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MOBILE PLATFORM FOR FISH MIGRATION UPSTREAM FROM THE DISCHARGE SILL SITUATED NEAR DACIA BRIDGE ON CRIȘUL REPEDE RIVER

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Abstract

Longitudinal connectivity represent the way in which organisms move the energy and material exchanges located throughout the water. Fragmentation the longitudinal connectivity of watercourses caused by dams or other hydrotechnical constructions represent a major impact on sediment transport, hydrological regime, downstream moving and biota migration. The hydromorphological elements (river continuity), as well as chemical, biological, physicochemical elements characterize the ecological status of rivers. Migratory fish species: 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) and Freshwater bream (*Abramis brama*) - protected by Bern Convention (Appendix III) are blocked by the hydrotechnical constructions (discharge sills, dams) located across the watercourse Crișul Repede River. One of the important think of this system is the gravitational fall of water. This solution will lead to the restoration of the longitudinal connection of the Crișul Repede River in the Oradea City, near Dacia Bridge. Romania is part of the European Union and it has the obligation to implement the provisions of the Water Framework Directive 2000/60/EC, transposed into Romanian legislation by the Water Law 107/1996 as supplemented and amended (Act 310/2004).

Keywords: ecosystem functionality, wetlands, Crișul Repede River, lateral connectivity

1 INTRODUCTION

Fish passage is an important design consideration for dams around the world, and many dams are now being retrofitted to facilitate upstream movement of ichthyofauna over these structures. The

success of fish passage systems is variable (Bunt et al. 2012), suggesting a need for continued work designing and testing new systems. Although the impacts of dams on geomorphology and thermal regimes remain, fish passage systems can provide some relief for migratory fish species in cases where dam removal is not an option.
The subject of this article represents an European theme of great topicality and interest regarding the restoration of the water courses affected by the hydromorphological pressures created by the presence of transversal works which lead to the interruption of longitudinal connectivity of rivers, stopping the fish migration and modifying the flow regime (Eric and Voicu 2013). The need for longitudinal connectivity of watercourses represents an essential condition for the Water Framework Directive approved by the European community and, therefore, it should be applied to all streams containing migratory species (Voicu and Merten, 2014). Biology, geomorphology, hydrology, water quality and connectivity are components of rivers that work collectively to define rivers and their health. Each of these components is, in itself, a complex group of variables. Changes in one of these components can have a cascading effect on the other components (Aadland 1993, 2010).

Fish passes (for both upstream and downstream migratory fish) must be designed so that the fish are able to find the entrance to the system provided for their passage and swim through without undue effort and unusual risk of injury. One of the most important parts of fish passes is fish pass pool (chamber). When wrongly designed the fish flowing through fish pass cannot find a proper way up the fish pass structure or a place for a rest in fish pass pools. Thus, in the present paper one of the fish passes construction was examined in the context of the optimal shape designed as far as distribution of water velocity, shear stresses in fish pass pools and the position of it the relation to a check dam weir are concerned. Fish passes as an environmental internal part of a hydraulic structure – investigations of a proposed optimal fish pass pool shape (Radecki-Pawlik, 2003).

There are many ways, many inventions by which specialists have tried to find solutions to facilitate the migratory fish passage over transversal obstacles (dams, discharge sill). These transversal obstacles block the passage of numerous species of migratory fish in many countries. The proposed solution is based on some theoretical principles and also provides a viable alternative to the old methods used (bypass, fish ladder, hatch, fish passage, natural bypass channels, Fish elevators / lifts).

There are plenty of systems supporting over various hydro construction for fish migration, especially discharge sills. All these classic systems (ladder, fish passage, lift, ramp etc.,) the biggest problem is attracting the fish towards the migration system whilst the second one is related the migration percentage using the systems that never reached 100%.

