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THE PROPOSAL OF POTENTIAL SOLUTIONS IN ORDER TO RESTORE THE BÂRZEŞTI –BRĂHĂŞOAIA WETLAND WITHIN THE BÂRLAD HYDROGRAPHIC BASIN

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Abstract
Construction of earth or concrete dykes has meant, on the one hand, reducing flood risk, but on the other hand, it meant total or partial destruction of lateral connectivity of watercourses. Both in our country and in other countries, the danger of floods disappeared on some sectors of watercourses from various reasons, such as (the construction of dams upstream), which allowed experts restoring water courses to propose breaking dykes on some sectors (breaches). Thus, in some places wetlands could be restaurated/created. Elsewhere, wetlands were created near rivers without affecting dykes or there were just created wetlands unrelated to rivers. The EU Water Framework Directive 2000/60 / EC supports wetland protection and improvement. Ensuring a balance between nutrients and sediment retention, flood control, climate change control and underground layer of water filling by the means of such wetlands give them a very important role in the aquatic ecosystem functionality. An important factor in reducing global crisis of drinking water is the sustainable use, conservation and wetland construction. Also, wetlands are very important for a variety of aquatic birds, from which some of them are very rare, fish production. Rehabilitation and construction of wetlands along rivers reduce the vulnerability of ecosystems in river basins. The objective of this paper is based on the need to ensure lateral connectivity of the inland rivers of Romanian, in the order to solving present problems of decreased river—floodplain connectivity caused by impoundment and regularization on the water courses. Therefore, the main purpose is to proposed two solutions to restore lateral connectivity of the Bârlad River, in the river sector *Bârlad confluence to Gârboveta – confluence to Crasna* by creating Bârzeşti – Brăhăşoaia wetland. In this area, in present exist agricultural land and grassland who replaced former natural wetlands. Thus, creating a wetland between Bârzeşti and Brăhăşoaia municipalities and after bordering the area by using the earth dike of the Bârlad River and the other one which is to be built near the railway will lead to the restoration of regional biodiversity and provide other ecosystem services. To implement

one of two solution proposed in tthis study has identify a problem in the way that agricultural land in the area are privaty property.

Keywords: ecosystem functionality, wetlands, Bârlad River, lateral connectivity

1. INTRODUCTION

In the middle of last century, many of the flooded areas were separated from the main water course through various works (damming, control, draining groundwater) in order to obtain as many large areas of agricultural land as possible and, therefore, to increase the agricultural production.

Making intensive agricultural work, in most cases associated with the widespread use and misuse of fertilizers (pollution), alluvial forest destruction, expanding urban and rural ecological systems, scale industrial activities, all these have eroded the natural aquatic ecological systems and also to the loss and fragmentation of natural habitats and, therefore leading in damaging the biological and ecological diversity.

The multiple functions (production, support, control and informational) these groundwater-dependent ecosystems – wetlands – *(Klove et al., 2011)* have to meet, the resources and services they generate have increased the number of international projects/actions targeting the existing wetland conservation and/or ecological restoration of wetlands in floodplains, currently confined by dykes, secondary grasslands, and so on during the last decade. It is now recognized not only that floodplains are one of the most productive and diverse ecosystems on Earth *(Tockner &Standford, 2002)*, but they also contribute more than 25% of all terrestrial ecosystem services *(Tockner et all., 2010)*.

Lateral connectivity is the link between the watercourse/river channel and floodplain, both parts of the same system - lotic system. Therefore, hydrology is a essential factor in determining the type and functional nature of floodplains (*Ickes et al., 2005)* wich facilitates the exchange of carbon and nutrients between the river channel and foodplain *(Thoms, 2003)*.

According to Ramsar Convention (Article 1.1) wetland are defined as *“areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”*.

Romania attaches great importance to preserving wetlands after joining the Convention on Wetlands of International Importance, especially as Waterfowl Habitat, signed in Ramsar (Iran) on 2 February 1971, ratified in Romanian legislation by Law no. 5 / 1991. Another legal instrument that supports conservation and/or restoration of wetlands (groundwater-dependent ecosystems) is the EU Water Framework Directive (2000/60 / EC). The basic tool for the implementation of this Directive, the River Basin Management Plan, which is part of the National Management Plan, approved by Government Decision no. 80/2011. The main element of the Management Plan is represented by the Programme of Measures whose implementation is intended to restore the ecological status or potential of damaged lotic systems.

The study area / case study presented in this paper was selected according to Annex 9.11. “Prioritizing potential additional measures according to the cost-efficiency analysis for the Prut-Bârlad catchment area” and to Annex 9.12. “Potential additional measures for reducing the effects of the significant pressure in order to improve the status of the Prut–Bârlad catchment area”; these annexes are part of the Programme of measures set out in the Management Plan for Prut-Bârlad area (2016-2021).

2. METHODS

2.1 The study area

Location, delimitation, general characterization

The area where the research took place is represented by the middle course of the Bârlad River, the Bârlad River Basin, part of the Danube River Basin (*figure 1*).

The Bârlad River Basin belongs to the Pontic Province ecoregions (12) and Eastern Plain (16), and due to its position in the Eastern part of Romania, it has got a temperate continental climate specific to Eastern Europe. The characterized area is dominated by agricultural practices, and directly subjected to pressures from urban and industrial centers: Vaslui, Negresti, Bârlad,Tecuci.

