

Typology of valuable natural elements from landscape reserves in the Prut Basin (Republic of Moldova)

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Abstract: In the study of the 12 Landscape Reserves (LR) in the Prut basin, these natural complexes were adjusted to the international and regional classifications regarding the typology of the landscape (aspects related to basic research), but also, we wanted to highlight the landscape value of some natural elements (aspects related to applied research). The latter are important for the institutions/agencies that perform LR monitoring and management, and in the context of Sustainable Development of the given region, they have a valuable tourist and cognitive potential, with morphological, geological, hydrological, biotic elements, etc., which require clear regulations on, both their conservation and their scientifically justified exploitation. Among the LR, the ones from the NW region stand out more, from the area of the Badenyan reefs that have an appreciable aesthetic-recreational and cognitive value (LR Geological - paleontological complex from the Lopatnic river basin, LR La Castel and others).

1. Introduction

The term landscape is first used by the German (Hommeyer, 1805), with a sense of the physiognomic aspect of nature. L.S. Berg, was born in Tighina, Basarabia, proposed in 1931 (Berg, 1931) the science of the landscape of the geographical areas of the Earth and the first classification of natural areas in the Asian part of Russia. Wieber in 1931 promotes ideas about the visual and ecological organization of landscapes.

Among the first attempts to classify landscapes are those made by the German naturalist (Humboldt, 1805), who at the beginning of the XIX century classified the landscapes according to the homogeneity of the vegetal associations. However, one of the most successful classifications of landscapes was made by the Frenchman (Bertrand, 1968). Taylor et al. (1993) mention the importance of the connection between landscape elements.

According to the IUCN classification, in category IV - Landscape Reserves, in the Republic of Moldova are included 41 natural complex and with a total area of approx. 34200 ha, of which in the Prut basin - 12 natural complex (Figure 1). In the literature, these natural complexes important for ensuring ecological balance, have been described in depth, either separately - an area, or - specific to a particular region, or more in-depth and complex - in monographs or series / collections of books. What is certain is that one of the most extensive and academic works remains the 1976 publication of the authors (Kravciuc et al., 1976) with the description of 493 natural complex with a total area of 103,109 ha, including landscapes natural constituted 22501 ha. In the subsequent basic works, the emphasis was placed on certain components and natural elements, depending on the profile of the authors: Proca, 1978 - on the form of relief and formative rocks, climate, biocenoses and soils; Postolache, 1995 - on vegetation; Boboc, 2016 - proposes the appreciation of the aesthetics of landscapes on the morphometry of the relief and the

way of covering the land; Begu et al, 2012 - on completing the floristic information with species of mosses and lichens, with some rare species of fauna, as well as the ecological state of the environment.