This river is provided with a lot of discharge sills inside the town and, according to the case study, one of them is near the centre of the town. In this case the discharge sill is located near Dacia Bridge.(fig.1a, 1 and 2). Migratory fish species: nase (Chondrostoma nasus and barbel (Barbus barbus - rare species, Freshwater bream (Abramis brama) (figure 1b, 1 and 2 and 3). Dimension for discharge sill near Dacia bridge are: h=1,5 m-height l= 50 m-length h1 (water fall) =1 m. The Crișul Repede River bed width is 50 m at the discharge sill, it has 25.6 m^3/s flow rate and its water speed is 0.4 m/s. In the Oradea town, the watercourse Crișul Repede underwent morphological alterations with a negative impact on the dynamics of the watercourse.


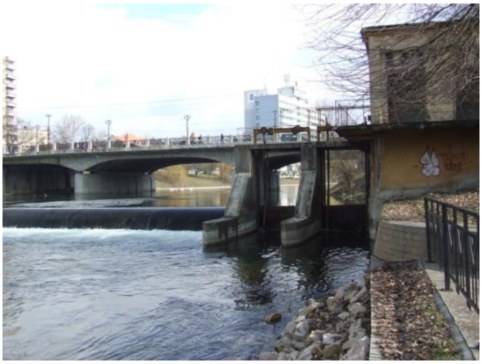

Figure 1a (1 and 2) Discharge sill and Dacia Bridge

Nase (*Chondrostoma nasus*)


Barbel (*Barbus barbus*) Freshwater bream (*Abramis brama*)

Figure 1b

2 RESULTS AND DISCUSSIONS

The solution provided in this paper comes in support of migratory fish that swim better or not, are young or old, sick or healthy. In general the system is based on a mobile platform situated in inclined plane with vertical sliding system, a metal or durable plastic grating fixed to this platform by using some hinges. The platform can be folded from the horizontal to the vertical. These two components are framed by two resistant sheet piles made of plastic that are fixed perpendicularly to the discharge sill.

The two mobile components presented are driven by some stone marble or stainless steel parallelepipeds that work gravitationally. Upstream the discharge sill, at about 1 m distance, three parallelepipeds with no exterior surfaces will be built in the riverbed. Their cross section is represented by some parallelepipeds. Inside these concrete vertical rectangular parallelepipeds, other stone parallelepipeds are to be fixed by the means of some metal railings and metal spacers endowed with resistant rubber (figure 2).

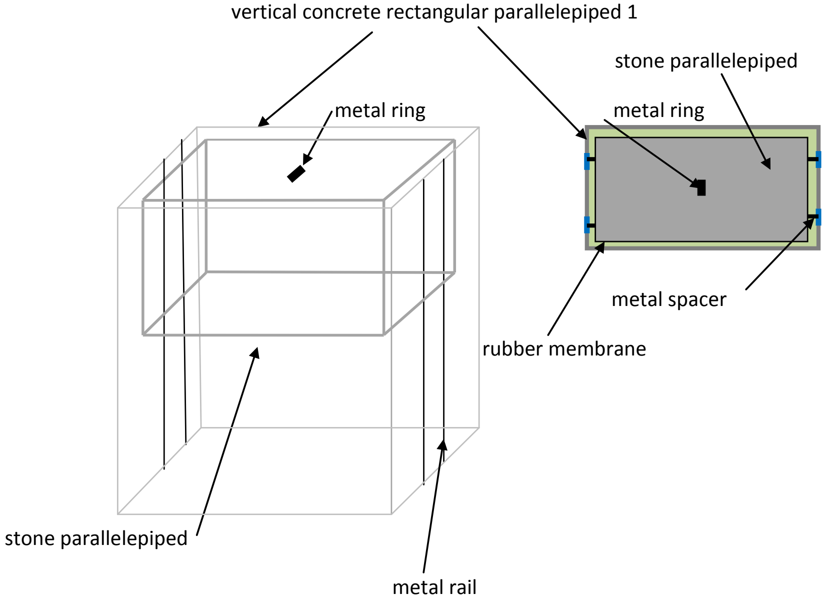

Figure 2 Positioning the stone parallelepiped inside the vertical concrete rectangular parallelepiped- indicative scheme