The present case study, submitted for analysis in order to restore a wetland in the floodplain of the Bârlad River middle course, concerns the area between the towns of Bârzesti – Brahăşoaia, Vaslui county, located in Ştefan cel Mare village, 14 km northwest of Vaslui and 2 km west of the residential area of Stefan cel Mare village.

This area called Bârzesti – Brahăşoaia *(figure 1)* is located on the right bank of the Bârlad River, being delineated as follows: the DC 110

Bârzesti local road in the north, the dyke of the right bank of the Bârlad River in the east, the DC 109 Brahăşoaia local road in the south and the railway embankment in Vaslui, Iaşi county in the west.

Figure 1. Delimitating Bârzeşti – Brahăşoaia area, Vaslui county
(Sources: https://earth.google.com/; *Photo A:* http://www.icpdr.org/;
Photo B: N.I.H.W.M., 2015)

The characteristic soils to the selected area are: alluvial soils, protosoils, but the most of them are marsh-type soils (formed under the influence of groundwaters).

At present, in the area the moisture excess is being drained for maintenance of agricultural lands. Besides non-irrigated arable lands (54 ha) there are also some secondary grassland.

Interrupting the lateral connectivity between the Bârlad River watercourse (water body *Barlad confluenta Garboveta - confluenta Crasna)* and its floodplain is due to the embankment and flood control process on the Bârlad River in the early 70s (*figure 2*).

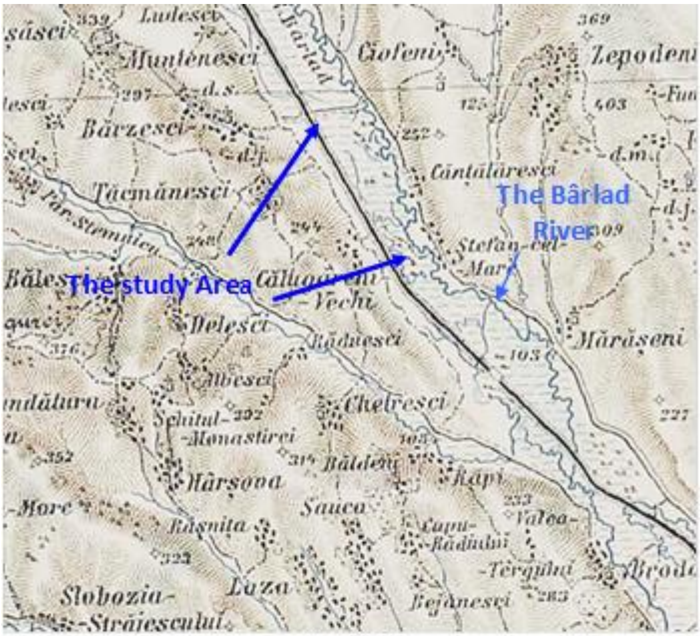
According to the reference situation (Banarescu, 1964), the dominant fish specie of this water body is *Leuciscus cephalus* (Linnaeus, 1758*).*

Scientific data shows that until 1970 the hydraulic works on watercourses in the Barlad hydrographic basin had had domestic and fishing features. After this date (1970), the socio-economic development nationwide, especially between 1970-1980, along with the new administrative division (1968-establishment of Vaslui county), led to water works developments, both with a role in ensuring sources water and the removal of flooding areas from the established socio-economic objectives.

Figure 2 Interrupting the lateral connectivity in the study area – the current state

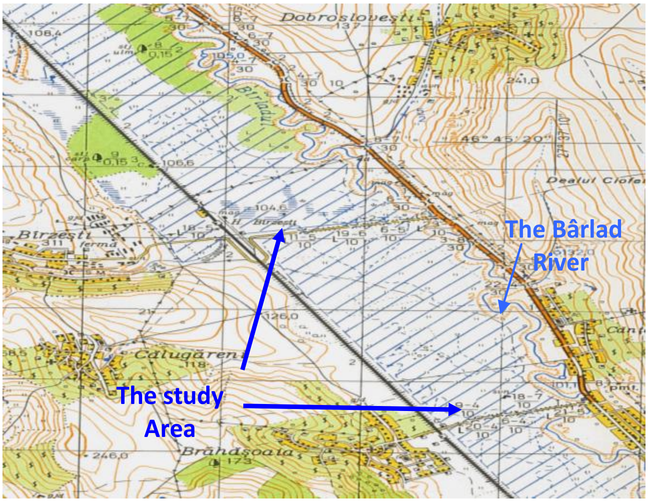
The status of the study area before carrying out any works to the Bârlad River

Analysis of historical data from the scientific literature on Barlad hydrografic basin showed that in 1960 there was already a tendency of transforming natural and semi-natural terrestrial ecosystems in agro systems for intensive agricultural production. Thus, existing agricultural land in floodplain were extended both on the grasslands and forests. Most of the natural vegetation in the Barlad basin (e.g.



a) The Austrian map in 1910 – re-projected in stereo-70 *(Source:* http://www.geo-spatial.org*)* forests and natural meadows) was replaced by a series of agricultural areas for cereals particularly.

To highlight the evolution of the area under the influences of the anthropogenic control factors (*figure 3a and b*) we used different maps / orthophotos available at different temporal scales.



b) Selected area before controlling the Bârlad River (Map updated in 1973 – published by the Ministry of Defence of R.S. Romania – Military Topographic Directorate (Scale 1: 50,000)

Figure 3. The study area at different temporal scales

The connections between the water and the floodplain (lateral connectivity) are closely dependent on the seasonal variation in water level.

