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State of the Art of Fish passes for Hydro-technical Developments in Romania

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Abstract

Romania, as member state of the European Union, must implement the Water Framework Directive where is stipulated, among others, that the hydro-technical developments must insure the longitudinal and transversal connectivity of the river. In this way, weirs must be envisaged with fish passes for the migrating aquatic fauna. The paper presents the state of the art of the existing fish passes in hydro-technical developments in Romania and what is to be envisaged for the future developments.

Keywords: *Water Framework Directive, river continuity, migratory species, fish passes.*

1. Introduction

Romania, as member state of the European Union, must implement the Water Framework Directive 2000/60 (WFD) whose provisions were transposed in Romanian legislation. WFD provisions cover some other European water directives aiming at water protection.

Running waters are called the "vital lines of communication in nature". The character of ecosystem is determined naturally by a complex and extraordinarily complicated structure involving numerous abiotic (non-living) and biotic (living) factors. Thus a change in only one of the parameters provokes a chain of very different effects on the living communities of running waters (biocoenoses) [1]. Therefore, according to Water Framework Directive, water status (water quality) means ecological status including biological, physic-chemical and hydro-morphological quality elements as well as chemical status (priority substances). The main aim of Water Framework Directive is "good" water status of all waters in Member Sates, in 2015.

One of hydro-morphological quality elements of ecological status is river continuity. The river continuity is defined as the transfer of energy, substance and organisms through a hydrological landscape. Water works should assure the longitudinal, lateral and vertical continuity of the river and the variability of hydrological regime over time.

One of biological quality elements of WFD is fish. Many fish species undertake more or less extended migrations as part of their basic behaviour. Amongst the best known examples are salmon (Salmo salar) and sturgeon (Acipenser sturio), which often swim several thousands of kilometres when returning from the sea to their spawning grounds in rivers [1]. In addition to these long-distance migratory species other fish and invertebrates undertake more or less short-term or small-scale migrations from one part of the river to another at certain phases of their life

cycles. The longitudinal water works are barriers on migration routes. Some engineering solutions had to be found in order to re-establish the river continuity, the upstream or downstream migration of aquatic organisms over obstructions to migration such as dams and weirs. The general term of such structures is fish passes. There are several types of fish passes depending of design principles namely fish pass, fish ladders, bottom ramp, protection (bottom) sill, by-pass channels, fish ramps, pool pass, fish lock, fish lift.

2. Some fish passages built in Romania

The river continuum concept was defined in late 70's, beginning of 80's. Since that time, the Romanian experts tried to take into account the river continuum concept. Some fish passages were built.

A fish ladder as shown in figure 1 was build for the Aleu water intake for water supply of Stei town within Crişuri Water Directorate, about 30 years ago. The Crişuri Water Directorate is one of the 11th river basins directorates of National Administration "Apele Române". The Romanian water authority is managing the water at the river basin level. There are 11 main river basins in Romania.

Fig.1. The fish ladder of the Aleu water intake in the Crişul Negru river
(source: Crişuri Water Directorate)

Another fish ladder was built within Siret Water Directorate, at Paşcani dam. The dam was built for industrial water supply (water intake and pumping station) for Paşcani town and it was put into operation, in 1980. The dam is 17 m height and it was designed by AQUAPROIECT SA – Bucureşti. The orifice for fish ladder was built close to water intake. Its dimensions are 0.6x0.6 meters and it can be closed manually with a valve of 0.5x0.5 meters.

After the WFD was coming into force and transposed to Romanian legislation, some fish passages were designed and built. On the Teleajen River there are built two fish ladders having two owners: ESZ. Prahova and SC Elsid SA Titu. The first one is built within the dam for water supply of Vălenii de Munte town. The ladder is placed in right side of the Teleajen River, its length is 45 m and it has 19 steps with 80 cm width each. The second one is 3 m height, has 14 steps with 20 cm width (figure 2). It is placed in the left side of the Teleajen River and was built in 2007.

The main problem of the fish passages built in Romania is that they are not functional.

