THE ROLE OF THE HYDROLOGICAL FACTOR IN HABITAT DYNAMICS WITHIN THE FLUVIAL CORRIDOR OF DANUBE

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ABSTRACT. -The role of the hydrological factor in habitat dynamics within the fluvial corridor of Danube. This paper had explored the connections between river hydrology with its changes and habitat dynamics. The fluvial corridor integrates spatially the channel and parts of its floodplain affected by periodical flooding and could be considered as an ecological corridor because of the size of the hydrosystem. The river and its ecosystems depend on geomorphogenetic and biological function and, thus creating a inter-dependence transposed into a concept, namely the *fluvial hydrosystem*, proposed firstly by *Roux 1982, Amoros 1987***.** The hydrosystem is an ecological complex system constituted of biotopes and specific biocenoses of stream waters, stagnant water bodies, semi-aquatic, terrestrial ecosystems localized in the space of floodplain modeled directly and indirectly by river's active force.

Keywords: *hydrological factor, habitats dynamics, fluvial corridor, Danube*

1. INTRODUCTION

The fluvial corridor integrates spatially the channel and parts of its floodplain affected by periodical flooding with an extention with hydrogeomorphological discontinuities. If initial name given to the afferent area of the lower stream of river " Le Balta du Danube" (*Emm. de Martonne, 1902*) and "Balta Dunării" (*Gh. Murgoci 1907*), were not used too much, and " the easily flooded area of the Danube" (*Gr. Antipa 1910*) only persisted till 1960 when it have been replaced with the syntagm "Danube floodplain". Danube is considered a hidrosystems which is analysed in this study from a perspective of interactions between hydrodinamics with structure and function of ecosystem.

The river and its ecosystems extention depends on geomorphogenetic and biological function and, thus had been created an inter-dependence transposed into a concept: the fluvial hydrosystem, proposed firstly by *Amoros 1987*. The fluvial hydrosystem includes specific biocenoses of stream waters, stagnant water bodies, semi-aquatic, terrestrial ecosystems localized in the space of floodplain modeled directly and indirectly by river active force.

This concept emphasizes water-energy-matter fluxes and focuses on the way how influence the sequence or recurrence of expading or withdrawal of the major channel and the riverine habitats.

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2. TEMPORAL ANALYSIS

After 1967 – the year in which the majority of embanking and sanitation sanitation works has been finished and damming for the hydropower systems Iron systems Iron Gate I and II the hydrological regime was modified within the same hydrological sector and to a hydrometric station or another.

A major component of the hydrological factor is related to ***flood duration*** and the ***value of hydrograph***, which has recorded an eloquent dynamics in the last 4-5 decades. It is important to make correlations between these two components of the hydrological factor, because the dynamics of biotope conditions depends on the evolution of these components.

Thus, concerning the floods periods during a normal year, on terrain situated at the same altimetric level (correspondingly to 6.5 hg) - a value considered as a minimum ecological condition for the euro-american poplars and maximum for the willow species (*Filat and al., 2009*) and we can point out that: before embankment the longest flood periods were recorded to all hydrometric station downstream on the this sector (Călăraşi 118 days, Olteniţa 108 days); after embankment, in the same hydrological conditions the order of hydrometric stations had been changed and for example in the proximity of Olt confluence (Corabia) the floods duration has grown at the level of the same hydrographer.