The Bârlad River watercourse in its natural state is hydrologically presented as torrential (Ujvari, 1972). Once in 3-5 years the Bârlad River overflows causing flood across floodplains, thus ensuring connectivity of the watercourse with its floodplain meadow (lateral connectivity), a phenomenon that has been diminished by diking and controlling the area during 1970s-1980s.

Changing the natural flow of the Bârlad River on the specific sector of the study area is highlighted in *Figure 4*, after processing data (*source: Database N.I.H.W.M.*), between 1953-2013, hydrometric stations located both upstream, Negreşti (between 1953-2013), and downstream, Vaslui (between 1963-2013) of the studied area.

Figure in graphically illustrating the average annual flow variations amplified science 1970, during which the hydrotechnical works started in the sector of river related area of study. Referring to decreasing flow rates recorded by Vaslui hydrometric station starting with 1980, in had beed influenced by the construction of Moara Domneasca storage lake on the Feresti stream, where much of the flow is retained in the lake.

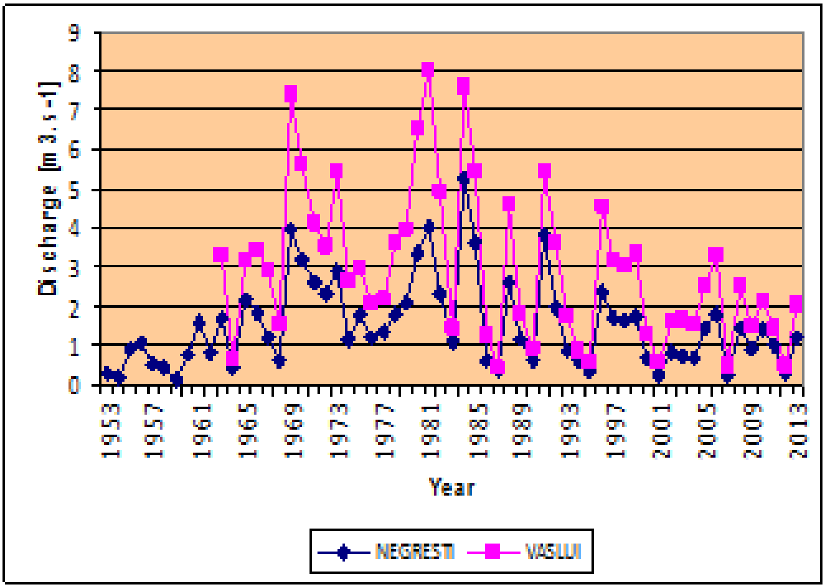


Figure 4 Evolution of average annual flow [m^3 s^{-1}] at Negresti-Vaslui hydrometric station between 1953-2013

3. RESULTS AND DISCUSSION

3.1. Presentation of the proposed solutions

In this paper, in order to restore/construct a wetland with controlled flooding, two solutions will be proposed for the area described above, as follows:

Solution 1 description

In order to build a wetland, the first step proposed is the rearrangement of the Bârzesti – Brahăşoaia area and the second step consists in supplying its system with water. It states that the created wetland will be supplied with water by the means of some tankers and tank wagons during its construction phase, whereas the water supply system shown below will used for a permanent water supply of the built wetland.

The arrangement of the area involves the construction and heightening of the existing dikes completely surrounding the area (*figure 5*).

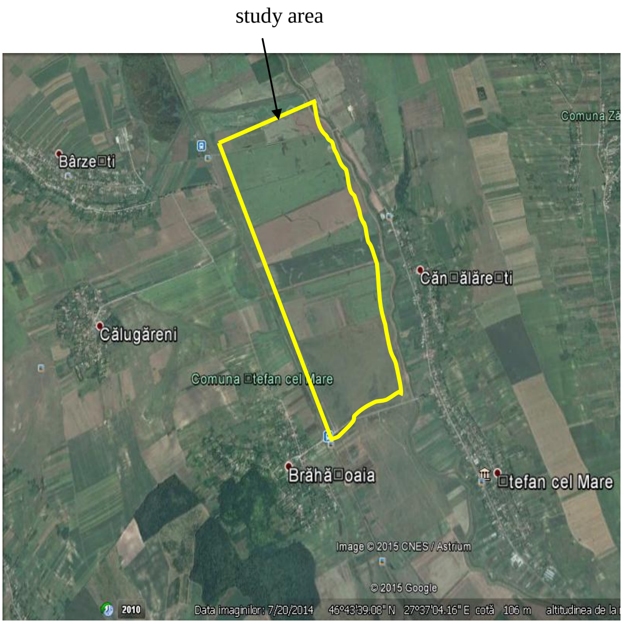


Figure 5. Placing dykes in the study area
(Source: www.google.earth)

The dyke must have a height of 2.5 meters, so the water level in the wetland must be kept at one meter. To protect the railway line (CFR Vaslui – Iaşi) an earth dyke will be built. A concrete pile of 10 cm thick will be fixed inside the dyke in order to protect the railway from the water infiltration coming from the wetland (*figure 6*). The concrete pile will be 4,5 m high, and the earth dyke 2,5 m high. The entire wetland will be dammed by an earth dyke of h = 2.5 m height (*figure 5*).

