RESEARCHES ON ENVIRONMENT DEGRADATION IN THE NATURAL SITES ON MOLDOVA RIVER LOWER COURSE

CERCETĂRI PRIVIND DEGRADAREA MEDIULUI ÎN ZONA SITURILOR NATURALE DE PE CURSUL INFERIOR AL RÂULUI MOLDOVA

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Abstract. *The European Ecological Network Natura 2000 in Romania is present on the lower course of the Moldavian River through the "ROSC10364 Community Site of Rila Moldova between Tupilati and Roman". Research over 15 years has shown that part of the natural reserve is affected by degradation phenomena. In the researched river sector (the minor and major riverbed, the riparian area) are located ballasts, bridges, water catchments, constructions, agricultural holdings, trees and bushes areas, etc. All these have influenced the arrangement of the river bed and the riparian area, which led to the degradation of the river and riparian habitat. Natural and anthropic risk factors have contributed to the degradation of the environment in the researched river area. The most important influences were the floods of the last 15 years, the exploitation of the ballast, the shore circulation areas, the absence of maintenance works in the river bed, etc.*
Key words: environmental degradation, flora, fauna, riparian area, floods

Rezumat. *Reţeaua ecologică europeană Natura 2000 în România este prezentă pe cursul inferior al râului Moldova prin „Situl de importanţă comunitară ROSC10364 Râul Moldova între Tupilaţi şi Roman”. Cercetarea efectuată pe parcursul a circa 15 ani a evidenţiat că o parte din rezervaţia naturală este afectată de fenomene de degradare. Pe sectorul de râu cercetat (albia minoră şi majoră, zona riverană) sunt amplasate balastiere, poduri, captări de apă, construcţii, exploataţii agricole, zone de arbori şi tufişuri etc. Toate acestea au influenţat modul de amenajare a albiei râului şi zonei riverane, situaţie ce a determinat degradarea habitatului fluvial şi riveran. Factorii de risc naturali şi antropici au contribuit la degradarea mediului din zona de râu cercetată. Cele mai importante influenţe au fost date de viiturile din ultimii 15 ani, exploatarea balastului, zonele de circulaţie de pe mal, absenţa lucrărilor de întreţinere a construcţiilor din albia râului etc.*
Cuvinte cheie: degradarea mediului, floră, faună, zona riverană, viituri

INTRODUCTION

The protection and preservation of geographic areas with a particular flora and fauna has led to the creation of "natural sites" protected by law. The ecological network "Natura 2000" has been created in Europe. It has been transposed in

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Romania through community sites differentiated as a structure in various geographic areas. Anthropic actions are limited by law in community sites.

In Romania there is a "National Network of Natural Protected Areas" consisting of parks, natural sites, nature reserves and monuments. These are designated by Law 5/2000, Government Decisions of Romania (GD 2151/2004, GD 1143/2007, etc.). At present, Romania has 30 parks, of which 14 are National Parks and 16 are Natural Parks. Romania has 585 "Natura 2000" sites, of which 437 are of Community importance as an integral part of the European ecological network. Romania owns 926 nature reserves and monuments designated by Law 5/2000 (Lengyel *et al.,* 2016).

Part of the riparian area of the Moldavian river falls into the "ROSC10363 Moldovan Ritual site between Oniceni and Mitesti". The action of natural and anthropogenic factors has intensified the phenomena of degradation on the habitat of the river bed of Moldova and its riparian area (Luca *et al.*, 2018). A particular influence is represented by the floods produced on Moldova, which morphologically modify the bed and cause disturbances in the living conditions of the aquatic fauna. Ballast operations and long-distance transport on the river bank disturb the stability of the environment and pollute the riparian habitat (Luca *et al.,* 2018).

The paper aims at presenting the results of the researches regarding the degradation of the environment in the lower course of the Moldova river and especially in the site of the "Tupilați - Roman" natural site.

MATERIAL AND METHOD

The research was carried out in the natural site "Tupilați - Roman" located on the lower course of the Moldova river. Within the natural site he has chosen a research sector on the Moldavian River between the locality of Pildeşti and Cordun, Neamț County. The research was conducted in several directions: theoretical studies, field studies and numerical simulations.

In the study area were included the minor riverbed of the Moldova River and the riparian area on the Tupilati - Cordun sector. A number of areas affected by environmental degradation and pollution phenomena have been analyzed in this sector.

The data used in the research comes from the following sources: technical expertise in the field of regulation of rivers and coastal defence constructions, A.B.A Siret Bacau Synthesis Reports, projects for works in the riverbed of Moldova and the riparian area, etc.