All these vertical concrete parallelepipeds (1,2,3) will be symmetrically built upstream from the discharge sill, at minimum 1m of it. Three concrete vertical parallelepipeds are to be built only on the discharge sills that are more than twenty meters length. Otherwise two or even a single vertical can be built. 0.5 m downstream of these vertical concrete parallelepipeds, right in front of them, a concrete foundation containing a concrete pillar with two extensions at the upper parallelepiped end is to be built in the riverbed. A winch is fixed on each of these concrete extensions (figure 3). The foundation for the concrete pillars does not affect the discharge sill to any extent.

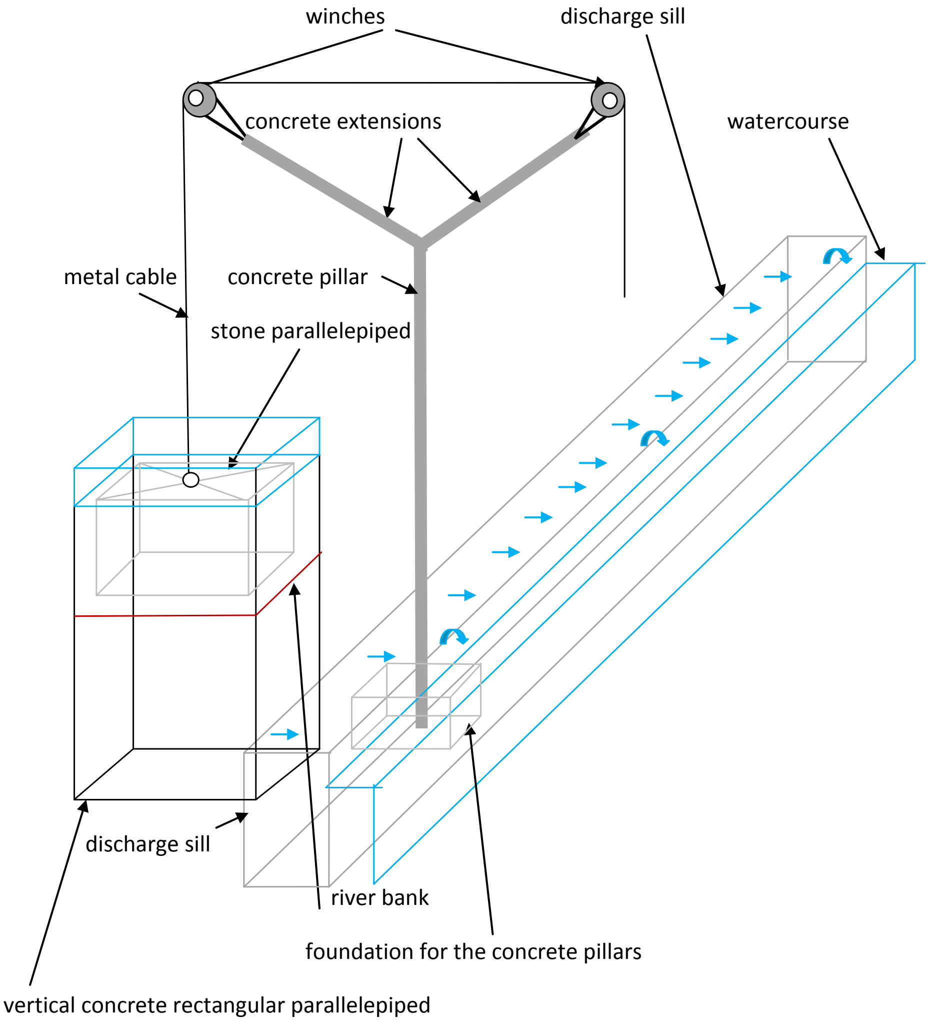

Figure 3 Positioning the foundation for the concrete pillars - indicative scheme

The three vertical concrete parallelepipeds are framed by two sheet piles made of resistant plastic (figure 4).

