

## LAND USE AND LAND COVER DYNAMICS IN THE DANUBE FLOODPLAIN - DROBETA-TURNU SEVERIN – BECHET SECTOR

## DINAMICA UTILIZĂRII ȘI ACOPERIRII TERENURILOR ÎN LUNCA DUNĂRII – SECTORUL DROBETA-TURNU SEVERIN – BECHET

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**Abstract:** The present paper analyses the context, nature, intensity and effects of the changes in the land use and land cover within the Danube Floodplain, between Drobeta Turnu-Severin and Bechet. The study follows the changes undertaken by the natural environment during ca. two hundred years (end of 18<sup>th</sup> century – present day).

As land use involves the transformation and management of the natural elements to the human benefit, the environmental changes within the Danube Floodplain were less the result of natural conditions and mostly the outcome of human impact. The latter exerted a highly significant influence mainly through the construction of longitudinal or partition flood-protection dykes, of the irrigation or drainage canals network, but also through the agricultural use of large surfaces naturally covered with water, forests, or reed. Nevertheless, the importance of the natural processes in the study of land use/land cover shows a growing trend over the last decades, when especially climatic changes are taken into consideration.

The importance of the present research is furthermore underlined by the strong connection that exist among the land use/land cover change and the dynamics of biological diversity, risk phenomena and sustainable development within this damaged environment, in the framework of its particular natural and social-demographical features.

**Key-words:** The Danube Floodplain, land use, land cover, sustainable development

**Cuvinte-cheie:** Lunca Dunării, utilizarea terenurilor, acoperirea terenurilor, dezvoltare durabilă

### INTRODUCTION

During the last decades, numerous national and international institutions included on their research priorities the land use and land cover changes, in the framework of the overall environmental changes. The complex system that triggers the spatial and temporal land use changes, as well as the impact of the latter ones on the natural environment and society called for the achievement of an integrated research methodology in the context of the *land use science*. Although standardization at international level is attempted, there are various definitions of land use and land cover, as well as a number of classification systems (among which the most important yet are

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*Land Cover Classification System/LCCS* – FAO and *CORINE Land Cover/CLC* - EEA) and few dynamic simulation models.

*Land cover* represents *the biophysical state of the Earth's surface and immediate subsurface* (Turner et al., 1995) and the related transformations include *changes in biotic diversity, actual and potential primary productivity, soil quality and runoff and sedimentation rates* (Steffen et al., 1992). *Land use* refers to the arrangements, activities, and inputs undertaken by a certain land cover type (a set of human actions); the term is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land use change refers to a modification in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use changes may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have radiative forcing and/or other impacts on climate, locally or globally (IPCC, 2012).

Land use changes and land cover changes involve several processes that are central to the estimation of climate change and its impacts (Turner et al., 1995). Firstly, the two complex processes influence carbon fluxes and green house gases (GHG) emissions, which directly alters atmospheric composition and radiative forcing properties. Secondly, they change land-surface characteristics and, indirectly, climatic processes. In the third place, they are an important factor in determining the vulnerability of ecosystems and landscapes to environmental change. Through nitrogen addition, drainage and irrigation, and deforestation, land cover changes may alter the properties and possible responses of ecosystems (McCarthy et al., eds., 2001).

Land use stands as a significant indicator of the human stress upon the local landscape (Dumitraşcu, 2006). Its characteristics, as well as the intensity of human impact on the landscape display considerable variations depending on the natural potential of the area and on the social-economic attributes of the population that transforms it in order to satisfy its needs.

The sector under analysis is located in south-western Romania, on a distance of about 260 kilometres, between the fluvial kilometre 937 - city of Drobeta-Turnu Severin (westwards) and the fluvial kilometre 677 - town of Bechet (eastwards), covering an area of ca. 230.000 hectares (of which 86,000 hectares represent the floodplain proper) (Licurici, 2011). From the administrative point of view, the 74 permanent settlements under study are located on the territories of Dolj and Mehedinţi Counties (NUTS 3) and of the South-West Oltenia Development Region (NUTS 2).