Part of the data comes from field research conducted by authors on the analyzed river sector (Luca, 2016, Sion, 2019). Authors' studies and research are conducted over a period of about 15 years (2004-2019).

The theoretical and experimental research was carried out in the following areas:

1. Studies on the evolution of natural sites in Romania under the conditions of hydro-climatic changes in the last period of time.

2. Studies and experimental researches on the influence of anthropogenic factors on natural sites located on the Moldova river.

3. Researching the natural and anthropic risk parameters influencing the evolution of the natural site located on the lower course of the Moldova river.

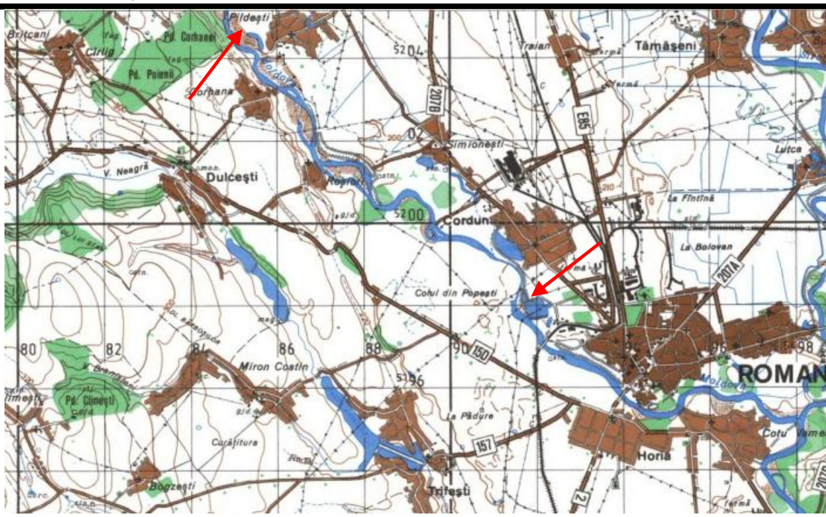


Fig. 1 Localization of the Pildeşti - Cordun Research Area on the Moldovan River From site ROCI0364 Tupilati - Roman on the Moldavian River.

The collection of field data was done by topographic measurements, field analyzes, material samples, photo and video surveys.

Primary data was processed using the statistical, hydrological and hydraulic calculation programs applicable to the case study.

RESULTS AND DISCUSSIONS

The ROSCI0364 - Moldovan River between Tupilați and Roman, as part of the "Natura 2000" site, was established by Government Emergency Ordinance no. 57/2007 on the regime of natural protected areas, conservation of natural habitats, wild flora and fauna, approved with amendments and completions by Law no. 49/2011. The protected area is located on the Moldavian River, including the riparian area, between Tupilați and Roman localities, Neamț County (fig. 1). The natural site has functional relations with four neighboring sites: ROSCI0363 "Moldova River between Oniceni and Miteşti"; ROSCI0365 "Moldova River between Păltinoasa and Ruşi"; ROSCI0378 "River Siret between Paşcani and Roman"; ROSPA0072 "Meadow Middle Meadow". The surface of the natural site is 4,720 ha.

Table 1

Location of ROSCI0364 - Moldova River between Tupilati and Roman

Coordinates		*S*	Alt_{min}	Alt_{med}	Alt_{max}	Biogeographic region
Latitude	Longitude	ha	m	m	m	
N 47^0 2' 13"	E 26^0 45' 16"	4720	175	247	333	Continental
S - surface; Alt - altitude.						

The biogeographic region is of "Continental Steppes Panonic Pontic Alpine". The natural site "Tupilați-Roman" contains habitats such as rivers, lakes, arable land, pastures and deciduous forests. The Moldavian River has the following parameters up to the Tupilați area: S (BH) = 3951 km^2, average altitude = 236 m, length = 176.6 km, slope 1.3 m/Km, multi-annual average flow 32.9 m^3/s suspended solid = 43.2 Kg/s.

The conservation objectives of the site are 10 species of fauna of Community interest, listed in Annex II of Council Directive 92/43 / EEC. The wetland is the specific habitat for 4 species of vertebrates, 4 species of amphibians and 3 species of conservative fish.

Within the natural site, there are a number of mammalian species protected under Annex II: *Lutra lutra, Spermophilius citellus, Myotis myotis şi Myotis blechsteini*. Within the site are species of protected amphibians and reptiles: *Bombina bombina, Bombina Variegata şi Triturus crestatus*. In the river of Moldova and its tributaries there are species of protected fish (*Barbus meridionalis, Cobitis taenia şi Sabanejewia aurata*).