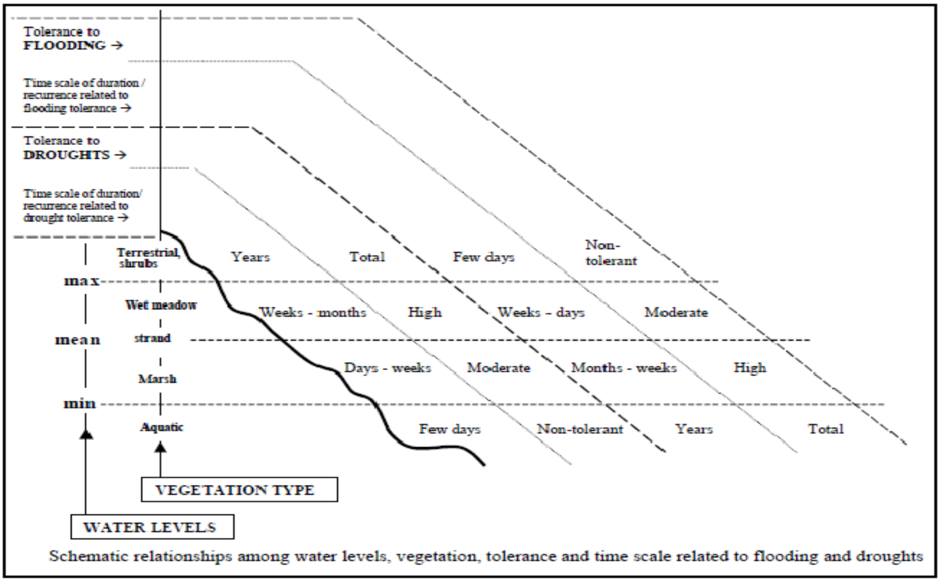
Analysing on long term 1967-2006, flood duration has been continuously decreased, for example during the years with light floods and lower levels of bench marks had an increasing frequency in the last two decades. Wood species and alien species of poplars and willows and other species as *Quercus* from Danube' floodplain are conditioned firstly by the specific hydrological regime (flood duration and phreatic level), and secondly by the inner characteristics of alluvial soils which constitutes the support of the biological activity for the habitat.

Stational factors which constrain the distribution and vitality of forest species from the fluvial corridor of Danube are: hydrological characteristics of the land (duration and frequency of the floods, velocity and the period of maintaining the flood waters, the level of phreatics) and edaphic characteristics (fibber, humus quantity, water supplying capacity). For a brief assessment of the relation between hydrological factor and habitat dynamics we have agreed that we must concurrently pay attention to flood duration and vegetation season and type pointed out below.

First table represents an exemplification (data from one hydrometric station - Bechet) and the later it is an extract from *"Encyclopedia of Inland Waters" Linkens (2009)* which follows our paper study aims: a schematic relationship among water levels, vegetation, tolerance and time scale related to flooding and droughts. Analyzing the data from the below table we can point out that vegetation season (days) duration is shorter than the level of hydrograph at Bechet hydrometric station.

Table1. ***Medium duration (days) of annual floods and the vegetation season between 1983-2001 measured in Bechet station***

Hydrographer	Year	Vegetation season
4,0	162	101
4,5	124	83
5	103	70
5,5	80	55
6	61	44
6,5	42	31
7	25	19
7,5	14	11
8,0	6	6
8,5	3	3
9,0	1	1
9,5	-	-



Schematic relationships among water levels, vegetation, tolerance and time scale related to flooding and droughts

Fig. 1 ***Schematic relationship among water levels, vegetation, tolerance and time scale related to flooding and droughts (extracted from Encyclopedia of inland waters, Linkens 2009)***

From the consequences with a specific character, which does relate to modifications of the hydrological regime determined by the hydro-technical works within fluvial corridor and also the drought periods with a high frequency from 1982 contributed to configuration and distribution of forest ecosystems within the floodplain regions:

- decreasing the duration and frequency at the level of the same hydrograph;
- amplifying the oscillating character of bench mark values, increasing the maximum level and decreasing the minimum levels;
- increasing of maximum speed of flow during the floods makes that river transport function and erosion to grow;
- altering the ecosystems functionality and setting of disorder periods until the reconstruction of the initial equilibrium of the systems;

Embankment and sanitation caused a shrinkage of the surface water especially of the afferent lakes and lacustrine basins and the fragmentation of wetland and forest habitats.

For instance, in a first stage, the unsilted part of the Potelu lake, situated at about 2 hg can be supplied permanently by gravity, insuring the existence of a water layer of 1,5 m from the CO channel which crosses the Dăbuleni-Potelu-Corabia are and supplies the irrigation system Sadova-Corabia (60.000 hectares).

In other situations the terrace underground flow can be used and in the fortunate case of the Bistreţ marsh it can be maintained further by simply discharging the waters of Desnăţui river. Damming had contributed to both the retention of large spring flows and the reduction of the medium and minimum discharges and, implicitly, to their levels.

Hydrologic exchange between main stream and their aquifers also influence biological structure of the flora and fauna that occupy both habitats.

At the same time water table elevations resulting from connections between the aquifer and innundated floodplain can alter metabolism and nutrient cycling in soils and subsurface sediments, may accelerate or retard organic matter processing and can influence the productivity of riparian vegetation.