The total population of the 28 territorial-administrative units (NUTS 5) located along the Danube within the study-sector is ca. 195.000 persons, of which almost 50 percent are urban residents (106.085 persons) (2011 Census, National Statistics Institute). Despite this latter value, the low number of urban centres (three: Drobeta-Turnu Severin, Calafat and Bechet), their main economic features and poor public infrastructure support the general rural character and man

agricultural use of the space under analysis. From the natural viewpoint, only few of these settlements are situated in the Danube Floodplain proper (three: Cozia, Desa and Pisculeț) or on the important islets of the Danube (two: Ostrovu Mare and Ostrovu Corbului), but the extension of their farmlands/other estates and, thus, of the human footprint within this unit, as well as the importance that the great river with its adjacent wetlands hold in the general dynamics of the settlements determined their consideration for the present analysis (Licurici, 2010, 2011).

Result of the fluvial and Aeolian processes, with high frequency in this sector, the micro-relief of the Danube Floodplain was severely transformed, especially during the last century, in order to valorise its important economic potential.

## **DATA AND METHODS**

The assessment of land use consequences firstly requires the identification and analysis of the main changes and of their triggering factors, through complex studies.

The present paper concerns the dynamic study of land use and a primary assessment of its consequences on the environment in the Danube Floodplain case-study sector. The analysis relies on an important volume of information collected from field research papers and statistical data supplied by the National Statistics Institute (Dolj Regional Office and Mehedinți County Office), National Agency for Cadastre and Land Registration (Dolj and Mehedinți branches), National Agency for Environmental Protection (*idem*).

Numerous spatial data sources were also used, starting with old generations of maps (*Specht Map, 1970; Szathmáry Map, 1857; General Austrian Map, 1912*), topographical maps (1:25.000), thematic maps (geological, hydro-geological, soil map), Landsat 7ETM+ satellite images (2000), orthophotos derived from different sources (*Cnes/Spot, DigitalGlobe, GeoEye, 2001 - 2012*). CORINE Land Cover (CLC 1990, 2000, 2006, EEA) database was also used for the present study.

The two main types of data were processed and correlated in GIS environment, the final analysis also including information collected during the field research (2007 - present).

## **RESULTS AND DISCUSSIONS**

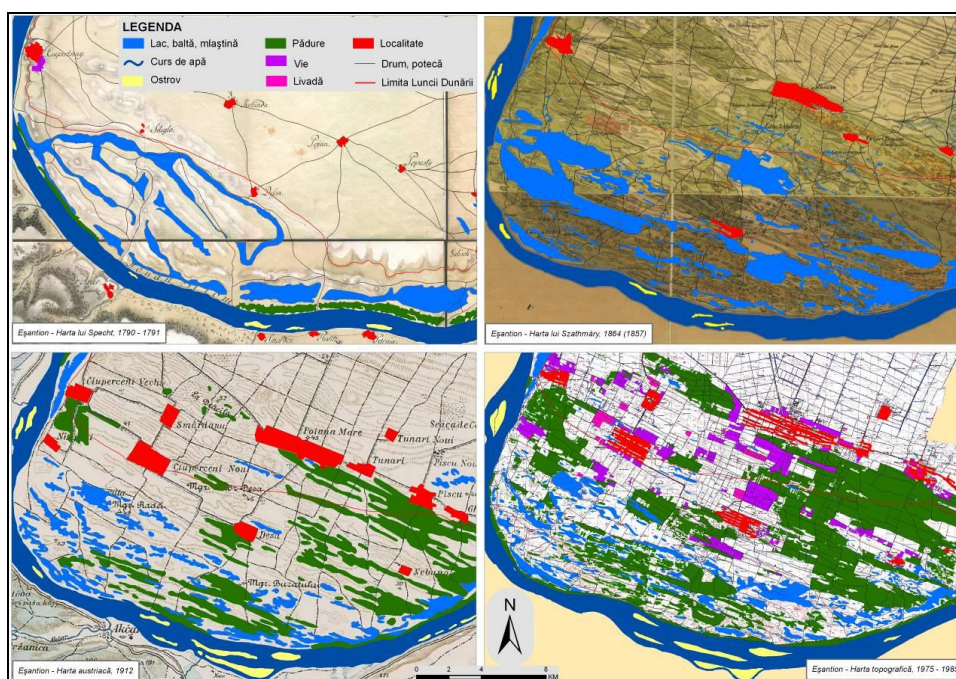
The Danube, as well as its riparian and floodplain areas offer such a variety of resources, that the successive generations have long sought to control and transform them to their benefit. Being a complex environment, where elements are in a dynamic balance, the Danube Floodplain undergone severe changes especially as a consequence of land use and land cover transformations. The changes were different in quality and intensity and they mainly depended on the social-economic and politic structures specific for a given period. The reflection on the floodplain landscape of such a structure or of the transition periods is analysed on successive map generations, starting with that realised by Specht (1790), which offers the first cartographic representation of land use in the study area (Toșa-Turdeanu, 1975). The second part of the 18<sup>th</sup> century marks exactly the period when feudality dissipates and the capitalist relations begin to