All these species require a conservation status of the aquatic or terrestrial living environment in the coastal area. Thus, *Lutra lutra* is affected by the destruction of the vegetation in the riparian area, the presence of the river bed constructions, the drainage of the wetlands in the meadow, etc. The main threats to *Spermophyllus citellus* are the conversion of pastures into arable land. The use of pesticides in agricultural habitats affects the habitat of *Myotis myotis* and *Myotis flechstein*. Destruction of wetlands, industrial pollution and human activities affect the habitat of *Bombina bombina*. Changing water quality affects habitat at *Triturus cristatus*. *Barbus meridionalis* is influenced by the presence of structures in riverbeds and water pollution.

The research has shown that the site of the natural site is characterized by various human activities (agricultural works, grazing, water abstraction, ballast operations, road transport, etc.). Moldovan and industrial waste is discharged into Moldova, which continuously degrades the living environment of the "Tupilați - Roman" natural site. The Moldovan River has a relatively large capacity to dilute and disperse the pollutants discharged into its bed. But the possibilities of self-restoration of the natural quality of river water are not unlimited. Exceeding some pollution limits can cause major and irreversible changes in aquatic ecosystems (Bica, 2000).

The natural risk factors, especially the hydrological factors and the anthropic factors, influence the morphology of the river bed, the stability of the bed and river construction. But these factors also influence the existing habitat in the minor and major river bed. Disastrous floods produced in recent years have degraded the aquatic and coastal environment.

In the riverside area on the Moldova River, downstream of Pildeşti, there is a Roman water catchments area. Water capture consists of 66 capture wells and seven reinforced concrete boxes located parallel to the river bank. Current maintenance works - repairs and conservation of the sanitary protection area have negatively

influenced the habitat in the meadow area (fig. 2). The sanitary protection zone requires an environment without agricultural crops and the use of fertilizers. This situation does not allow the existence of optimal habitat conditions for some species.

a b

Fig. 2 The riparian area on the left bank of the Moldova River downstream Pildeşti, with the water catchment area: a - general view of the habitat area; b - detail of the sanitary protection area of the capture well, year 2018.

Ensuring the hydraulic parameters at the capture wells required the calibration of the Moldova river bed. Albia has a width of about 400 - 750 m across the catchment section, which causes the migration of the minor bed from the left bank to the right bank to pass through the floods. In order to ensure the water level in the catchment area, regularization works were carried out to move the small bed to the left bank (routing dams, docks, sleepers, bottom sills, shores, etc.) (fig. 3). Multi-annual average flow is 33.0 m^3/s, situation that imposed the presence of the bottom thresholds to ensure a water depth of 0.90 - 1.20 m (fig. 3.a). The works of this type influenced the habitat in a series of species protected in the natural site.

a b

Fig. 3 The state of the natural site in the Pildeşti area on the Moldova river: a - the riverbed branching zone (year 2015), 1 - the new bed in the capture area, 2 - the old riverbed, 3 - digging dam; b - view of calibrated bed and shore defence in capture area (year 2018).

The shore defence is made of geo-bags (fig. 3.b). By way of vertical and horizontal installation of geo-bags, favourable conditions for restoration of the habitat in the minor riverbed of the Moldova river are achieved. Geo-bags reduces water speed, deposition of alluviums and the creation of flora and fauna in the shoreline environment (Luca *et al.,* 2018).

The frequent floods of the years 1992, 2005, 2006, 2008, 2010, 2016, 2018 modified the bed and degraded the river-related settlement work in research. Flows recorded at floods showed high values that exceeded the probability of calculating the adjustment works (Q_{max} = 600 - 1200 m^3/s). The repeated morphological modification of the bedrock has altered the conditions of existence of the aquatic habitat (fig. 2.a and fig. 4.a). The restoration of the bed stability ensures optimal living conditions for the species protected in the natural site.

a b

Fig. 4 The state of the "Tupilati-Roman" natural site on the Moldova River: a - bottom (1) in the calibrated riverbed, Pildeşti area; b - protection of the concrete slab in the Cordun catchments area (year 2018).

A degradation of the natural environment within the site is determined by the intense movement in the riparian area of the ballast transport machines (fig. 5.a). The road is from the ground, with varying widths, with penetrations on the natural ground, which causes a continuous degradation of the riparian area. Noise, dust, and especially pollutant gases dispersed in the air by Diesel engines severely affect the quality of air, water and soil in the natural site area (Sion, 2019).