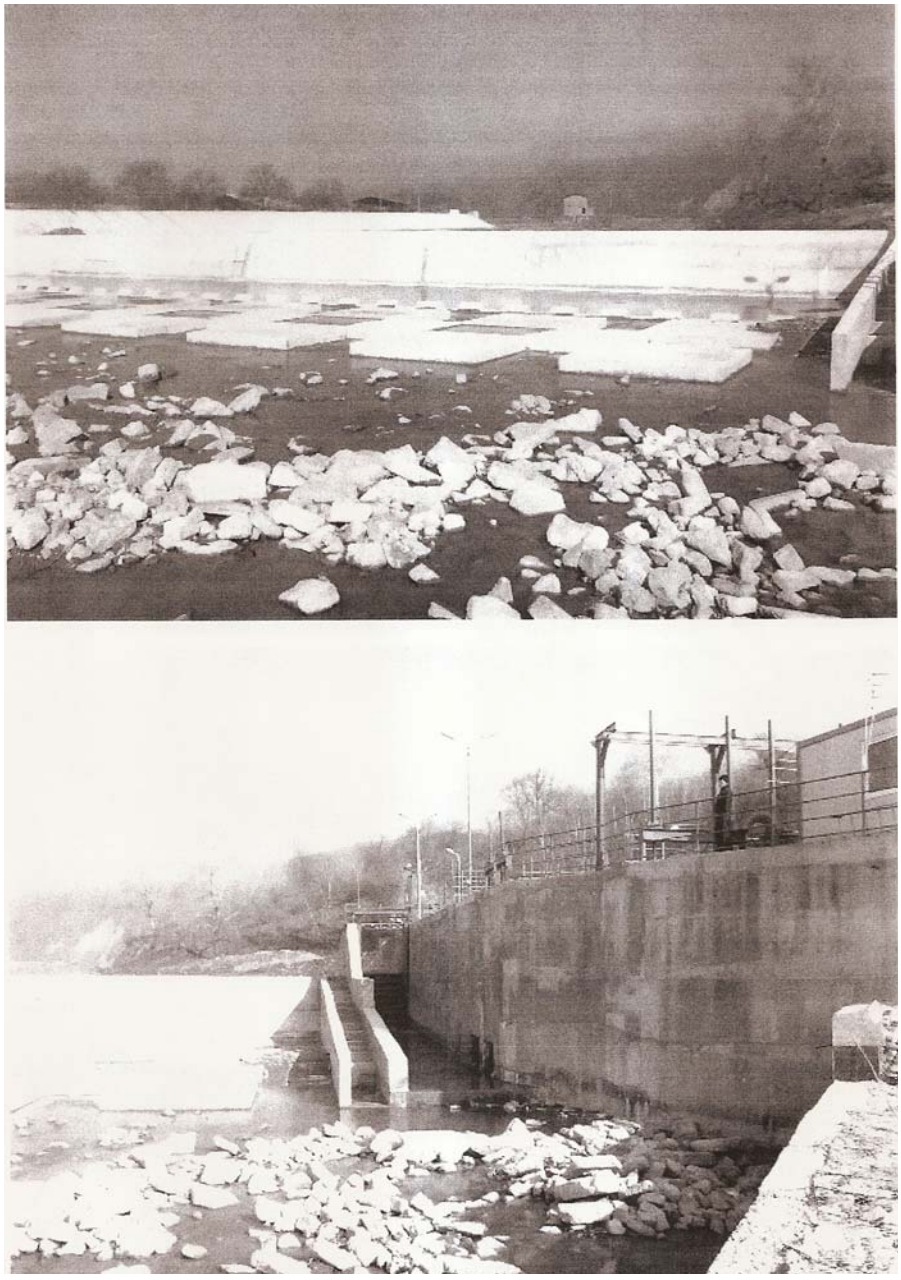

Fig. 2. The fish ladder of the Sc Elsid SA Titu in the Telejen River within Ialomita-Buzau Water Directorate (source: Ialomita-Buzau Water Directorate)

3. New requirements in Romanian legislation regarding hydro-technical developments

The Ministerial Order no. 1163/2007 referring to the technical solutions for designing and building of water works or rehabilitation of the old ones published in the Official Monitor no. 550/13.08.2007 highlighted the principles of river continuum and the

concept "more room for the river". Some principles that should be considered are mentioned below [2]:

- the natural mobility of the water course;
- the man influence on river should be minimized as possible; canalization, modifying the water course's geometry, hard engineering works should be avoided;
- the cross-sectional water works with height greater than 40 cm should be designed with fish passages in case that there are migratory species on that particular river, exception the cases where the solution is cost disproportionate;
- minimum in-stream flow requirements for conserving aquatic flora and fauna should be assured downstream of the water works.