penetrate the economy. The comparative analysis of the Specht Map with the cartographic documents of the following centuries underlines significant land use changes, during a number of stages. This first document displays the pastoral and piscicultural character of the local economy, which is supported by the extension of pastures, forests and water bodies, as compared to the agricultural fields; a secondary support element is represented by the road texture, these transportation lines forming a chaotic and dense network and indicating the common use of terrains. Furthermore, the analysis points out the slow extension of the cultivated fields and pastures during the 18<sup>th</sup> century, in the detriment of the natural vegetation, by means of small-scale deforestation or grass removal, which were realised outside any regulation system and only in the context of the *land custom*, according to which the land could be freely used by peasants. This right starts to be limited towards the end of the 18<sup>th</sup> century, at the same time with the achievement of the *reserved domains* belonging to the landed gentry and with the beginning of the feudal structure disintegration (Toşa-Turdeanu, 1975). Specht Map also indicates the scattered presence of vineyards (especially on glades and at the forest fringe, more important being those located south of Ciuperceii Vechi, Calafat, and Basarabi), but the document does not represent the orchards (although more extended than the graperies). The presence of the orchards is suggested by the green space that accompanied the settlements, as well as by the allegoric ornamentation of the maps belonging to that period (as it is the case of the Schwantz Map), being also recorded in the previous and contemporary historical documents.

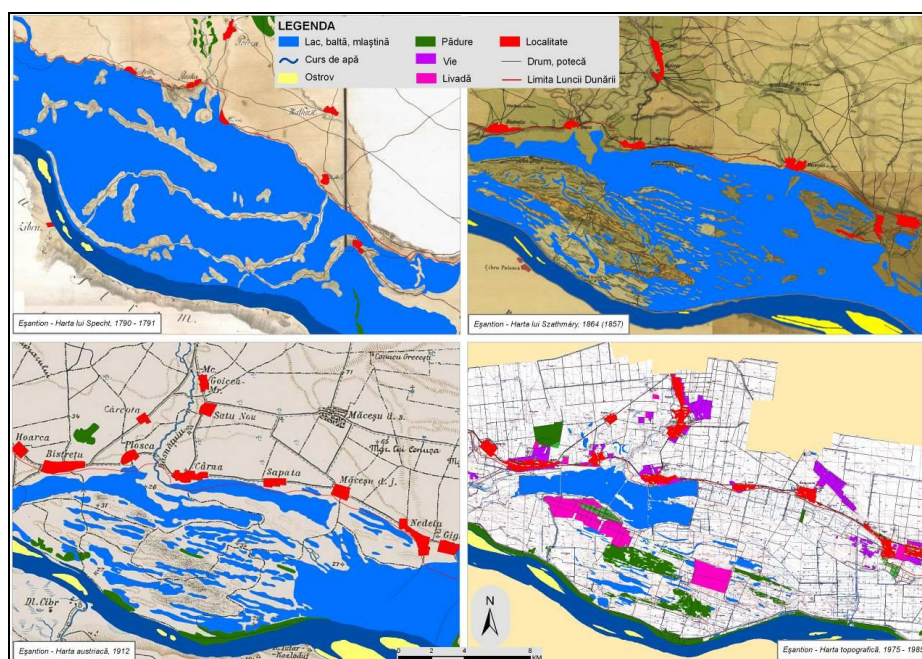
The maps realised by Specht and Szathmáry (1790, respectively 1864/1857) underline that the analysed sector of the Danube Floodplain was, for its most part, a domain of ponds, wetlands, natural pastures and hayfields, to which there were to be added less important forest surfaces (along the Danube, the Jiu and predominantly on the west, where they descended from the terraces) or mobile sand (Figs. 1 and 2). The arable fields were the least represented and they started to significantly expand after 1829, when cereals began to represent a highly requested export commodity.