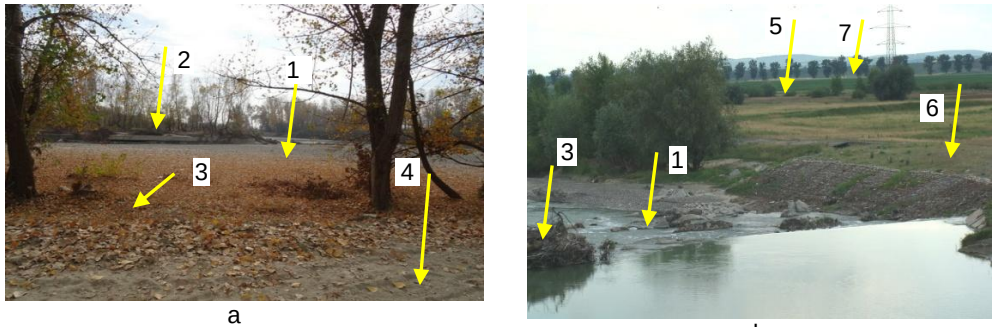
a b

Fig. 5 State of the natural site in the riparian area: a - earth road (1) used for ballast transport, (year 2018); b - the presence of ballasts in the riverbed and the riparian zone.

A degradation factor of the aquatic environment is due to the presence of the ballasts in the locality of Pildeşti and Cordun (fig. 5.b). The research showed the change of the turbidity of the water and the increase of the solid flow

transported on the bedside sector located in the natural site. This situation has greatly disrupted the aquatic habitat of protected species within the natural site.

At the contact between the Pildeşti area and the Cordun area, the Moldova River passes through a vegetation area of shrubs and trees, followed by agricultural crops (fig. 6a). The river has a natural riverbed and a satisfying riparian area for a normal habitat of protected species. Only the presence of traffic on the earth road disrupts the ecological stability of the natural site.



a b

Fig. 6 The state of the ecosystem on the Moldova River in the Cordun area: a - entry into the researched area (year 2018); b - industrial water catchment area Roman, (2011), 1- river riverbed, 2- right river bank, 3-left river bank, 4-way, 5- river right arm, 6-island, 7- had a right arm with farm crops.

In the industrial water catchment area of the Roman town there was a morphological change of the riverbed of the river Moldova (Luca, 2011). The capture of water is "surface", which led to the realization of two arms on the Moldova River (fig. 6.b). The left arm on which the capture is located is regularized (bottom edge, dipstick, shore defence) and rectilinear on a length of about 420 m. The left arm of the river does not provide optimal habitat conditions for the protected species due to high speeds water. The right arm of the river has a curved path with a natural bed at low speeds, favouring a normal habitat. The presence of the island allows the realization of normal living conditions for the protected species.

a b

Fig. 7 Degradation of the aquatic habitat through works in the riverbed of Moldova River: a - transverse works (bottom threshold); b - exploitation of the ballast with morphological degradation of the bed (year 2018).

Hydro-hydraulic work done in the natural site must ensure the living and conservation conditions of mammalian species, which is among the few sites designated for *Spermophilius citellus* and *Lutra lutra*. It is worth mentioning that some constructions and works for regulating the river bed of Moldova exist from a period before the designation of the natural site.

The correct and continuous functioning of natural ecosystems is necessary to ensure living conditions for biological communities. A number of plant and animal species that are integrated into the biotic community depend on certain physical conditions in the site and some ecological processes necessary for their survival (Amoros and Bornette, 2002). Physical conditions include mainly water, temperature, soil type, and organic processes include water circuit, nutrient and nutrition relationships. Changing or losing a certain type of habitat within the natural site determines the loss of species that depend on that type of habitat (Nilsson and Berggren, 2000).

The works included in the building rehabilitation project in the riverbed of Moldova meet the requirements for habitat assurance of the species listed in Annex II of Council Directive 94/43 / EEC.

CONCLUSIONS

1. Natural sites located on the watercourses must effectively collaborate with the riverbed and riparian buildings to ensure the most viable living conditions of the protected species.

2. The research carried out in the area of the "Tupilati - Roman" natural site on a section between Pildeşti and Cordun has revealed a complex of disturbing factors for both the aquatic habitat and the coastal area for the preserved species.

3. The regularization of the river bed of Moldova as well as those executed in the riparian area on the researched section must ensure the living and conservation conditions of the protected species within the natural site in view of the presence of extremely rare species (*Spermophilius citellus* şi *Lutra lutra*).

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