4. Recommendations for fish passages design and construction

The technical normative to apply the Ministerial Order has not been published yet. Some recommendations to design the fish passages in order to assure the migration of aquatic biota are itemed below.

- In practical applications, the possible dimensions of any fish migration aid are strictly limited by hydraulic and economic constrains especially on large rivers. Therefore, the position of fish passage is very important within the dam. It is possible to be the case, to build several fish passages, for only one dam in order to assure the migration for all species. As an example for McNary Lock and Dam two fish passages should be build for hydropower generation dam, one next to the hydro-electric power plant and another one next to the dam (figure 3).
- The most important design principle of fish passage is that maximum flow velocity should not exceed 2 m/s. The dimensions, life cycle, ability and performances for swimming of the fish living in the river should be considered in order to design an efficient fish passage.
- The fish passage should look like the natural riverbed (e.g. the fish passage slope, the type of substrate should be the same as those of the river).
- The water falls with air should be avoided.
- For most of the fish passages, the maximum slope varies between 1:5 and 1:10 depending on the design principle chosen. The fish swimming performers including their life cycles and also the needs of week species should be taken into account when the length of the fish passages is established.
- In case of barriers with big height, some resting pools should be design. The fish need to rest after the effort caused by ascension. The resting pools should be placed in such a manner that the difference in level is not greater than 2 m. For example, The Denil fish passage – the most known type – foreseen resting pool for each 10 m-length of passage sector for salmonid species and 6-8 m for cyprinid species.
- The fish passages should be operational all the year, excepting the extreme events – low or high water (but no more than 30 days low water and also 30 days high water) when anyway the fish migration is low. For example, for salmonid species, in case of low water, the average depth should be greater then 0.3 - 0.4 m.
- The works should be done according to biological needs of aquatic species including their life cycle (e.g. for migratory species the works should not be carry on in the migration period).