*Charta României Meridionale* records more extended agricultural fields, this type of surfaces increasing to the detriment of pastures and hayfields, but not to that of forests (deforestation being forbidden by law). The different land use emphasises the change of the economic character from pastoral towards cereal based to a more important extent, which is characteristic for the capitalist structure of the 19<sup>th</sup> century (Toşa-Turdeanu, 1975).

Towards the end of the 19<sup>th</sup> century and the beginning of the following one, the sand settling actions through acacia and grape-wine plantation become intensified. Figs. 1 and 2 underline the increase in the forest surfaces between 1857 and 1912, the afforestation continuing during the 20<sup>th</sup> century, as proven by the topographical maps realised in the last decades of this century. During the same interval (20<sup>th</sup> century), significant increase is recorded by the orchards and vineyards, which are extended especially on the sandy terrains (Bechet, Ostroveni, Bistreţ, Cârna, Piscu Vechi, Calafat, Maglavit, and Gârla Mare).



**Fig. 1 Aspects of land use dynamics within the Ciuperceii Vechi – Ghidici sector of the Danube Floodplain**

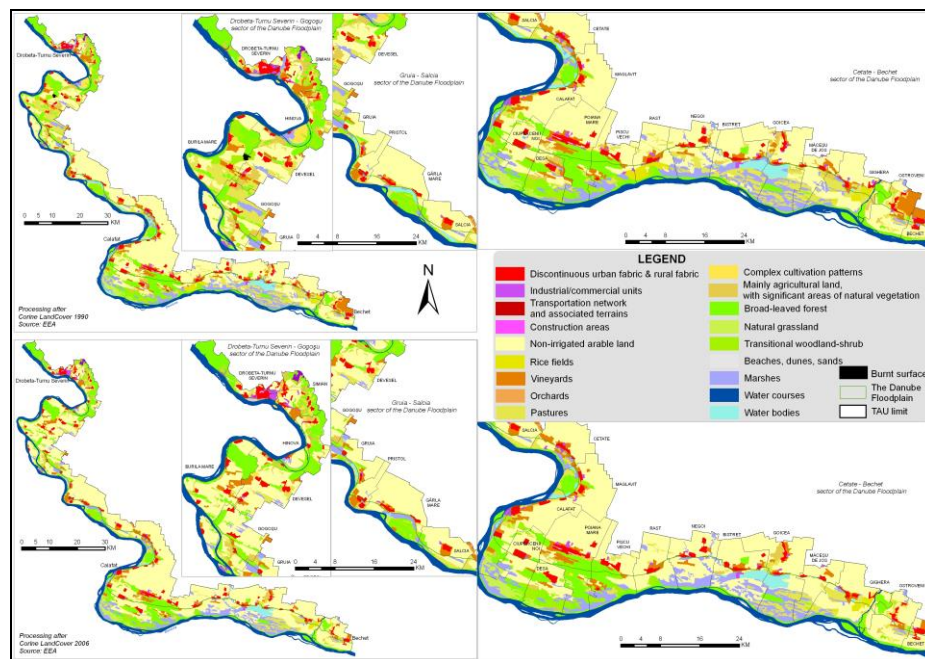


**Fig. 2 Aspects of land use dynamics within the Bistreț – Gighera sector of the Danube Floodplain**



Despite the favourable soil and climate conditions and the important labour force volume, the agricultural activities and, implicitly, the cultivated terrains within the Danube Floodplain were frequently subject to hydro-meteorological dangerous phenomena, especially floods. Certain crops were achieved only on higher banks (mostly corn and grapes) (\*\*\*, *Geografia Văii Dunării Românești*, 1969). The flood-protection dykes built between the Jiu river and Bechet settlement during 1908 – 1912 period (rebuilt between 1930 and 1933), as well as on the Ghidici - Rast - Bistreț sector, during 1925 – 1930 period, were surpassed and broke during the great floods occurred in 1937 and 1942; as consequent, after 1958, the old levees started to be repaired or reinforced and new flood-protection dykes began to be built. Within this framework, the dammed precincts extended considerably (ca. 17.000 ha in 1965, according to the above mentioned paper), this being the period that marks the severe reorganisation of the land use and land cover within the Danube Floodplain, with the important extension of the agro-ecosystems and the associated biodiversity loss. The natural meadows, wetlands and water bodies were limited to the favour of the arable fields.

