a transfer of matter, energy and organisms within or between elements of the hydrologic cycle*".

Often one solution for migration of fish over the bottom sill is not enough and must need to find more like a system that can function as complementing each other. Restoring lateral connectivity of rivers represents an ecological necessity for lotic ecosystems and represents a solid support in restoring water courses (Voicu and Bretcan, 2014).

Engineering solutions must be found to combines the gravity flow with the possibilities of migratory fish to swim against the flow of watercourses. (Voicu and Dominguez, 2016).

Integrated approach permanent for longitudinal and lateral connectivity of rivers can lead to good ecological state (Peacock, 2003).

The effects on aquatic biota (algae, zooplankton, benthic macroinvertebrates, amphibians, fish, etc.) is a worldwide problem due to fragmentation and connectivity ecosystems lotic (Fuller et al., 2015; Dudgeon et al., 2005; Grill et al., 2014) and the Transylvanian hydrographical net is not an exception from this perspective (Onciu et al., 1999; Curtean-Bănăduc, 2005; Momeu et al., 2009; Bănăduc et al., 2016; Moshu et al., 2006).

2. METHODS

The Somesul Mic River is the most important tributary of the Somes, with an area of 3771 km2 and a total length of 178 km. It is formed by the confluence of the Somes Warm with the Somesul Rece. Somesul Cald springs from the Vladeasa Mountains and the Somesul Rece from the Gilau Mountains. The Somesul Mic is an average slope of 8 ‰ and a coincidence coefficient of 1.65.

The two proposed solutions on the river Somes Mic river come under the Water Framework Directive 2000/60/EC and will support the lotic system restoration (Voicu at all 2016).

Along the studied water body *(Someșul Mic – cf. Nadas-Dej), near the bottom sill area in Apahida*, the migratory fish species concerned, in order to propose the solution to facilitate the fish fauna migration above the bottom (discharge) sill, are: the common nase *(Chondrostoma nasus)*, the barbel *(Barbus barbus)* and the chub *(Leuciscus cephalus)*, which are part of the cyprinid family.

The fish fauna in the analyzed watercourse belongs to the Common Nase area (Bănărescu, 1964). This is a characteristic of small rivers in hilly regions, with their riverbed consisting of sand/clay and a moderate flow rate.

The chain of storage lakes arranged on the upper watercourse, the numerous dams and bank protection systems, and also the pollution sources located along the river in Cluj – Dej sector have a strong influence upon the quality of aquatic biocenosis.

3.RESULTS AND DISCUSSIONS

The first scenario proposed in order to facilitate fish species migration above the bottom sill in Apahida (*Fig. 1a)*, consists in achieving a bypass (a concrete semicircular canal) inside the left bank and supplied with water: i) directly from the Someșul Mic River, and also by ii) two underground canals connected to a wooden basin catching water from the Somesul Mic River by a water intake.

The wooden basin will be built upstream from the bottom sill in Apahida (Fig. 2).

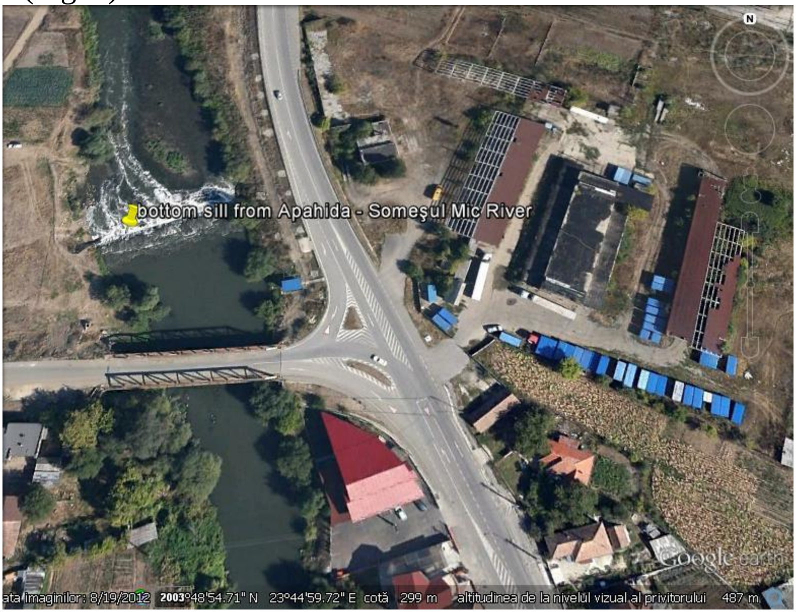

Figure 1a Placement to bottom sill from Apahida (Google Earth, 2014)