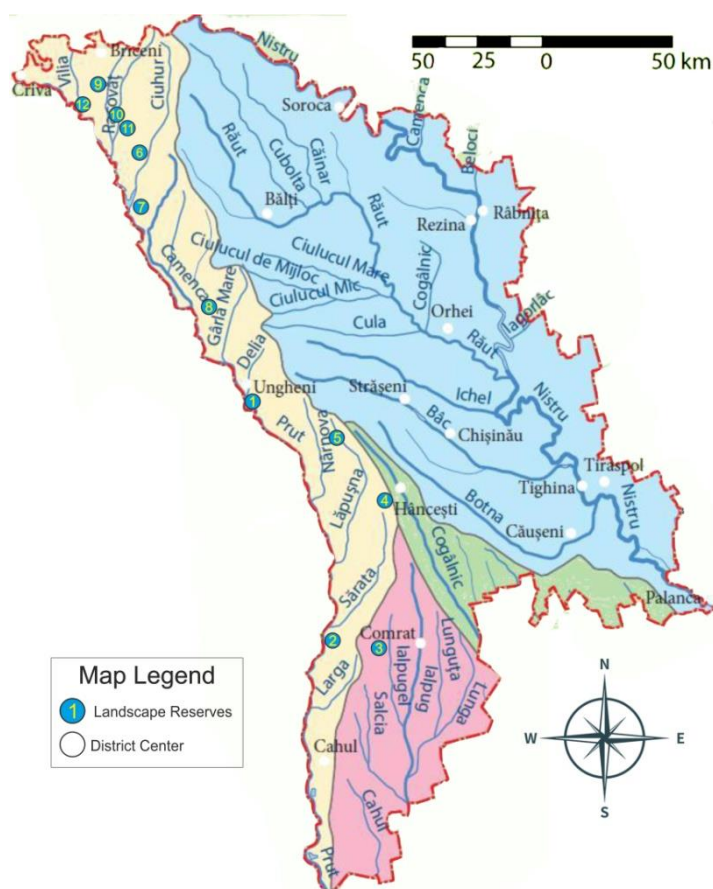


Figure 1. Distribution of Landscape Reserves in the Prut basin

However, a well-argued scientific algorithm for each category of Protected Natural Area (PNA), including LR, has not been developed. Attempts have been made: Protected area passport (Postolache et al., 2004); Criteria for the ANP Cadastre (Regulation of the OC Cadastre from FANPS / GD No. 414 of 02.05.2000. Published: 12.05.2000 in OJ No. 054) and Models for describing the categories of ANP (Begu, Liogchii, 2016), last, proposed ministry, with detailed details of the 7 criteria established According to (ANP Cadastre Regulation of the OC Cadastre from FANPS / GD No. 414 of 02.05.2000), but which did not have financial support to be implemented by the Institute of Ecology and Geography (IEG), responsible, according to the same decision, for completing and holding the database regarding the ANP Cadastre. To overcome this condition, it is necessary to create a team of experienced specialists in the fields of ecology, botany, zoology, geology, hydrology, paleontology, pedology etc. to finalize the models for the description of the ANP categories (according to the IUCN classifier) and subsequently submit for approval by an extended meeting of the IEG Scientific Council, with the participation of specialists from the relevant ministry. So, the purpose of this study is to finalize a model of scientific description of the distinct elements of the Landscape Reserves, and the novelty consists in the ecosystem approach of the main landscape components (water, soil, rock, biota).

2. Materials and Methods

The establishment of the LR landscape typology was made based on the Criteria proposed by (Postolache et al., 2004), and adapted for Romania by (Stupariu, 2012): A.

General; B. Specific; C. Large categories of landscape - classification introduced by the European Landscape Convention; except for criterion D - The typology of the landscape in the Romanian references. A broader analysis was performed on the 7 categories of Criterion A: 1. According to the physical-geographical elements; 2. By functions: natural, anthropic (cultural, rural, urban) 3. Dominant elements: abiotic, biotic, anthropic; 4. Spatial scale: mega / macro / meso / micro. At criterion 4 we applied the 6 spatial levels used in the analysis and delimitation of landscapes proposed by (Bertrand, 1968), which include six nested synthetic units: area, domain, natural region, geosystem, geofacies and geotope. 5. Time scale: pre-quaternary, quaternary, current; 6. Zonality criterion: zonal, azonal; 7. By evolutionary and dynamic state: stable / unstable.

Regarding the application part, the landscape elements were registered and partially described in field expeditions, using the camera, cartographic sketches developed for the areas protected by the Urbanproiect Institute and those of the Forest Management, quantification of some parameters of the physical-geographical elements etc.

3. Results

According to the **General criterion A. 1 - depending on the physical-geographical elements**: relief, vegetation, water, among the 12 LR, it possesses edifying landscape elements of meadow relief - 2 LR located in the Prut meadow, of hilly relief - 3 LR with spread geographical location in the Center, North and South of the country, with hilly relief - 3 LR located in the Codrilor Plateau and Tigheciului Hills, etc. (Table 1). Depending on the vegetation, the ones with forest vegetation dominate - 7, followed by the petrophyte ones - 3, steppe - 1 and marsh - 1. The lake-building elements from LR Lunca inundată Antonești and LR Suta de Movile are also important, the latter possessing edifying geomorphological elements - landslide mounds.