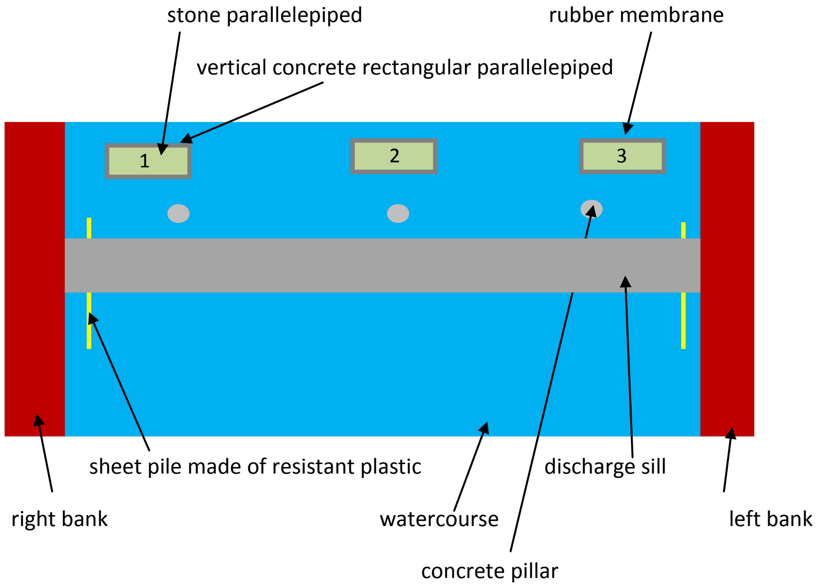

Figure 4 Positioning the three parallelepipeds and the metal sheet piles - indicative scheme

On the downstream surface of the discharge sill 6 stainless steel bars are fixed on a 20 meters side (a rod for every four meters). The stainless steel bars are closed before the maximum height of the discharge sill. A grilled metal platform in inclined plane fixed to the bars by the means of some spacers and pipes of the diameters as those 6 stainless steel bars (figure 5 a). Some stainless steel hinges are fixed (welded) to the top of this metal platform built in inclined plane, and these hinges are fixed (welded) to another metal grid (figure 5 b).

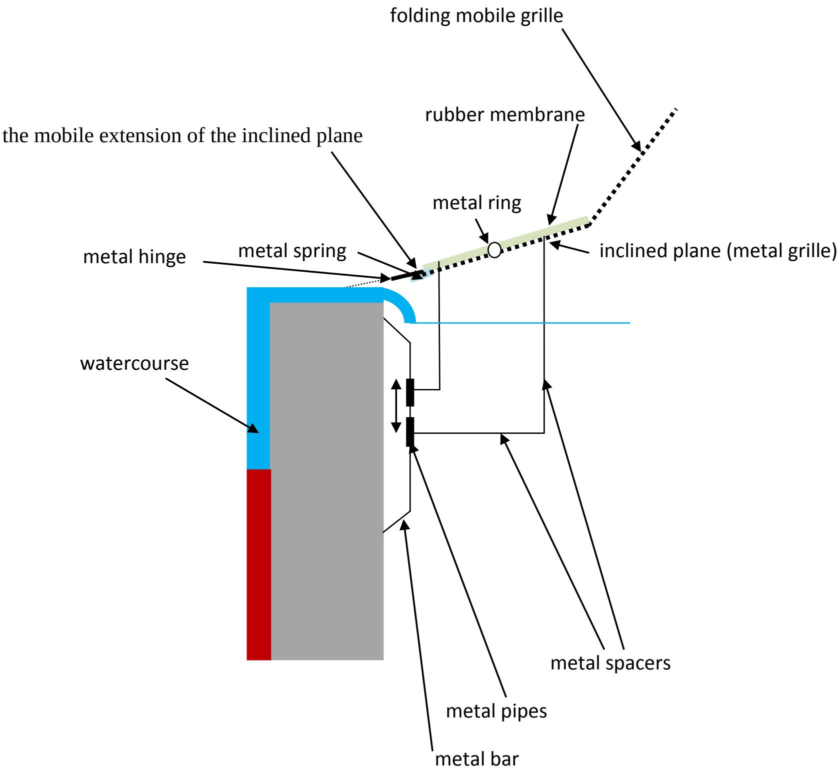

Figure 5 a Positioning the inclined plane made of metal grille lined with a rubber membrane- indicative scheme