Figure 1b. Bottom sill from Apahida

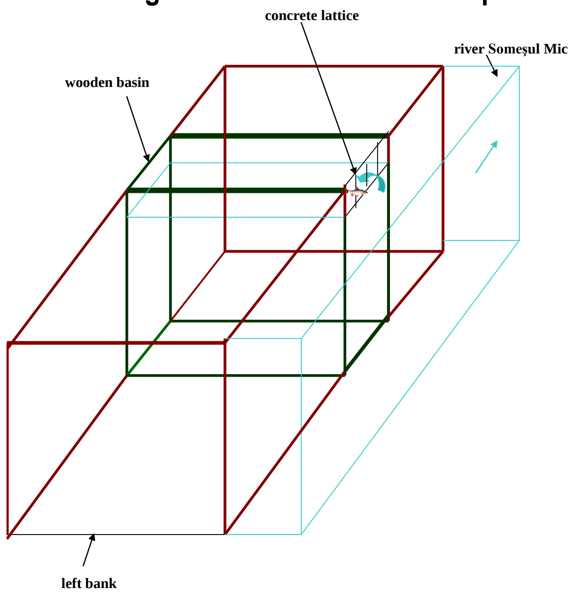

Figure 2. Positioning wooden basin – indicative scheme

As mentioned previously, a concrete canal will be also built upstream from the bottom sill, but at a distance of approx. 10 m downstream of the wooden basin; it will have a semicircular shape with the following dimensions: length L = 12 m, width l = 60 cm and height h = 120 cm (*Fig. 3*). It is connected to the Somesul Mic River by the means of a crenel (h = 42 cm and l = 40 cm) and, therefore, facilitates fish migration upstream / downstream of the bottom sill.

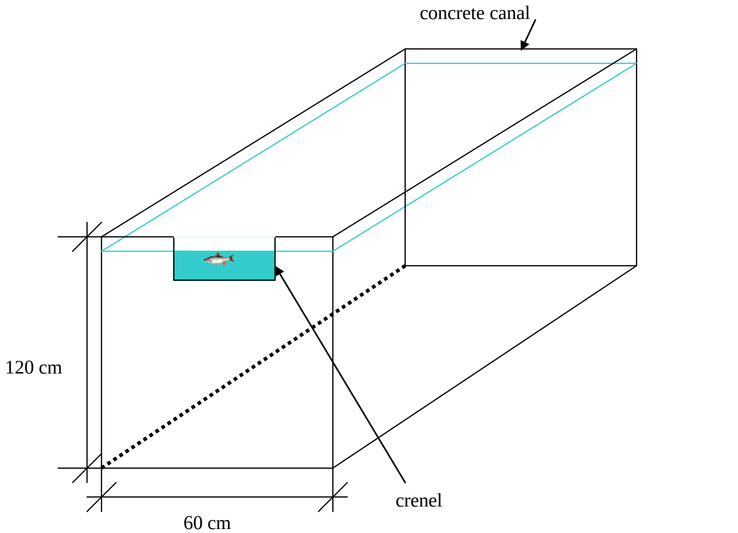

Figure 3. Water level in the concrete canal – indicative scheme

Fig. 4 shows how the downstream end of the concrete canal communicates directly with the Someşul Mic River. *Fig. 4. Confluence between the concrete canal and the Someşul Mic River, concrete lattice*. The canal is entirely covered by a concrete lattice.