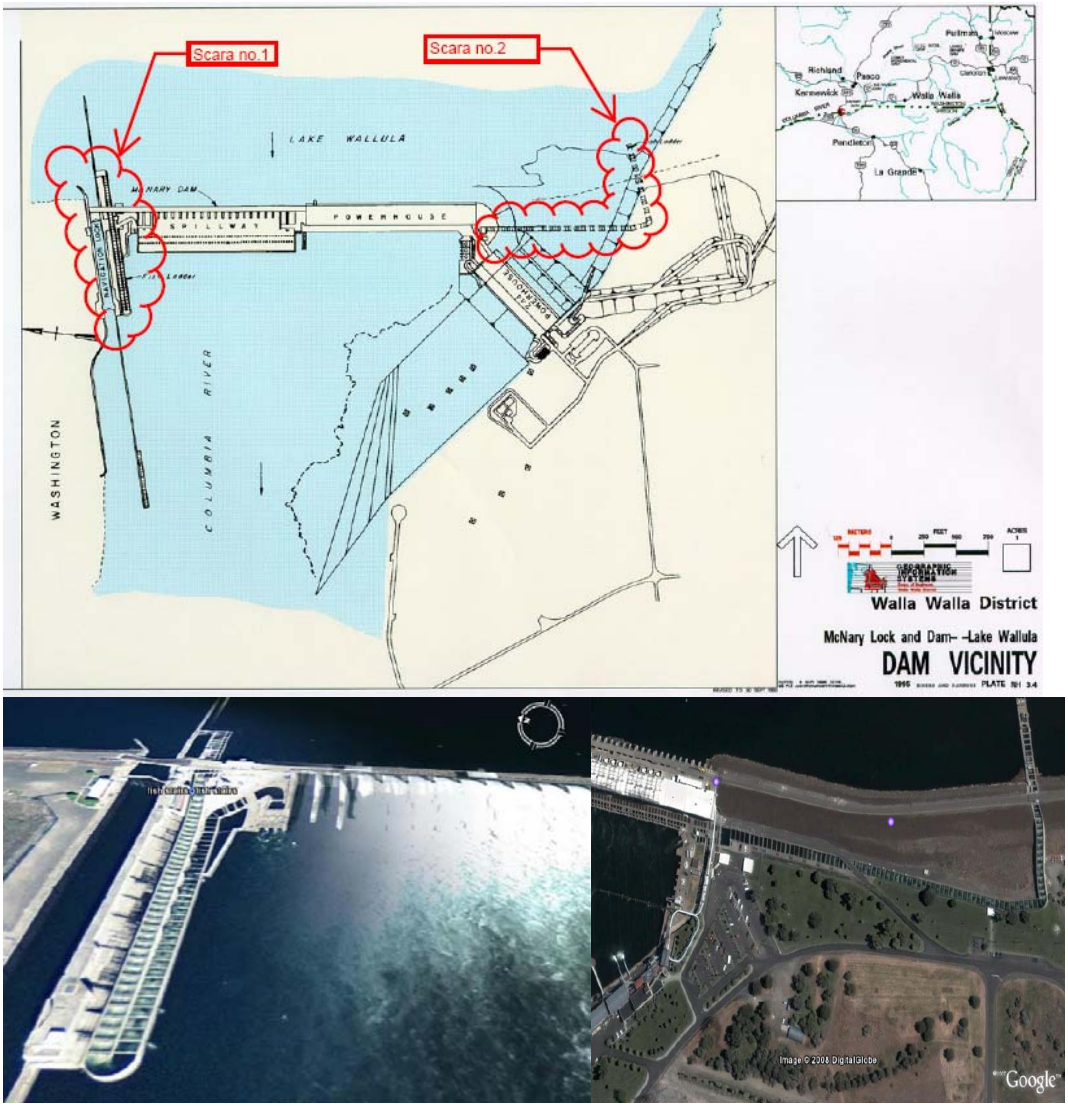

Fig. 3. Fish passages - McNary Lock and Dam in The United States
(source: http://en.wikipedia.org/wiki/Image:McNaryDiagram60percent.jpg and Google Earth)

5. Conclusions

In Romania, even though concerns on river continuum were shown since the definition of the concept, few fish passages were built. The existing ones are not functional. More effort should be put in rehabilitation of the old fish passages and on their monitoring.

In the last decades, complex computer programs for modelling of environmental resources were elaborated. In Romania, modelling activity on biological resources is not well developed. The modelling tools for biological processes are strongly required. More studies on habitats of migratory fish species and their swimming performances should be done in order to design efficient fish migration aids. More effort should be put in understanding the ecosystems dynamics and the links between them and river flow and morphology.

Due to the fact that one of the quality elements of WFD is river continuity mentioned in the Ministerial Order no. 161/2006 on water quality classification, fish passages should be built for

new regarding hydro-technical developments where migratory fish species are living as well as for the old cross-section structures unless human water usage is not significantly influenced or the costs of constructions are disproportionate.

Knowledge transfer from researchers to water managers as well as a joint effort among biologists, chemists, river engineers, and economists is required in order to fulfil the provisions of Water Framework Directive transposed in Romanian regulations.

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Situația scărilor de peşti pentru amenajările hidrotehnice în Romania

Rezumat

România, ca stat membru al Uniunii Europene, trebuie să implementeze Directiva Cadru a Apei, unde este stipulat, printre altele, că amenajările hidrotehnice trebuie să asigure conectivitatea longitudinală şi transversală a râului. În acest sens, barajele trebuie prevăzute cu scări de peşti pentru fauna acvatică migratoare. Articolul prezintă situația scărilor de peşti existente la amenajările hidrotehnice din România şi ce trebuie avut în vedere pentru amenajările ulterioare.