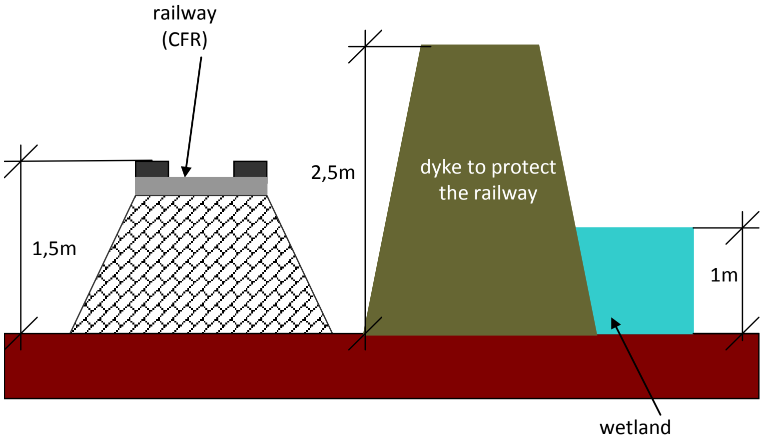


Figure 6. Schematic representation of the dyke placing for Vaslui- Iasi railway protection.

Description of the water supply to the wetland

Construction or development of a wetland requires finding ways for water to be brought, and stored, so that a constant level of water to be maintained. Figure 7a, b, c.

The water supply process in the area proposed above in order to create a wetland will be achieved through a system described here in after.

Figure 7. Examples of wetlands restoration

Given the above, the construction of water intake on Căzăneşti Water Reservoir is proposed, right about 12 km from the study area. We mention that water intake will be located in the most eastern point of the storage lake not to affect the dyke (*figure 8*).

A Φ = 10 cm diameter underground metal pipe is set within the water intake (*figure 9*) and provided with an automatic valve through which water will be captured and transported (under pressure), under gravity, in the study area. The water flow in this pipe will be a part of the flow that is currently discharged through the sluiceways of Căzăneşti Dam. Water quality of this lake is classified as III class, the same quality for the river sector of interest.

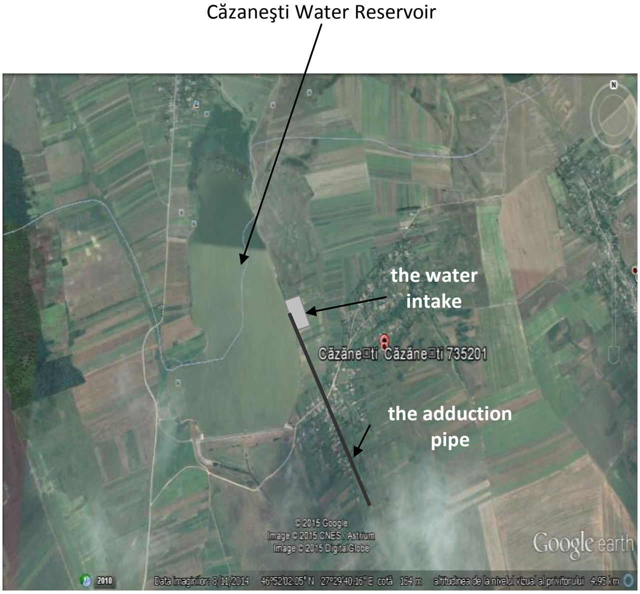


Figure 8. Positioning the adduction pipe in regard to Căzăneşti Dam
(Source: www.google.earth)

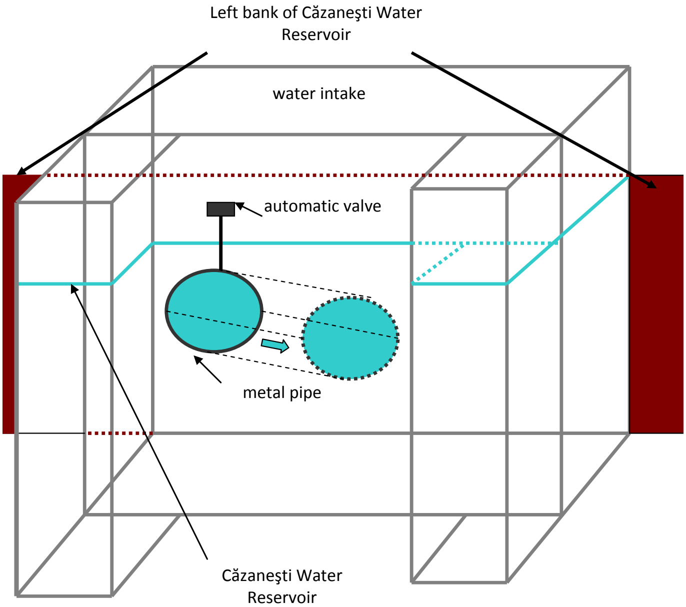


Figure 9. Schematic representation of water intake and underground metal pipe position

The automatic valve maintains a flow of 5l/s through a stainless steel pipe, regardless of the water level in Căzăneşti storage lake. The water supply pipe in the wetland maintains a constant level within the wetland being essential for the local biodiversity. The upstream end thereof will be provided with a metal grid in order to avoid clogging.

The underground metal pipe will get right up in the study area (*figure 10*), and the flow will be discharged into an underground concrete basin built upstream from the DN 15 D Vaslui – Roman National Road.