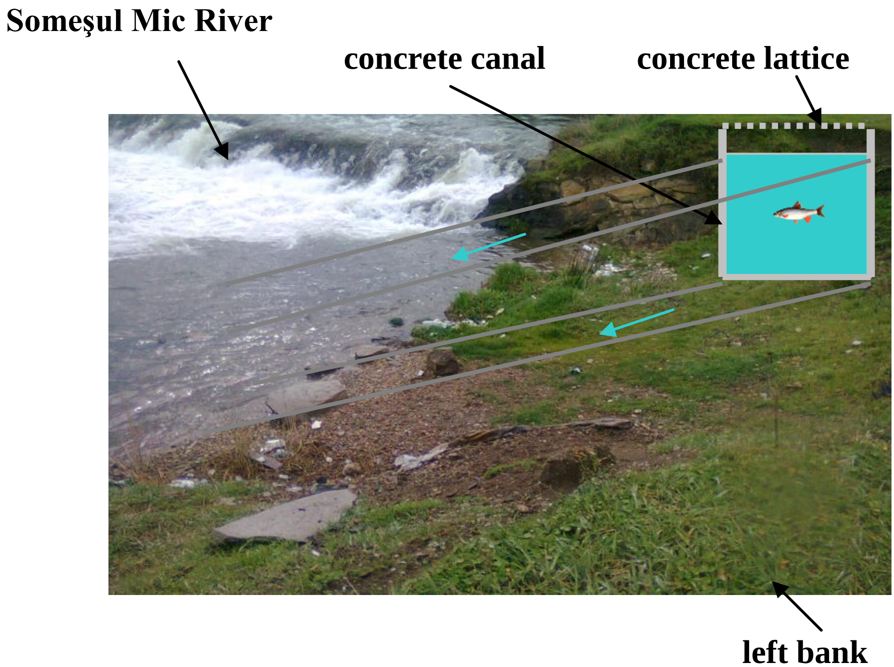

Figure 4. Confluence between the concrete canal and the Someşul Mic River

The water flow inside the concrete canal will be supplemented by continuous supply of water coming from the wooden basin located upstream of it, as stated above, so that the mentioned canal will be almost full all the time (up to the average level in the crenel) *(Fig. 5).*