3. SPATIAL ANALYSIS

Before embanking works the floodplain landforms and hydrological regime were corelated in a inter-dependency relation; the river erosion and accumulation functions had contributed to process of forming new floodplain banks, which changed the hydrological regime and also the watercourse direction, affecting the riverine habitats.

We can distinguish two categories of factors: natural and antropic ones; *Maria Pătroescu (1982)* framed into factors all the environmental components such as light, water and heat and in the category of determinants those which influence directly (litology, relief, water chemistry and man).

The dependence of the hydrological factor and the new modified conditions of the former wetland ecosystems it will be analyzed by exemplifying specific local cases or exposing the situation for specific vegetation types and fauna.

From the point of view of the European importance habitats (according to **Habitats Directive-** ***92/43/EEC***) within the floodplain we can frame the following habitats**:**

- 91 E0**-** Alluvial forests with Alnus glutinosa and Fraxinus excelsior;
- 91 F0**-** Riparian forests with Quercus robur, U. laevis, U minor, F. excelsior, F angustifolia developed along the large river in our study sector of the corridor has a slightly distribution along the most consolidated bars settled in before the channel regularization and river embankment;
- 92 A0 **-** Alluvial forest with Salix alba si Populus alba considered the most representative habitat from forest ecosystems within the Danube's lower floodplain;

Negative landforms – the places were water became stagnant for a long time populated with palustrine species as *Phragmites australis, Typha laxmannii, Typha angustifolia, Bolboschoenus maritimus, Schoenoplectus tabernaemontani.*

On the way the level of phreatics decreased in these negative landforms, the humidity excess was collected by the sanitation channels network and the environmental conditions for that species had disappeared. The same process of restraining halophyte vegetation of *Salicornia prostrata, Suaeda maritima, Obione pedunculata* it occurs the same, replacing some associations of *Puccinellia limosa* and *Puccinellia distans* thus, preparing the habitat condition for xero-mezophyte vegetation dominated initially by associations as *Cynodonti-Poëtum angustifoliae* or *Cynodonto-Atriplicetum tataricae,* in the vicinity of majority of human settlements.

Sanitation works reduced considerably the water bodies and, thus, only the Danube watercourse and some of the major lakes remained the domain for fish populations and the migration zones and for semi-migratory stagnophyle fish (carp, widow fish, flounder) used these areas of lower floodplain and the lacustrine basins linked with Danube for reproduction too; these types of migration of fish population and reproduction were important element for Danube flooded region as *Grigore Antipa* in *1920* said.

Fig. 2 ***Neo-formation phenomenon of alluvial forest ecosystems from dyke-river bank area Bechet – Dăbuleni sector (February-March 2010)***

These interventions within Danube hydrosystem had reduced the ***biodiversity function of ecosystems*** within Danube's fluvial corridor.

The specific hydrological regime characterized by periodical flooding determines the evolution process of vegetation; within the floodplain, in places with a high degree of deposition of alluvial material take place *syngenesis*, *neo-formation processes*, biocenozas passes the ***stadial colonization***, consolidation and stabilization (willow and poplar) species that are perfectly adapted to occupy new terrains with accumulation alluvial material.

After flood's withdrawal until autumn the willow species grow up about 1 meter high. Next year willow and poplar can reach 2-3 meters high (figure2), consolidating their roots in alluvial material and creating in a short period a new alluvial forest).

This phenomenon had been observed in the proximity of the confluence with Jiu river in 2010 during the early spring floods, in the area situated between dyke and bank in Bechet (*figure 2.*); the sustenance of forest ecosystems is realized by the periodically floods and depositions which cover the favorable land for these types of ecosystems capable to fix the alluvial material, to contribute to continuous accumulation processes, protecting banks and stabilization of phenomenon and functions for maintaining the ***hydrosystem equilibrium*.**

The deposition process was interrupted and the quantity of alluvial materials has diminished - an inappropriate consequence upon the alluvial forests and after 20-30 years the process of rarefaction could not regenerated because of the dense vegetation layer; gradually, poplar and willow get seared under the attack of different species of fungus and pest; alluvial forest ecosystems convert into sparsness grass land and, then, into lower floodplain lawns ecosystems.

River dynamics affected the architecture, the species and habitat distribution, the nutrient cycling of all forest communities living in floodplains, in close relation with the frequency, the duration and the kinetic energy of surface waters, the annual amplitudes of the groundwater, and the porosity of the substrates.