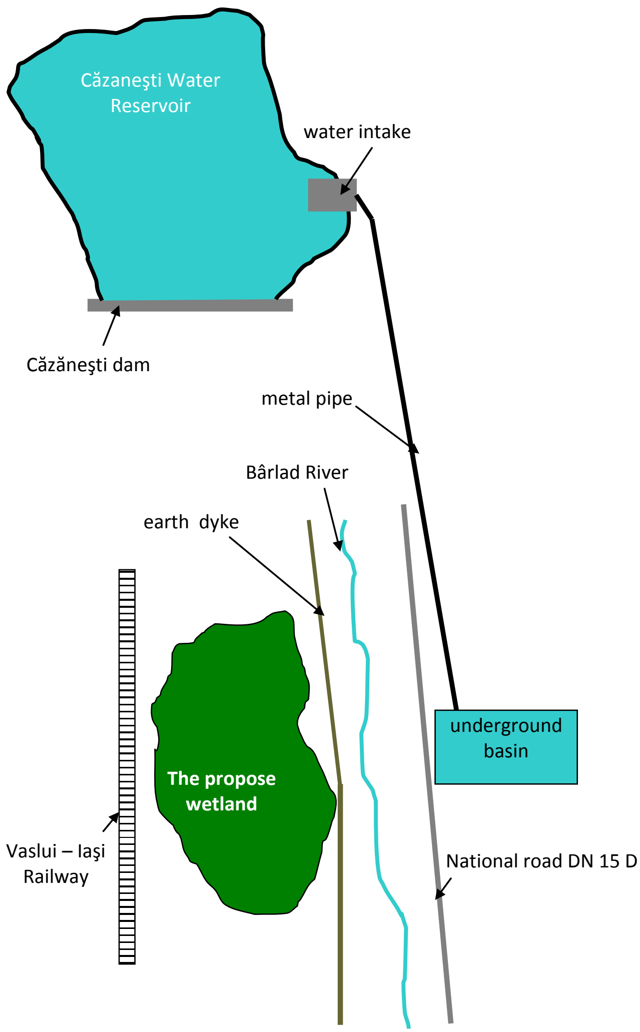


Figure 10. Schematic representation of the study area and the water supply system

Therefore, the underground concrete basin will store water transported through the metal pipe from Căzăneşti Dam. Water stored in this pool will be taken through a metal pipe, which will pass under the road connecting Vaslui to Roman (DN15 D), then it will go over the Bârlad River and penetrate the existing earth dike (*figure 11*) supplying the wetland. The downstream end of the pipe should be situated above the current water level in the wetland. The water level in the wetland should be one meter high for the development of flora and fauna.

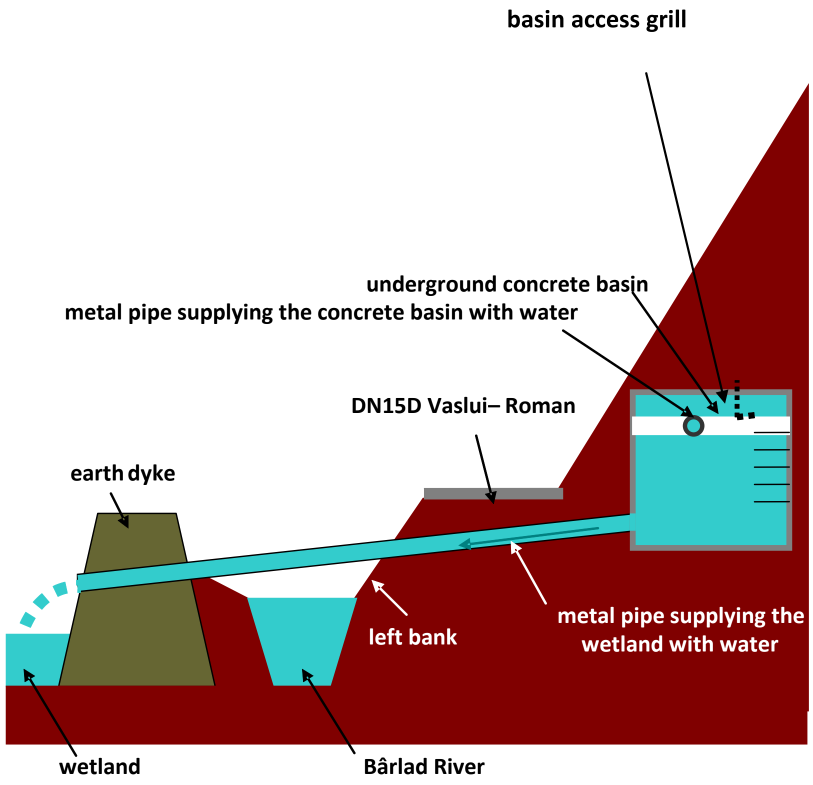
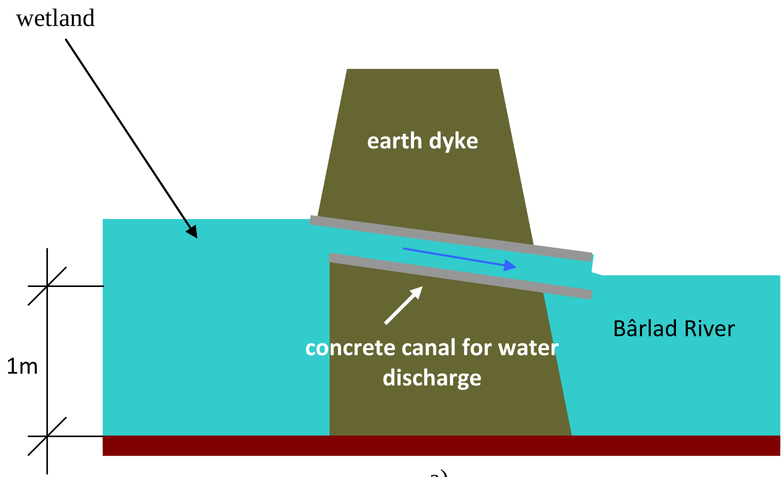
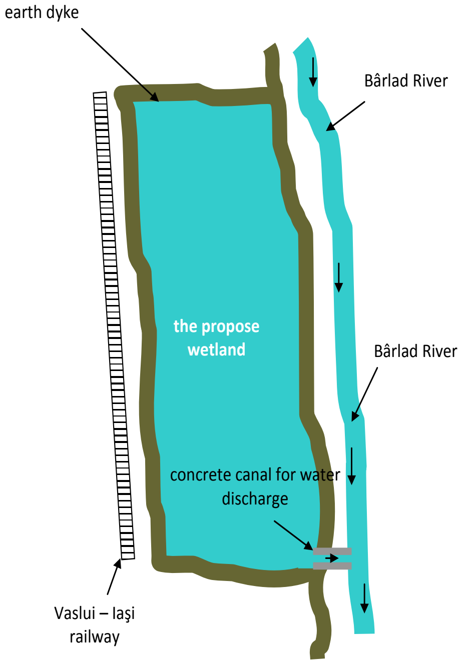