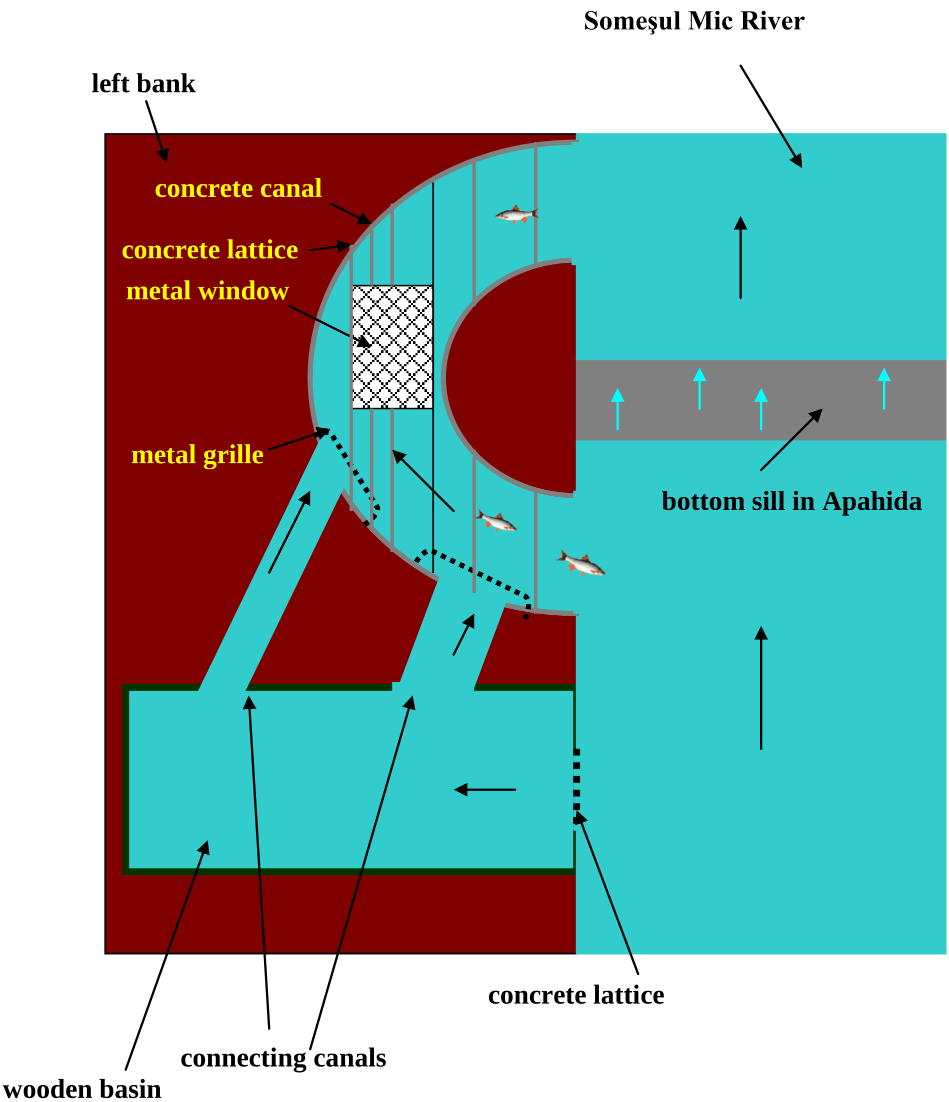

Figure 5. Positioning connecting canals – indicative scheme-

The concrete canal will be built so that the water velocity within to be less than the water flow speed in the bottom sill area in order to facilitate fish species migration upstream-downstream.

The underground connected canals discharge the water through dense concrete lattice at the concrete canal base and built both in order to reduce turbulence that may be generated and for preventing fish from entering those canals. *(Fig. 6).*

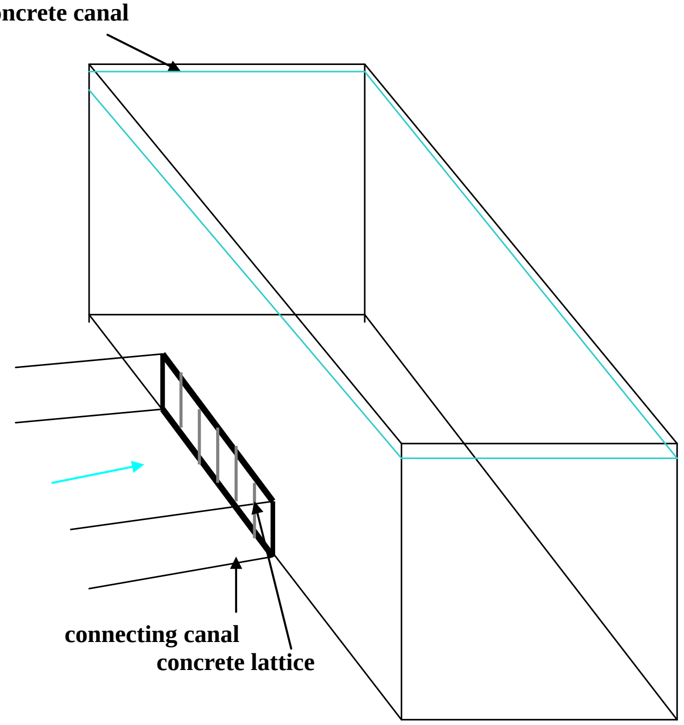

Figure 6. Positioning connecting canal – indicative scheme-

Inside the existing concrete lattice above the semicircular canal, an access window for maintenance will be performed in order to facilitate the authorized interventions (if clogged, damaged canal).

The second scenario proposed for the fish species migration above the bottom sill in Apahida *(Fig. 7)* consists in building two concrete basins (I and II) with different heights, placed downstream of the discharge sill.

The first basin will be fixed to the bottom sill in Apahida by the means of its own footing, and of some metal slots. It will be provided with a crenel of over a meter long (120 cm) on the rectangular basin where the slots can be found. The water level in the basin I will be about 20 cm above the bottom sill due to walls (surfaces) taller than the discharge sill *(Fig. 8).*

Figure 7 Discharge sill (bottom sill) in Apahida

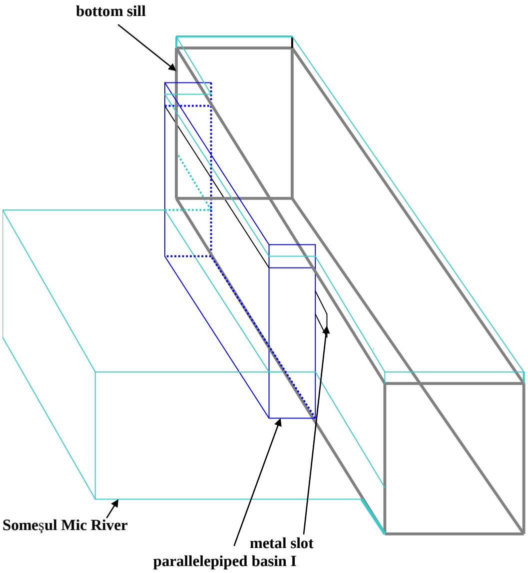

Figure 8 Positioning the basin I on the discharge sill (bottom sill) indicative scheme