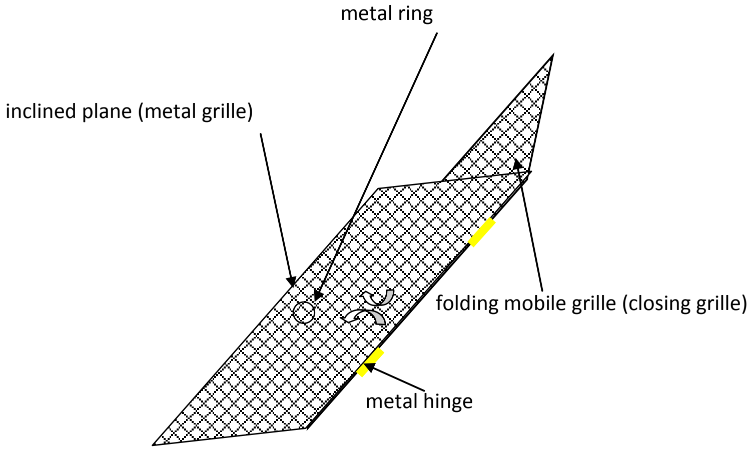

Figure 5 b Positioning the folding mobile grille (closing grille) - indicative scheme

The extension of the inclined plane near the metal hinges is provided with some metal springs (figure 5 a) strained when the inclined plane is under water and relaxed when plane is above the discharge sill. This will allow fish to reach upstream from the discharge sill.

The platform situated in inclined plane, which is movable vertically, is framed by two sheet piles made of resistant plastic. The distance between the sheet piles and the platform and is of 1.5 cm. (figure 6). The folding metal grille can be also made of durable plastic.

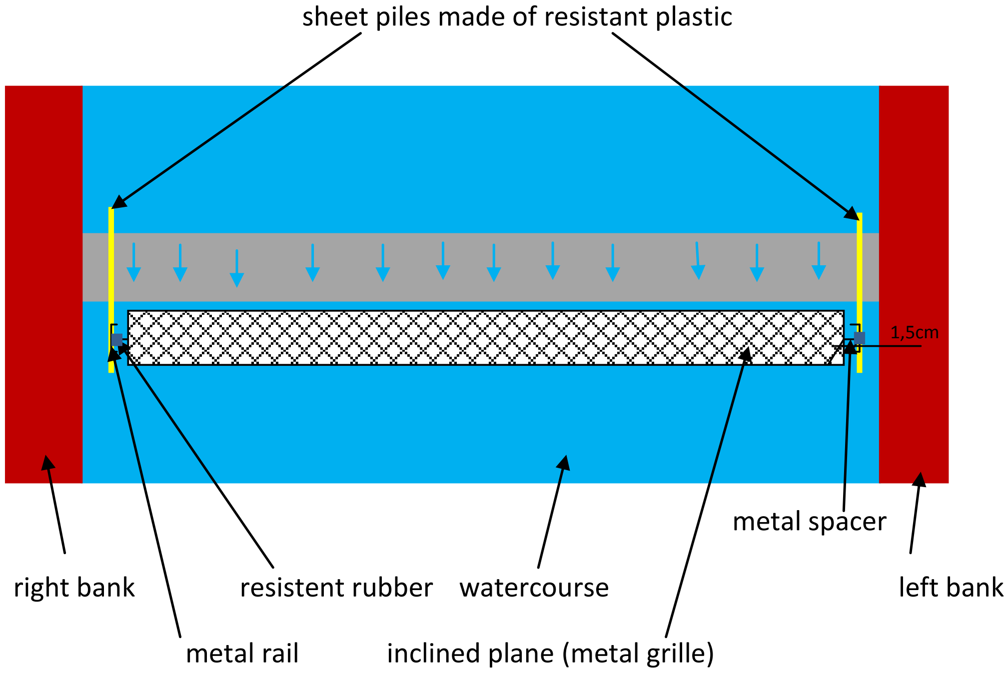

Figure 6 Positioning the grilled platform towards the sheet piles made of resistant plastic- indicative scheme