Figure 11. Schematic representation of the location of metal pipe that will supply the wetland with water.

If the level exceeds 1 m, then a concrete canal collecting the water from the wetland will be built downstream of this area. The concrete canal collecting water will pass through the old dike and reach the right in front of the Bârlad River, the place where the water is going to be discharged. (*figure 12 a and b*).



a)



b)

Figure 12. Schematic representation of the location of the concrete canal collecting water from the wetland.

The metal pipe that takes water from the underground concrete basin needs to discharge water in the wetland area through a multichannel system sloping towards the railway. Thus the water will disperse evenly over the entire study area *(figure 13*).

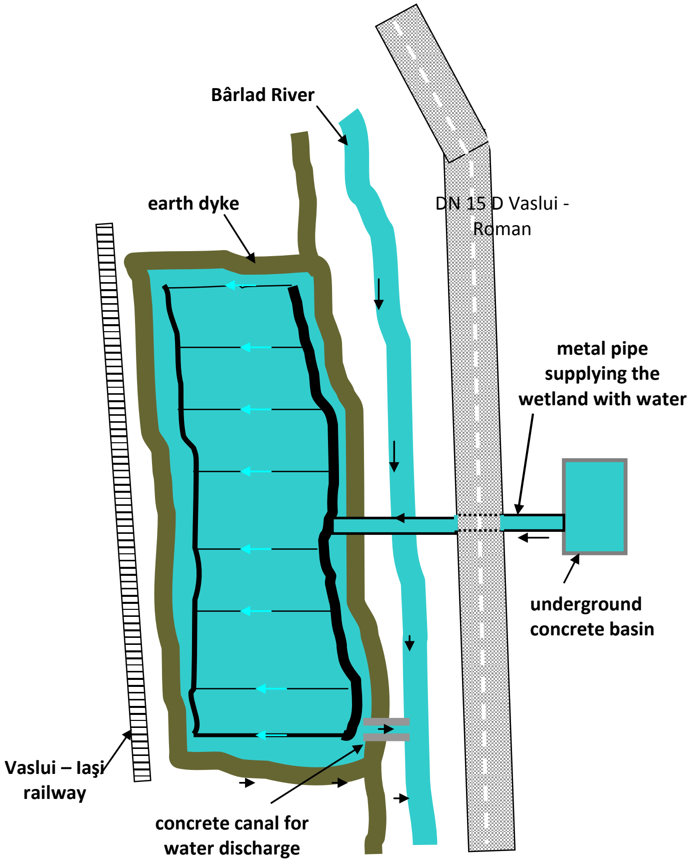


Figure 13. General schematic representation of the wetland drainage system

Before water supply, the wetland will be built as an inclined plane sloping towards the railway (*figure 14*).

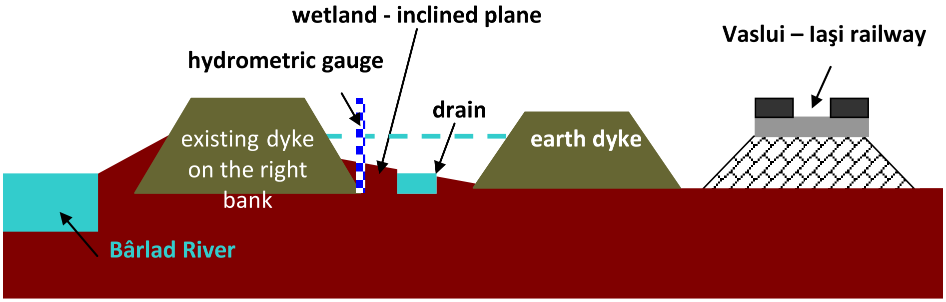


Figure 14. Schematic representation of a drain positioned in inclined plane – wetland

In the wetland, near the metal pipe supplying the area with water from Căzănești Lake, a hydrometric gauge equipped with a 1m high sensor will be installed. In case the water level exceeds one meter, the sensor will automatically close the valve mounted on the metal pipe. In this case, the water from the dam will be discharged through the current weir only. When the water level reaches or falls below 1m high, then the automatic valve is activated. In course of time the wetland drains disappear as they have been built just for a homogeneous filling of the surface designed as wetland. Filling the wetland with water implies using tanker wagons and road tankers.