Riparian forests are complex and dynamic ecosystems that strongly depend on flood pulses for primary productivity, biodiversity and functioning. Softwoods, white poplars and hardwoods may be connected by successive stages in a number of cases, in function of environmental gradients and river processes. Salix bush communities colonize only the most dynamic parts of the river and the fluvial islets. On the edges of the floodplain, where floods are not very dynamic, forest composition changes: alder colonizes old channels while ash-alder distributes on more elevated terraces.

The cycle of ecosystem metamorphosis is controlled and conducted by new floods and siltings which cover the land with the alluvial material recreating the appropriate environment conditions for alluvial forest ecosystems (*Frontier and al., 2004).* This could be resumed as a short description of Danube floodplain ecosystem dynamics which had been directly affected by channel regularization, interruption of longitudinal connectivity of Danubian hydrosystem as ***Bradshaw*** modeled the relation between structure and function of ecosystems (figure3).

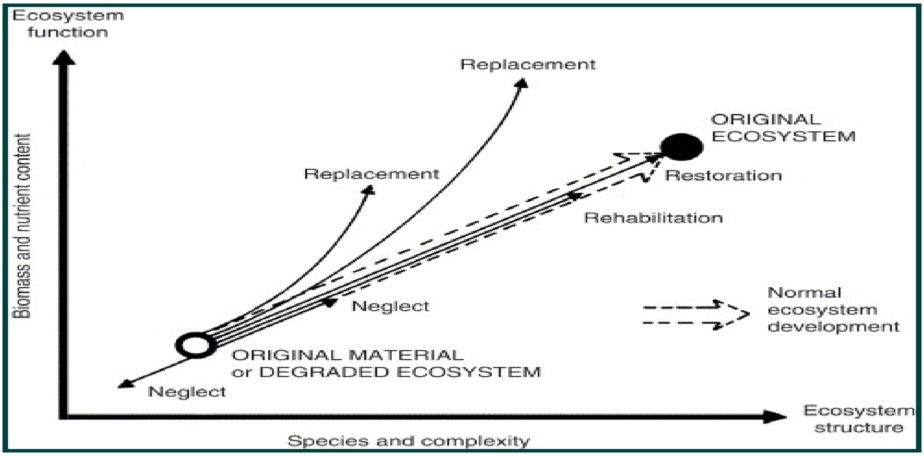


Fig. 3 ***Relation between structure-function ecosystem - Bradshaw model***

The hydrological characteristics of the riverine terrains as duration and frequency for floods, speed and type of flowing of flood waters, the level of phreatics, all considered as *stational factors* that condition highly the distribution and vitality of forest' species from lower Danube fluvial corridor.

Disturbances, such as periodic flooding, play major roles in the development of vegetation patterns in alluvial bottomlands (*Kirkman and Sharitz, 1994*) and control some plant communities that persist in dynamic equilibrium (e.g. *Hack and Goodlett*, *1960*, *Pickett*, *1980* and *Osterkamp et al., 1995 and Osterkamp et al., 1995*)

The distribution of forest ecosystems is connected with the spatial development degree of the floodplain***; the embankments from longitudinal profile of the river had limited the intensity of periodical floods*** and thus the hydrosystem equilibrium has been affected, restraining floodplain extention and its riverine habitats typology.

Major land conversion with agricultural new destinations of the flooded terrains generated major modifications in population's structure and specific fauna distribution within floodplain's geographical space.

For large mammals and other terrestrial species high water level means a real threat to population communities especially during the reproduction period, and thus the alluvial forests do not represent a proper habitat for terrestrial species during the high floods, only after the water withdrawal.

High spring floods of Danube (2006) had a high impact, reorganizing the plant communities and the structure of population and represented a threat also for birds, destroying nests places situated on soil or on the fluvial bars, islets which are partly destroyed or remodeled by the river active force during the flooding period (Bistreţ lake 2006 spring flood situa

4. CONCLUSION

Variability in natural systems has been recognized as a valuable characteristic, resulting in species richness and biodiversity.

On the other hand, hydrology has been stated as one of the most important driving variables that shape landscapes and habitats at several scales. Such variability, however, has been barely quantified and related to the assumed ecological benefits. Patterns of high and low flows are essential for ecological sustainability and biodiversity.

The impacts of impoundment, river regulation and channelization affected important riverine hydromorphological processes and the fluvial dynamics which define the dynamic equilibrium of habitat distribution within its corridor.

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