Inside the basin I, on a surface perpendicular to the bottom sill in Apahida, a crenel with of about 30 cm high and 40 cm wide is built. A concrete canal is fixed to the crenel with the same dimensions on the outside surface *(Fig. 9).*

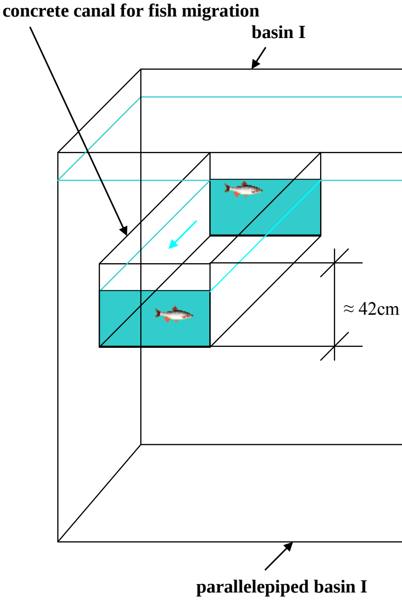

Figure 9. Positioning the canal for fish migration -indicative scheme

This channel will provide connectivity between the two basins (I and II). The second (concrete and rectangular) basin will be positioned at a distance of approximately 3 m from the first basin (*Fig. 10*) so as to facilitate the water flow through the concrete canal.

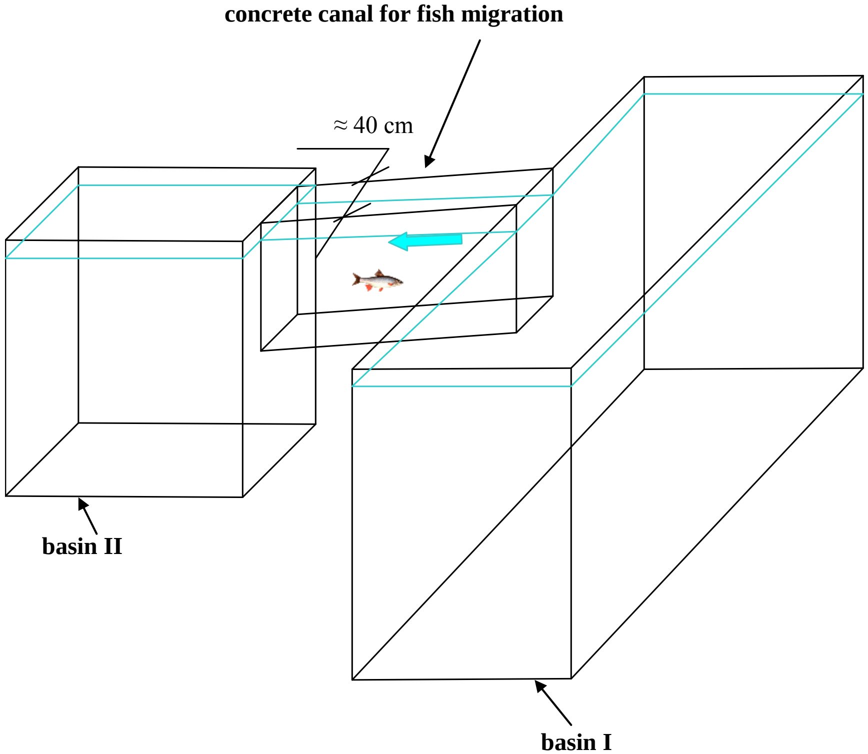

Figure 10 The connection between the two basins -indicative scheme

Basin II has another crenel through which the fish migrate upstream of the concrete canal mentioned above – basin I – Apahida sill *(Fig. 11)*. This system is used for downstream migration.