After 1990 (Fig. 3), in the context of the new land and infrastructure ownership relations and of a general economic decline, most of the irrigation network ceased to function, while the crops are frequently reduced or compromised by the more acute dryness and drought phenomena. The analysed sector of the Danube Floodplain is among the few Romanian areas where both drought and flood hazards are characteristic, with all the consequences triggered upon the biotic, abiotic and human subsystems of the environment.



**Fig. 3 Drobeta-Turnu Severin – Bechet sector of the Danube Floodplain. Land use dynamics during 1990 – 2006 period**

Nevertheless, the arable surfaces record important extensions at the level of the territorial-administrative units (TAUs) located along the Danube within the case-study sector: about 40 percent of the total surface, with even higher values in the case of Gogoşu, Rast, Negoii, Măceşu de Jos, Gighera, Ostroveni and Bechet settlements. The surfaces occupied by vineyards (2.8 percent) and orchards (0.05 percent) are characterised by a scattered distribution, being mostly located at the floodplain –terrace geomorphologic contact (Photo. 1). The human stress through this type of cultures recorded a descending trend during the post-1990 period (Photo. 2), which is firstly triggered by the abandonment or clearing of orchards and vineyards; in its turn, this phenomenon is explained by the difficulties appeared after 1989 in relation to the management, production and marketing costs, which convinced the small farmers to keep only the plantations necessary to their own consumption. The pastures and hayfields account for more important surfaces within the Pisu Vechi – Calafat floodplain sector, while forest surfaces are less extended, this category being mostly represented on the sandy surfaces (acacia), in the dyke - river bank area (the Danube and its more important tributaries – willow and poplar, Photo. 3), or descends from the neighbouring higher geomorphologic units. After the uncontrolled clearings that accompanied the change of the land ownership system, the recent years accounted for a new increase in the afforestation of the area, the forest fund covering ca. 18.7 percent of the total surface under analysis. The built-up surfaces and those occupied by transportation infrastructure account for ca. 2 percent of the total area of the TAUs along the Danube in this sector.



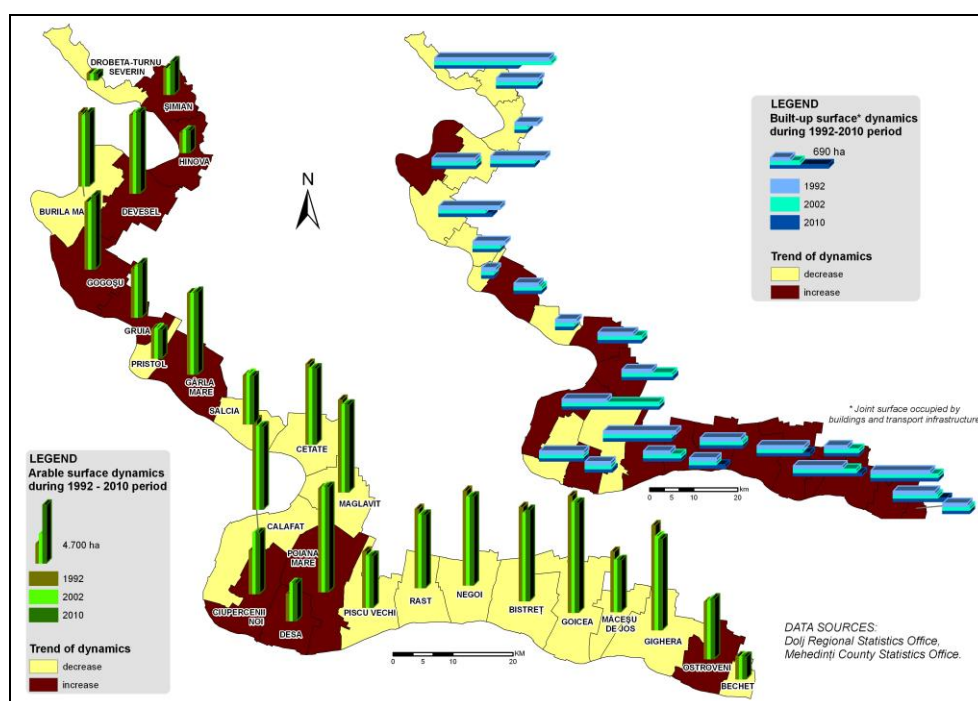
**Photo. 1 The complex land use in the floodplain, south of Maglavit settlement**