One extremely important thing is that the water supply system in the wetland is using gravitational acceleration and the wetland water excess will be redirected towards the Bârlad River using the same type of gravitation-based system. The water, which is currently discharged from Căzănești Lake, drains almost entirely into the Bârlad River, so it can be used to supply the study area.

Solution 2 description

In order to build a wetland, a second solution for the previously selected and presented area (*see description of the study area*) will be proposed. In the first stage, the will be excavated up to 8m depth and creating an 8m-depth pool/catchment basin (B1) with the width of 5 meters and the length 6 meters and the entire remaining area (B2) to excavate to a depth of 1 meter. This entire excavated area will be dammed by creating an earth dyke (*figure 5*) of about 2.5 meters high, according to the current earth dyke on the right bank of the Bârlad River (*figure 15*).

Figure 15. Existing earth dyke position

The dyke between the created wetland and railway is meant to stop the water infiltrations (*Figure 16).*

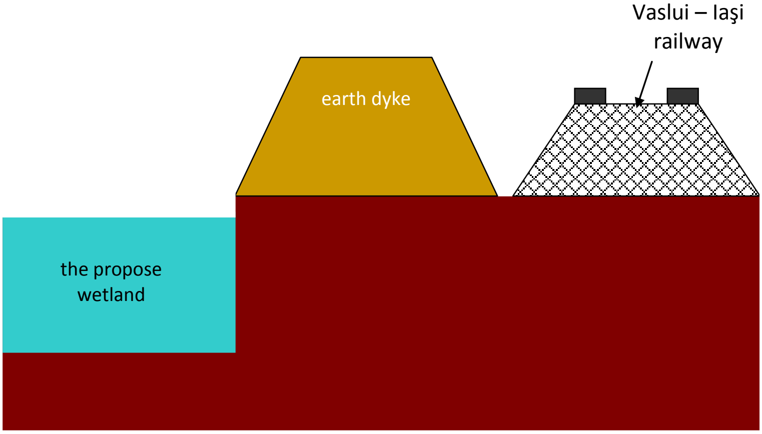


Figure 16. Schematic representation of the dyke between the created wetland and the railway

The propose wetland supply can be performed by a metal pipe equipped with an automatic valve. The metal pipe will pass under the existing earth dike and reach the basin built in the study area (*figure 17*). The propose wetland will be continuously supplied with water as maintaining a constant water level is essential for the local biodiversity.

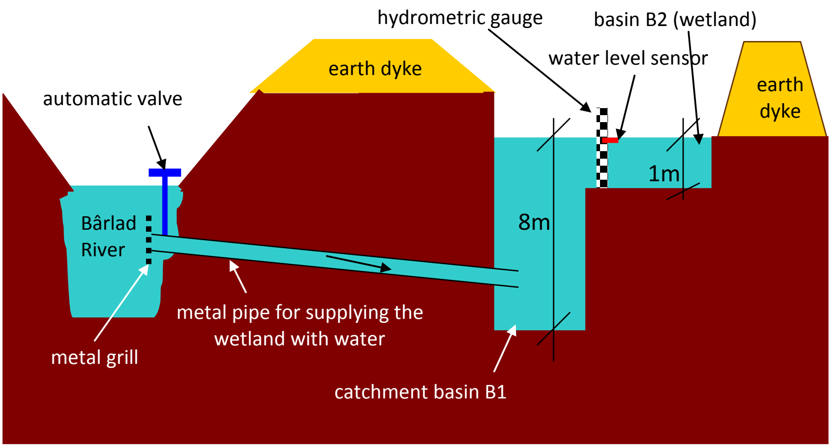


Figure 17. Schematic representation of wetland water supplying system

The pipe will be equipped with an automatic valve connected to a water level sensor on a hydrometric gauge located inside the wetland (*figure 17*). The upstream end of this pipe will be equipped with a metal grid in order to avoid clogging. When it rains heavily, the sensor automatically closes the valve and the water excess from the basin will be taken over by a concrete canal at the sensor level. The water is going to be discharged in the Bârlad River (*figure 18*). The pipe supplying the water basin and the concrete canal will have approx. 10cm and 20 cm diameter, respectively. All these calculations will be done thoroughly before developing the project.

The automatic valve maintains a flow of 5l/s inside the stainless steel pipe regardless of the water level of the Bârlad River.

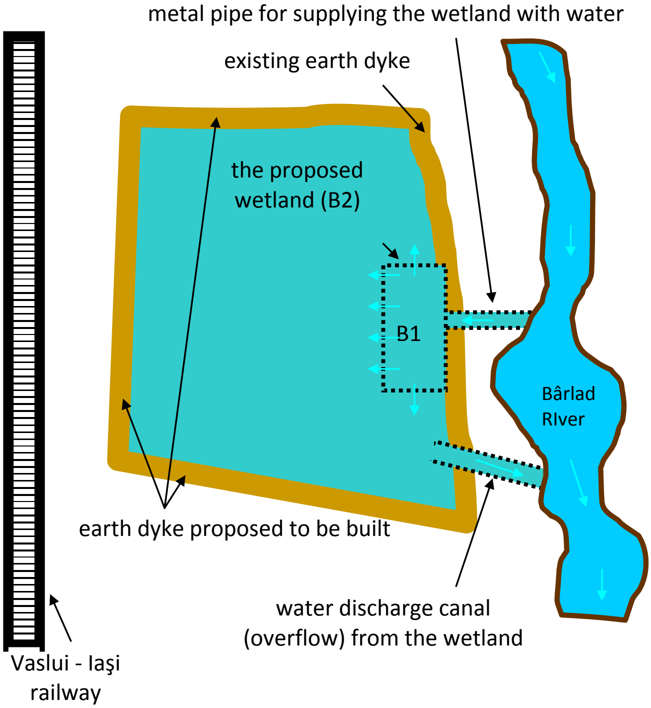


Figure18. Schematic representation of positioning the water discharge canal (overflow) in the wetland