The platform situated in inclined plane, which is movable vertically, is framed by two sheet piles made of resistant plastic. The distance between the sheet piles and the platform and is of 1.5 cm (figure 6). The folding metal grille can be also made of durable plastic. Two metal railings supporting platform up and down the grille using some metal spacers and resistant rubber surfaces are fixed to the two sheet piles (figure 6). The movement of these components (the metal grille platform and the closing grille) are to be made by using some vertical concrete parallelepipeds (1,2,3), stone parallelepipeds, pulleys and metal cables. In the initial position the stone parallelepiped is fixed to two folding metal stoppers (figure 7 and figure 8.)

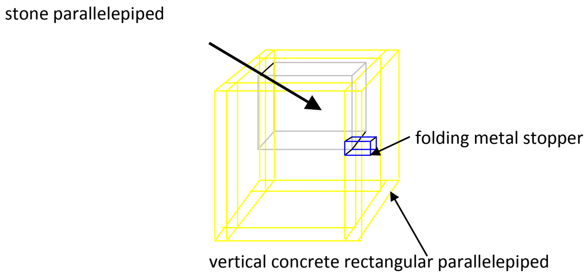

Figure 7 Positioning the stopper located at the top of the parallelepiped-indicative scheme

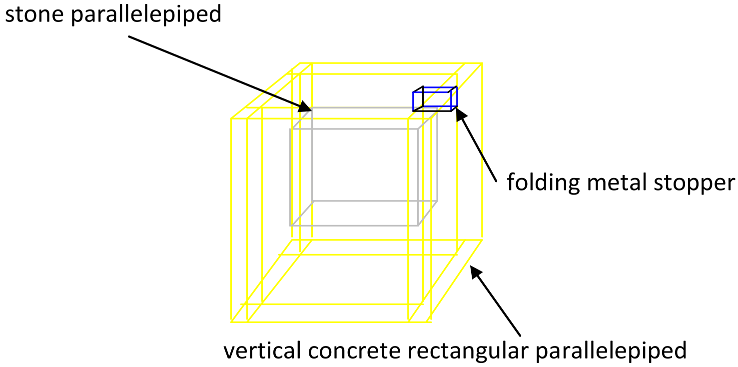

Figure 8 Positioning the stopper located at the bottom of the parallelepiped-indicative scheme

These metal stoppers supporting and blocking the stone parallelepiped are of great important for in running the system which helps fish migrate above the discharge sill.

The perimeter these sensors operate exceeds symmetrically one meter above each vertical concrete parallelepiped cross-section (figure 7 and figure 8). These stoppers withdraw into the concrete parallelepiped due to some fish fauna sensors placed upstream and downstream of the discharge sill. For example, the two stoppers inside a vertical parallelepiped works on the principle of the opening-closing the automatic locking systems with sensors. All opening-closing components of the locking systems are fixed inside the concrete parallelepipeds (1,2,3) in a specially designed space and totally waterproof. The electrical energy for operating the locking system comes from some solar panels. Each concrete pile is attached to a solar panel or more, depending on the energy requirements of the system. Inside the first concrete parallelepiped there is a circular hole where some underground pipes are fixed. When the stone parallelepiped lowers, the underground tubes collect the fish absorbing them and then place them downstream of the discharge sill. The diameter of these tubes is between 10 cm and 100 cm (figure 9). To prevent water from penetrating inside, the stone parallelepiped is tightly framed by a resistant rubber collar in the maximum position (figure 8).