Table 1. Types of edifying landscape elements registered in the Landscape Reserves of the Prut Basin (structured according to (Proca, 1978))

Name of the protected Landscape Reserve (LR)	Area, ha	Landscape elements according to general criterion A - depending on:				
		1. physical-geographical elements			2. by functions	
		relief	vegetation	hydrography	natural/AP	anthropic
LR Valea Mare	390	meadow	forest		forest	
LR Lunca inundată Antonești	94	meadow	marsh	lakes	marsh	dams
LR Codrii Tigheci	2770	hill	forest		forest	
LR Padurea Hancesti	4573	hill	forest		forest	
LR Vila Nisporeni	3538	hill	forest		forest	
LR Zăbriceni	607	knoll	forest		forest	
LR Suta de Movile	1058	mountain slides	of steppe	lakes	steppe with forests	discontinuous
LR Izvoare Risipeni	1481	knoll	forest		forest	
LR compl. geol-pal. r. Lopatnic	400	valley-gorge	petrophyte	river	petrophyte	
LR Fetești	564	valley-gorge	petrophyte	river	petrophyte	
LR La Castel	746	valley-gorge	petrophyte	river	petrophyte	
LR Tețcani	133	trapezoidal valley	of forest	river	forest	

General Criterion A. 2 - *by LR functions* are: natural and anthropogenic (cultural, rural, urban). Probably, it is a debatable criterion, because the natural ones, as mentioned by (Stupariu, 2012), are Protected Areas (PA), and in some places, they repeat the vegetation criterion. Sometimes the anthropic element is present, through arrangements (dams) or negative impact (illegal agrocenoses among mounds), the latter establishing a discontinuity of the landscape (LR Suta de Movile).

General Criterion A. 3 - *dominant elements*: abiotic, biotic, anthropic. The abiotic element represents the base of the landscape and includes elements such as climate (within the studied area - temperate-continental), geology, topography, hydrography, soil (Table 2). The second level, biotic, includes the elements of flora and fauna, seen in the context of the complex interactions that exist between them. The anthropic / cultural level refers to the way in which the human factor intervenes in the structure of the landscape.

Table 2. Types of dominant landscape elements in the LR of the Prut Basin (structured according to (Proca, 1978))

Name of the protected Landscape Reserve	Area (ha)	Types of landscape elements according to general criterion A.3 - depending on the dominant elements.					
		abiotics			biotic		
		geology	topography	hydrography	soil	flora	fauna
LR Valea Mare	390	clays, sands	meadow	ephemera l lakes	alluvial	higro-, mesophyte	
LR Lunca inundată Antonești	94	clays, sands	meadow	pond with springs	alluvial	paludous	aqua tic
LR Codrii Tigheci	2770	loessoid clay	hill	-	chernozem	meso-, xerophyte	
LR Padurea Hancesti	4573	clays, sands	hill	-	gray	mesophyte	
LR Vila Nisporeni	3538	clays	hill	-	gray	mesophyte	
LR Zăbriceni	607	limestone clays	knoll	-	cernoziom	meso-, xerophyte	
LR Suta de Movile	1058	clays, sands	river terraces	dam, lakes	chernozem	meso-, xerophyte	
LR Izvoare Risipeni	1481	clays, sands	knoll	-	gray	mesophyte	
LR compl. geol-pal. r. Lopatnic	400	badenyene limestone	defile		chernozem	mesophyte	
LR Fetești	564	limestone	defile		chernozem	mesophyte	
LR La Castel	746	limestone	defile		chernozem	meso-, xerophyte	
LR Tețcani	133	limestone clays	river valley		chernozem	higro-, mesophyte	

General Criterion A. 4 - *by scale*, to this criterion, we applied the 6 hierarchical spatial levels used in the analysis and delimitation of landscapes proposed by Bertrand

(1968), which includes six nested synthetic units: area, domain, natural region, geosystem, geofacies and the geotope. The first 2 levels, the temperate zone and the pontic domain, are specific to all the LR studied. According to the natural regions, the LR were distributed as follows: 4 - located in the Middle Prut Plain (two, directly in the Middle Prut Corridor), 5 - in the Northern Moldavian Plateau, 1 - in the Tigheci Hills and 2 LR - in the Codrilor Plateau (Table 3).