Given that both solution presented proposed the same level of water (about 1 meter) in the restored wetland, in this case populating it with different species will be done, taking account of the characteristic species of aquatic ecosystem slow shallow < 1meter (relatively small fens/puddles). Those have the following features: is characterized by the absence of a proper bank, emerged vegetation is well developed in the bank; pelagial is crossed entirely by solar radiation; the thermal oscillations, both diurnal and seasonal ones are felt th throughout the water depth *(Brezeanu & Simon-Gruiţă, 2002; Pârvu, 2001*).

4. CONLCUSIONS

The wetland water supply system that is to be built between Buhăiești and Brăhășoaia relies on the gravitational flow from Căzănești Lake using a part of (or all) water that is currently discharged downstream of the dam. Equipping the system with water level sensors and automatic valves reduce the cost of the fuel system verification by specialists. In case of heavy rains, the water level within the wetland remains constant due to concrete canal built to collect and discharge the water excess into the Bârlad River. For both solutions proposed above, water supply will be permanent and the automatic valve maintains a flow rate of 5l/s into the stainless steel pipe regardless the level of water in the Bârlad River.

The proposed solutions is to achieve a former floodplain wetlands in the river Barlad, whose implementation will provide restoration of natural ecosystems and thus the generation of resources and services for local socio-economic systems.

Considering that one of the important functions of wetlands is the retention of nutrients, and practiced farming zone, it is estimated that the proposed wetland restoration in the study will help to reduce diffuse pollution in this zone. It also provides opportunities for scientific research, educational and represents a good opportunity to determine the effectiveness of proposed solutions and learning how these solutions can be improved and avoided some mistakes in the future.

REFERENCES

Bănărescu, P., 1964, *Fauna Republicii Socialiste România*, Pisces Osteichthyes, Volumul XIII, Editura Academiei RPR., [in Romanian].

Brezeanu, Gh. si Simon-Gruita, A., 2002, *Limnologie generala,* Editura H*G*A*, Bucuresti, [in Romanian].

Ickes, B. S., J. Vallazza, J. Kalas, and B. Knights, 2005, *River floodplain connectivity and lateral fish passage: A literature review,* U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, June 2005. 25 pp.

Kløve, B., Ala-aho, P., Bertrand, G., Boukalova, Z., Ertürk, A., Goldscheider, N., Ilmonen, J., Karakaya, N., Kupfersberger, H., Kværner, J., Lundberg, A., Mileusnic´, M., Moszczynska, A., Muotka, T., Preda, E., Rossi, P., Siergieiev, D., Šimek, J., Wachniew, P., Vadineanu, A., Widerlund, A., 2011, *Groundwater dependent ecosystems: Part I – Hydroecology, threats and status of ecosystems,*

Environmental Science & Policy **14**: 770– 781.
Pârvu, C., 2001, *Ecologie generala,* Editura Tehnica, Bucuresti, [in Romanian].
Tockner, K., and J. A. Standford, 2002, *Riverine flood plains: present state and future trends,* Environmental Conservation **29**:308–330.
Tockner, Klement, Mark S. Lorang and Jack A. Stanford. 2010, *River Flood Plains are Model Ecosystems to Test General Hyrogeomorphic and Ecological Concepts. River Research and Applications* 26.1 (2010): 76-86. Web. 29 2 2012.
Thoms, M.C., 2003, *Floodplain – river ecosystems: lateral connections and the implications of human interference,* Geomorphology 56, pp. 335-349.
Ujvari, I., 1972, Geografia Apelor României, Editura Ştiinţifică, Bucureşti, [in Romanian].
*** Baza de date: Institutul National de Hidrologie si Gospodarire a Apelor, Bucuresti, Romania [Database N. I. H.W.M., Bucharest, Romania].
***Directiva 2000/60/CE a Parlamentului European şi a Consiliului din 23 octombrie 2000, de stabilire a unui cadru de politică comunitară în domeniul apei (DCA). [Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (WFD)].
***Identificarea de măsuri bio-inginereşti pentru refacerea conectivitatii cursurilor de apa. Studiu de caz., INHGA, Bucuresti, 2015, in curs de aparitie [in Romanian].
***Legea Nr. 5 din 25 ianuarie 1991 pentru aderarea Romaniei la Conventia asupra zonelor umede, de importanta internationala, in special ca habitat al pasarilor acvatice, website:http://biodiversitate.mmediu.ro/implementation/legislaie/legislaie-naional/legislatie-arii-protejate/legea_5-1991_privind_aderarea_la_Conventia_de_la_Ramsar.doc
***River Basin Management Plan Prut-Barlad, Draft (2016-2021), available online at: http://www.rowater.ro/SCAR/Planul%20de%20management.aspx
*** The Convention on Wetlands of International Importance (the Ramsar Convention)/1971, website: www.ramsar.org.
***http:// www.google.earth.
*** http://www.fws.gov/northeast/nyfo/partners/wetland.htm.
***http://www.fws.gov/southwest/es/oklahoma/pwp.htm.
***http://www.icpdr.org.