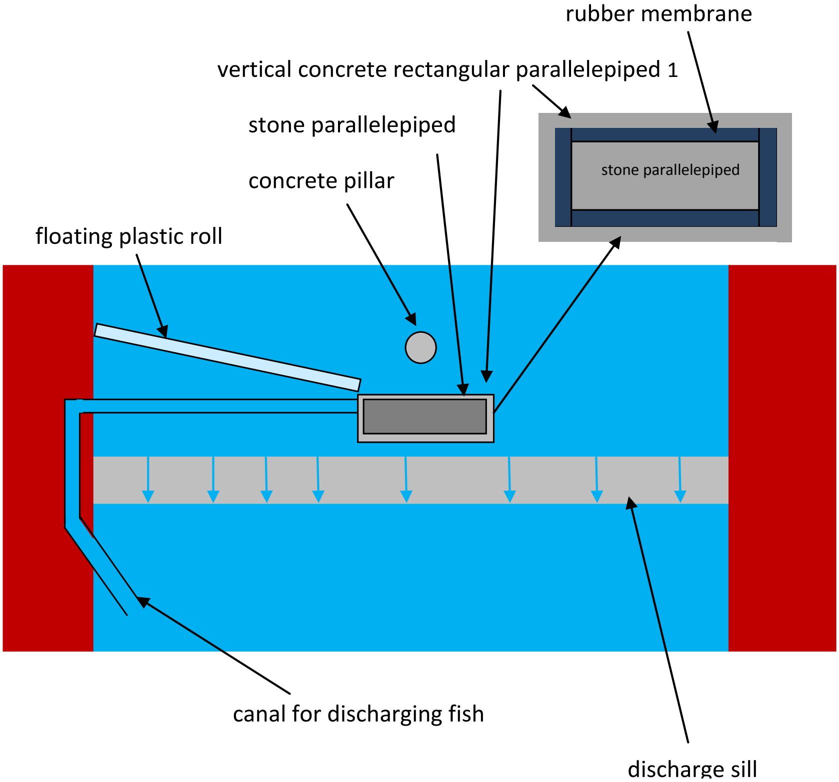

Figure 9 Positioning the canal for discharging downstream of the discharge sill 1- indicative scheme

The fish redirecting system, where needed, can be made of floating rolls (figure 9) or by using low amperage electric fields. There are fish fauna sensors situated on the metal grille platform which, when detecting the ichtyofauna, give folding command to the upper stoppers allowing the stone parallelepipeds to reach the base of the vertical concrete parallelepipeds (1,2,3). For each vertical concrete parallelepiped, at the same time with the top stopper, the stopper at the bottom of the vertical concrete parallelepiped will fold down, allowing the stone parallelepiped to reach the base of the vertical concrete parallelepiped. As soon as the stone parallelepiped has reached the base of the concrete parallelepiped, the stop at the bottom folds back and supports the stone parallelepiped at the base of the concrete parallelepiped. The stopper on the bottom of the vertical concrete parallelepiped is programmed to close after 30 seconds.

Any sensor unlocks the stoppers that all the vertical parallelepipeds are endowed with and, thus, engages the system. At the same time the stone parallelepipeds set in motion the grilled platform and mobile folding grille (closing grille) so that all the fish near the discharge sill are being collected. The sheet piles of resistant plastic prevent fish from getting out of the system as the fish cannot slip by 1.5 cm gap between the sheet pile and the mobile system.

The mobile extension of the inclined plane described above offers the fish the chance to arrive safely above the discharge sill. After 30 seconds the system returns to its initial position, being perfectly folded and positioned for a new fish capture to be transported over the discharge sill. Reopening of the system or closing the upper stopper is to be made after 10 seconds. If no fish is detected, the system does not operate. Thanks to the winches and also to the metal cables, stone the minimum level of the stone parallelepiped coincides with the maximum height of the metal grille platform and the folding mobile grille and vice versa.