Table 3. Types of landscape elements registered in the Landscape Reserves of the Prut Basin (structured according to (Proca, 1978))

Name of the protected Landscape Reserve (LR)	Area, ha	Altitude, m	Types of landscape elements according to general criterion A. 4 - depending on the <i>geomorphological scale</i> :			
			natural region, 10-100 km ²	geosystem, over 100 km ²	geofacies, 1-10 km ²	Geotop, <1 km ²
LR Valea Mare		30-50	The middle Prut corridor	meadow	meadow	prealbial dams
LR Lunca inundată Antonești	390	10-15	The middle Prut corridor	meadow	meadow	meadow lake
LR Codrii Tigheci	94	70-310	Codrii Tigheci hills	of the plateau	at the top	
LR Padurea Hancesti	2770	110-320	Central Codrii	of the plateau	at the top	
LR Vila Nisporeni	4573	140-370	Western Codrii	of the plateau	at the top	
LR Zăbriceni	3538	210-270	The plateau of Northern Moldova	of the plateau	at the top	
LR Suta de Movile	607	130-270	Middle Prut Plain	river terraces	intramonticular depressions	Mound Țiganului
LR Izvoare Risipeni	1058	150-210	Middle Prut Plain	interfluvial ridge	the slope of valley	
LR compl. geol-pal. r. Lopatnic	1481	150-250	The plateau of Northern Moldova	r.Lopatnic valley	river valley	
LR Fetești	400	150-270	The plateau of Northern Moldova	gorge sector	river valley	
LR La Castel	564	110-250	The plateau of Northern Moldova	gorge sector	river valley	
LR Tețcani	133	90-140	The plateau of Northern Moldova	gorge sector	river valley	

General Criterion A. 5 - time scale includes pre-Quaternary, Quaternary and, current landscapes. Pre-Quaternary landscapes retain relict elements, for example, rocks from ancient Neogene (Badenian) and, more narrowly, Cretaceous geological structures. For example, the plateau of Northern Moldova, the hilly plain of the Middle East. At the Quaternary period (Pleistocene) is attributed LR Suta de Movile which, according to Professor Gheorghe Năstase, was formed towards the end of the Upper Pleistocene, until the formation of the Prut meadow in the Holocene (Năstase, 1937). However, in the Pleistocene-Holocene we can also attribute LR 9-12 (Table 1), when, by erosion, the Neogene reef structures are brought to light.

General Criterion A. 6 - zonality criterion (zonal, azonal landscapes). According to the latitudinal zonality all LR are *temperate landscapes*, and after the altitudinal one 9 - they are *campestre landscapes* (0-200 / 300) m and 3 - *hilly and knoll landscapes* (200 /

300-400 / 420 m altitude). At the azonal criterion we can nominate LR Antonești floodplain as *hydromorphic landscape* and LR Suta de Movile as *partially hydromorphic landscape*, or, probably, lithologically-hydromorphic.

General Criterion A. 7 - according to the evolutionary and dynamic state are distinguished: stable / unstable landscapes. In the state of biostasis are 8 LR, and in the state of rexistasia 4 LR, and parastasis - 0 (Table 4).

Table. 4. Types of landscape elements registered in the Landscape Reserves of the Prut Basin (structured according to (Proca, 1978))