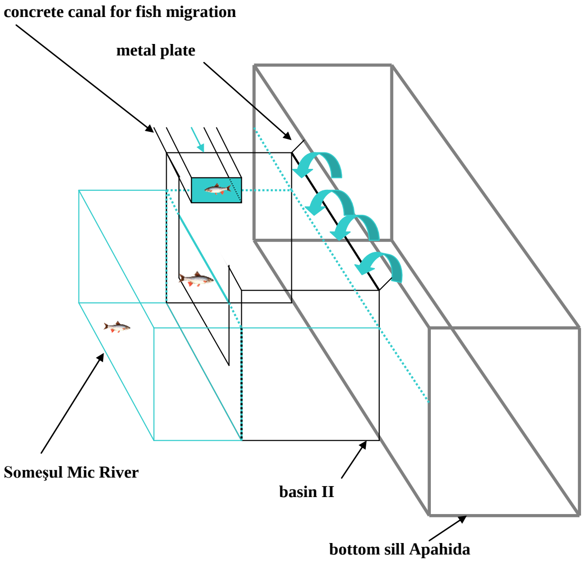

Figure 11. Positioning the connection plate between basin II and Apahida sill - indicative scheme-

The second concrete basin is not fixed to the bottom sill in Apahida, because the distance between the two designs is over 30 cm. The link between the bottom sill and the second concrete basin is made by a non-corrosive metal plate (Fig. 11). The water flow over the non-corrosive metal plate in the basin II and the flow through the concrete canal for fish migration maintain a constant water level in the basin II. The same amount of water entering the basin II both over the non-corrosive metal plate, and through the concrete canal for fish migration is discharged through the crenel in basin II. The structure of the discharge or bottom sills in Apahida is not affected by the construction of two rectangular concrete basins I and II. These basins are meant to calm the water flow so that fish can climb above the discharge sill without any difficulty.

Upstream, about 3 m from the bottom sill and right next to the basin I, some semi-circular metal lattice is fixed to the Someşul Mic River bed using four metal bars in order to dissipate the water (in the right tank I) and to redirect the floating bodies. The fish migration process will not be affected by this metal construction, because it does not touch the riverbed substrate *(Fig. 12)*.

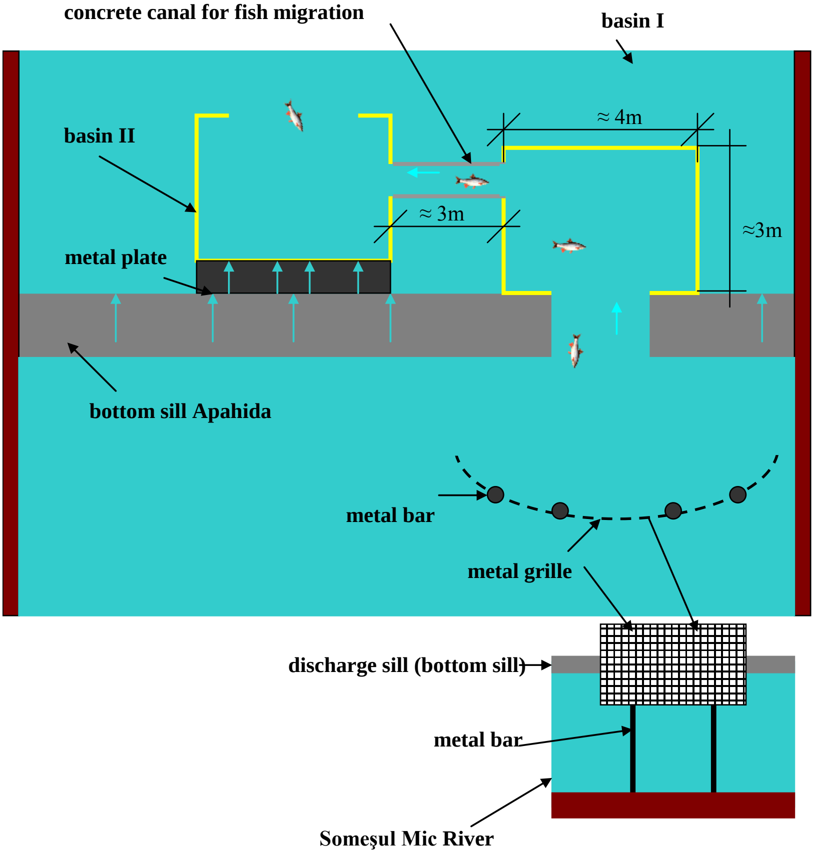

Figure 12. General scheme of the ichthyofauna migration system -indicative scheme-

The semicircular metal lattice is placed in the riverbed so that the water level reach about ½ the height of the lattice (h = 80 cm).

This solution is not expensive and does not affect the structure of the discharge sill in Apahida.