If there are three vertical concrete parallelepipeds (see the case presented), the traction for the metal grilled platform is achieved by the lateral stone parallelepipeds whereas the traction for the mobile grille traction is achieved by the central stone parallelepiped. Hauling the metal grilled platform is performed vertically due to winches position on the concrete extensions. In general migratory fish species gather in large groups near transversal obstacles, so the proposed solution is ideal and can be successful 100 %. This solution can be applied successfully to the dams of up to 30 m, maybe more. In these conditions, the railing supporting the metal grilled platform will have their own foundation; therefore they will not be fixed directly to the dam, but by metal spacers, where appropriate. They will be larger and made of more resistant materials. However, the system works on the same principles. The operating principle has got four stages (figure 10).

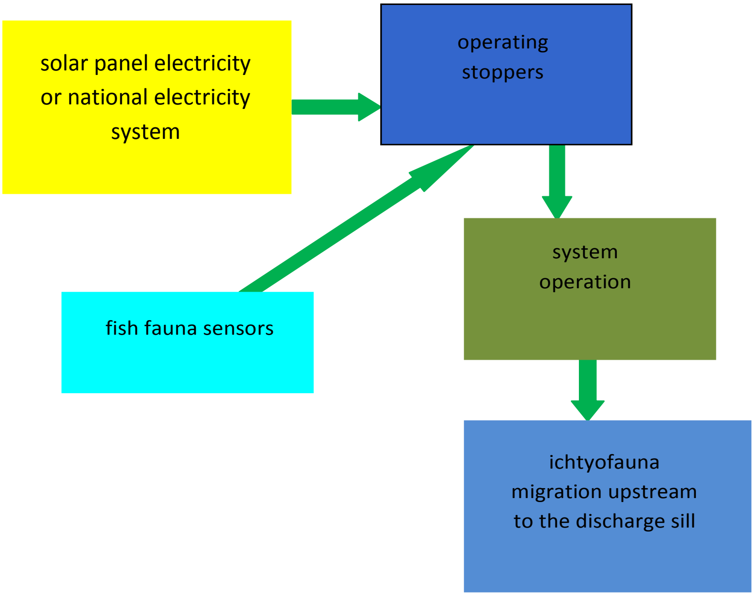

Figure 10 Scheme of operation system regarding the ichtyofauna migration above the discharge sill- indicative scheme

CONCLUSION

Developing without too much difficulty the components of the system presented, assembling them easily, lack of consumption of electricity from the national grid, protecting the ichtyofauna along the upwards-downward movements through the canals, gravitational water flow and fish slipping make this solution a real opportunity to improve the system for ichtyofauna migration worldwide. Once entered into a system fish can migrate upstream or downstream to the discharge sill. Another problem for systems for fish (ichtyofauna) migrationing is the speed of flow through the system that can prevent some of the ichtyofauna to reach their destination. This solution solved this impediment was resolved, the fish not swim, for downstream they use gravity and for upstream they are picked up by mobile folding grille. Using good quality components, this system can work for a long time without repairs, the routine checkups being necessary. All metal components must be resist areas where there is no fish migration, the fish fauna sensors operating the whole system can be disabled. The system can run at full capacity, which is fish can migrate upstream and downstream of the spillway sill at the same time. Another problem in fish migration systems is their structure that can hurt fish in both, in ascent and descent. And this impediment has been resolved by this solution as well as the materials they are made do not hurt fish, protect it. Another advantage is that this system can be used from any species, including migratory fish species such as beluga and sturgeon. This system is projected considering the target migratory species but can be used for different species and even nonmigratory. The system is not complicated and high quality components can function for a long time is changed only consumables (hinges, bearings).This system involves average costs, does not pollute and is safe for of all fish passage regardless their specie or age, or effort capacity as the swimming distance against the current is minimal and runs under the best conditions. All engineering calculations will be performed depending on the characteristics of migratory fish species, the spillway sill size, the local climate.

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