**Photo. 2 Cleared orchard, presently used as pasture, south of Bistreş settlement**

**Photo. 3 Recent poplar plantation in the Jiu – the Danube confluence floodplain**

During 1992 – 2010 period, 60 percent of the TAUs under study recorded decreasing arable surfaces (Fig. 4), the most significant instances being represented by Gighera (above 1,000 ha), Măceşu de Jos, Goicea, Calafat (above 500 ha), Rast, Negoii (above 400 ha) etc. The other settlements registered an increase of the arable field, the most important values being characteristic to Ciupercenii Noi (above 1,000

ha), Desa, Șimian, Gogoșu (above 500 ha), Gruia (above 400 ha) etc. Generally, this land use category recorded a drop of 575 ha. During the same interval, there is to be noticed the augmentation of the surfaces occupied by buildings and transportation infrastructure with 1,073 ha. This positive trend also characterised ca 60 percent of the TAUs under study, the highest values being recorded at the level of Calafat, Maglavit, Goicea settlements (with more than 200 ha each), Ostroveni, Măceșu de Jos, Piscu Vechi, Rast, Cetate, and Gighera (above 100 ha).



**Fig. 4 Drobeta-Turnu Severin – Bechet sector of the Danube Floodplain. Dynamics of arable vs. built-up surfaces during 1992 – 2010 period**

## CONCLUSIONS

Land use has changed drastically during the last century, sometimes with important negative effects such as built-up sprawl, soil sealing, erosion and degradation, loss of biodiversity, floods or drought and dryness accentuation. Land is a limited resource and its use represents one of the main reasons for environmental change, with significant impacts on quality of human life and ecosystems, as well as on the management of infrastructure. The socio-economic activities are reflected in land use and at a single point multiple uses can be present. This means that an integrated policy approach, based on reliable data to balance sectoral demands and manage land in a sustainable manner is required.

The analysis points out that the present land use structure within the Drobeta-Turnu Severin – Bechet sector of the Danube Floodplain is not sustainable



and this only adds to the general social-economic and environmental issues that characterise the area. After the severe change of the land cover during the 20<sup>th</sup> century and the shift of trend brought by its last decade, there are extended misused or abandoned surfaces, as well as other terrains and equipments marked by incertitude over their ownership.

The economic and environmental policy must take into account the natural and demographic features, as well as the complex dynamic balance of the Danube Floodplain, especially in the framework of the climate changes with severe manifestations during recent years. It is necessary to soundly reassess the land use structure and the local infrastructure and it might be considered the hypothesis in which certain terrains regain their initial function (wetlands, fisheries, pastures etc.), which would correspond to the local environmental conditions.

Important non-structural measures, such as rising community awareness regarding the importance of a proper land use, the know-how transfer, the sharing of good practices in this field or the creation of support and monitoring structures to assist the local communities could increase the effects of political measures. Positive results could also have the increase of land use management capacity, through information regarding the practising of ecological or traditional agriculture, the development of fair trade networks intended for small farmers or rising the awareness on the benefits of association.

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