Name of the protected Landscape Reserve (LR)	According to the general criterion A. 7 - depending on the evolutionary and dynamic state: stable / unstable		Criterion C. European Landscape Convention Florence, 2000	According to criterion B. Applied / Specific
	biostasis	rhexistasis	2. The patrimonial value	NPA according to IUCN categories: I-VI
LR Valea Mare	+		remarkable	IV: Habitat / Species Management Area
LR Lunca inundată Antonești		fishing, pasture	special	IV: Habitat / Species Management Area VI: Protected Area for Resource Management
LR Codrii Tigheci	+		remarkable	IV: Habitat / Species Management Area VI: Protected Area for Resource Management
LR Padurea Hancesti	+		remarkable	IV: Habitat / Species Management Area
LR Vila Nisporeni	+		remarkable	IV: Habitat / Species Management Area
LR Zăbriceni	+		in good condition	IV: Habitat / Species Management Area
LR Suta de Movile		agrarian	special	III: Monument of Nature V: Protected Landscape
LR Izvoare Risipeni	+		special	Ib: Wilderness area III: Monument of Nature V: Protected Landscape
LR compl. geol-pal. r. Lopatnic		mining	special	III: Monument of Nature V: Protected Landscape
LR Fetești	+		remarkable	IV: Habitat / Species Management Area
LR La Castel		mining	special	III: Monument of Nature V: Protected Landscape
LR Tețcani		agrarian	in good condition	IV: Habitat / Species Management Area

Criterion B. Applied / Specific. The International Union for Conservation of Nature (IUCN) has defined 6 main categories of protected areas according to the main management objectives. Any protected area can fall into one or more of these categories, regardless of its local title. Of the 12 LR studied, 7 falls into the IV IUCN category: Management Area for Habitat / Species, and 2 of them can also be assigned to Category VI: Protected Area for Resource Management; 4 LR - to IUCN Categories III: Nature

Monument and V: Protected Landscape, and among these, LR the geological and paleontological complex in the Lopatnic river basin can be attributed to Category Ib: Wilderness area (Table 4).

Criterion C. Large landscape categories - general multicriteria classification of the landscape, introduced by the European Landscape Convention, Florence 2000: 1. Dividing the land area into landscape categories / Large areas (land areas, inland waters, marine areas); 2. The patrimonial value, state of conservation or arrangement of the landscape (special, remarkable landscapes, in good condition, ordinary, daily, degraded); 3. Dividing the landscape by the interference between natural and cultural elements (natural areas, rural areas, urban areas, suburban areas). At criterion C, position 1 - we do not have, at position 3 - all are *natural*, and at position 2: 5 LR are *special*, 5 - *remarkable* and 2 - *in good condition*.

4. Discussion

The results of the adjustment of scientific information (obtained in the field, laboratory and subject to mathematical analysis) to the categories of landscapes proposed by the French school, highlighted the importance of applying classical classifications, perhaps with small adaptations, as did Romanian researchers, ensure methodological compatibility in this area. Of course, there are difficulties in covering all the parameters indicated in the 7 criteria, probably we should not strive to include less distinct landscape elements for one or another landscape. We must take into account both the depth and purpose of the research - fundamental or applied, as well as the requirements of the study commander or implementer.

In the case of protected areas, assigned to the Landscape Reservation category, for the successful monitoring and management of these natural complexes it is important to evaluate the distinct landscape elements (geological, hydrological, edaphic, biotic, etc.), which are the business card of the LR and for which excluding any threat of destruction / extinction.

5. Conclusions

1. Most of the Landscape Reserves in the Prut Basin have valuable natural elements, which express their landscape individuality, being placed, according to the spatial criterion: altitude zonality in campestre landscapes (9) and hilly landscapes (3), and by latitude zonality - all represent temperate landscapes, attributed, according to the scale, to the Pontic domain.

2. Depending on the physical-geographical elements (essential in appreciating the aesthetics of landscapes), the meadow relief has 2 LR, hill and knoll relief - 5 LR; valley relief - 4 LR, including 3 gorges sectioned in Badenian and Volhynian limestones and one represents LR of massive landslides. Depending on the vegetation, LR dominates with forest vegetation - 7, followed by petrophytes - 3, steppe - 1 and marsh - 1.

3. Important are the lake building elements from LR Lunca inundabilă Antonești and LR Suta de Movile, the latter also possessing edifying geomorphological elements - mounds with altitudes from 1-3 m to 20-30 m. The geosystems LR Fetești, LR La Castel, and, in particular, LR the geological and paleontological complex in the Lopatnic river basin, possesses a special patrimonial value, especially, aesthetic-recreational value, but which also has an appreciable cognitive value.

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