CONCLUSIONS

The proposal of the two solutions one front and one side gives of the bottom sill safety fish migration. Depending on the size flow (high flow) on the river Somes Mic can work both proposed solutions if the flow is small will operate only one side. In general, the flow of this river, which is about 20mc / s (average annual flow), can support the functioning of both solutions that suit the three migratory species presented. The design and components of the second solution give it a practical practical utility that can be fixed and put into operation at other spills (spill thresholds) if there are requirements in this regard. The first solution can withstand large floods being made on the left bank of Somesul Mic River. None of the great financial contributions must offer for the solutions construction and their position does not affect the structure of the spillway sill Apahida.

REFERENCES

Bănăduc D., Pânzar C., Bogorin P., Hoza O. and Curtean-Bănăduc A., 2016, Human impact n Târnava Mare River and its effects on aquatic biodiversity, *Acta Oecologica Carpatica*, IX, 189-198.

Banarescu, P. *Fauna of P.R.R.*. Academy Edition, Bucharest, 1964 (in Romanian).

Curtean-Bănăduc A., 2005, Study regarding Târnava Mare and Tţrnava Mică rivers (Transylvania, Romania) Stonefly (Insecta, Plecoptera) larvae communities, *Transylvanian Review of Systematical and Ecological Research*, **2**, 75-84.

Date de calitatea apei raului Somesul Mic pentru perioada 2010-2013, Fondul de date al Administratiei Nationale “Apele Romane”, Bucuresti, 2013.

Date hidrologice din baza de date a INHGA, Bucuresti, 2013.

Diaconu S. 1999, *Cursuri de apa. Amenajare, impact, Reabilitare*, Editura *H*G*A, Bucuresti

Dudgeon D., Arthington A. H., Gessner M. O., Kawabata Z., Knowler D. J., Lévégue C., Naiman R. J., Prieur-Richard A. H., Soto D., Stiassny M. L. and Sullivan C. A., 2006, Freshwater biodiversity: importance, threats, status and conservation challenges, *Biological reviews of the Cambridge Philosophical Society Journal*, **81**, *2*, 163-182.

Fuller M. R., Doyle M. W. and Strayer D. L., 2015, Causes and consequences of habitat fragmentation in river networks, *Annals of the New York Academy of Sciences*, October **1355**:31-51, DOI: 10.111/nyas.12853

Grill G., Ouellet D., Fluet-Chouinard E., Sindorf N. and Lehner B., 2014, Development of new indicators to evaluate river fragmentation and flow regulation at large scales: a case study for the Mekong River Basin, *Ecological Indicators*, **45**, 148-159, DOI: 10.1016/j.ecolind.2014.03.026

Momeu L., Battes K., Battes K., Stoica I., Avram A., Cîmpean M., Pricope F. and Ureche D., 2009, Algae, macroinvertebrate and fish communities from the Arieș River catchment area (Transylvania, Romania), *Transylvanian Review of Systematical and Ecological Research*, **7**, 149-180.

Moshu A. J., Davideanu G. and Cebanu S., 2006, Materials on the ichthyofauna diversity of Prut River basin, *Acta Ichtiologica* Romanica, I, 171-184. *Transylv. Rev. Syst. Ecol. Res.* ***18****.1 (2016), "The Wetlands Diversity"*

Onciu T. M., Radu A. and Galațchi L., 1999, Contributions to the knowledge of the zooplankton from the Olt River, *Transylvanian Review of Systematical and Ecological Research*, **1**, 67-76.

Peacock C., 2003, Rivers, floodplains and wetlands: connectivity and dynamics, Review of the importance of floodplain connectivity and dynamics for riverine biodiversity, including implications for definitions of ecological status under the Water Framework Directive, 64.

Planul national de amenajare a bazinelor hidrografice din Romania, Sinteza versiune revizuita, Administratia Nationala "Apele Romane", Februarie 2013.

Voicu R, Dominguez L. 2016, Facilitation fish migration above the discharge sill located on the Ialomiţa river near cave Ialomicioara, *Annals of Valahia University of Targoviste, Geographical Series*, **16**(*2*): 44-58.

Voicu R., Bretcan P. 2014, Solution for fish migration on the Somesul Mic river upstream downstream of Manastur dam in Cluj Napoca, *Annals of Valahia University of Targoviste, Geographical Series*, Tome **14**(*1*): 125-132