ACROSS
Journal of Interdisciplinary Cross-Border Studies
Vol 10, No.5, 2026

Environment

Sustainable Management of Saline Ecosystems: Challenges and Prospects for Lacu Sărat Brăila

Carmelia Mariana BĂLĂNICĂ DRAGOMIR[1], Ciprian CUZMIN[1], Aurel Gabriel SIMIONESCU[2], Viorel Marian DRAGOMIR
[1]Cross-border Faculty, "Dunărea de Jos" University of Galati, 111 Domnească Street,
[2]"Constantin Brâncoveanu" University, Brăila, Romania
*Corresponding author: carmelia.dragomir@ugal.ro

Abstract

Land use monitoring is an essential tool for understanding landscape dynamics and assessing the ecological status of natural habitats, particularly in areas included in the European Natura 2000 network. In these territories, sustainable resource management depends on the ability to identify the spatial structure of habitats, the degree of fragmentation and the anthropogenic pressures that can influence fundamental ecological processes. In this respect, geospatial products from the Copernicus programme, such as CLCplus Backbone 2023, provide a solid analytical basis through their high resolution and standardised land-cover classification. Lacu Sărat – Brăila is a halophilic ecosystem of community importance, included in the Natura 2000 network, characterised by unique habitats, specialised biodiversity and natural resources with ecological and therapeutic value. In the context of climate change, anthropogenic pressures and regional hydrological changes, the site faces increased vulnerabilities. This article analyses the current state of biodiversity, emerging risks and the necessary directions for the sustainable management of the lake.

Keywords: Lacu Sărat Brăila, nature conservation areas, land cover

Introduction

The habitats designated within the Natura 2000 network represent the fundamental ecological infrastructure of the European Union, with the role of ensuring the long-term conservation of species and habitats of Community interest, in accordance with the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC). (EEA, 2021). The establishment, monitoring and effective management of these areas requires detailed knowledge of the spatial structure of the ecosystems, the degree of fragmentation and the anthropogenic pressures that may affect the integrity of the protected habitats (Orusa, et al, 2026).

In this context, modern remote sensing tools and European-standardised mapping products, such as the CLCplus Backbone 2023 from the Copernicus Land Monitoring Service portfolio, provide essential support for assessing the status of Natura 2000 habitats. This dataset, based on the Sentinel-2 series, provides land cover information at a spatial resolution of 10 m, enabling accurate identification of habitat boundaries, ecotonal transition zones, and subtle changes in landscape matrices. The CLCplus Backbone classification, structured into 11 fundamental classes, is developed for the entire European territory and ensures a uniform and interoperable representation of data across borders (EEA, 2025a).

The European Natura 2000 network is well represented in Brăila County, where 13 sites of community importance (ROSCI) and 10 special bird protection areas (ROSPA) have been designated. The 10 special bird protection areas total 59,788.37 ha, which corresponds to 12.54% of Brăila County's area. Regarding sites of community importance, 9 sites have been declared on the county's territory, with a total area of 43,318.74 ha, representing 9.08% of the county's area (APM Brăila, 2024).

The primary objective of these protected natural areas is to ensure the conservation and sustainable use of the natural heritage by maintaining or restoring a favourable conservation status for both natural habitats and the wild flora and fauna they shelter. This approach involves protecting essential ecological structures and functions and promoting management practices that ensure the long-term sustainability of these ecosystems (EC, 2019; EEA, 2020).

Lacu Sărat – Brăila (ROSCI0307) is one of these sites in the Bărăgan region, covering 329.4 ha and designated in 2011 to protect biodiversity specific to saline ecosystems. Lacu Sărat Brăila is an old course of the Danube, now blocked, located in the south of the municipality of Brăila. The water is highly saline, and the bottom of the lake is covered with therapeutic sapropelic mud. Morphologically, it consists of two compartments (I and II) separated by County Road 212, which can communicate at high levels via an underpass beneath the road. Lacu Sărat I Brăila is the only therapeutic lake in the county whose resources (salt water and sapropelic mud) are currently being exploited. The therapeutic value of the water and mud has long been known to the inhabitants of this region and the surrounding areas. Since the groundwater is located at shallow depths, this factor determines the formation of predominantly saline soils – classified as solonchacs and solonetzs. These are characterized by a strong accumulation of salts either on the soil surface or in the upper layers (Maiorescu et al, 2018).

Figure 1. Zoning of Lacu Sărat, Brăila County
Source: Natura 2000 Website
(http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=ROSCI0307)

From an ecological point of view, Lacu Sărat hosts two types of natural habitats characteristic of halophilic environments: Pannonian salt steppes and marshes, respectively habitats dominated by Salicornia and other annual species specific to salt marsh areas.

These habitats are recognised in the specialised literature as being fragile ecosystems, with dynamics strongly dependent on the hydrological regime and local climatic conditions. A species of community interest, the common ground squirrel (Spermophilus citellus), a species vulnerable to the loss of steppe habitats, was identified within the site, along with a diverse floristic fund (22 plant species) and 2 amphibian species that complete the ecological profile of the area (EE, 2023).

The objective of this article is to analyse how the current land cover organisation, as represented in the CLCplus Backbone 2023 dataset, influences the integrity and functioning of Natura 2000 habitats in the study area. By examining the distribution of land cover categories and their spatial relationships, the study aims to highlight the degree of habitat fragmentation, ecological connectivity and relevant anthropogenic pressures, providing a scientific perspective necessary for the development of regionally tailored conservation measures.

Materials and methods

To assess land use in the study area, data from the European CORINE Land Cover (CLC) program, part of the Copernicus Land Monitoring Service, coordinated by the European Environment Agency, were used. This program provides a standardised pan-European inventory of land cover and land use types, designed to provide a coherent basis for monitoring at a continental scale. CLC provides a uniform classification consisting of 44 thematic classes, which enables comparative analysis of changes in the European landscape over time and space (EEA, 2025b).

To characterise land use for the reference year 2023, the CLC datasets were accessed in vector format, which provides adequate conceptual resolution for analysing the spatial distribution of different land cover classes. The CLC data comply with the specifications of the INSPIRE Directive, ensuring interoperability with other geospatial information sources and facilitating further processing within GIS systems. At this stage, the data were imported into a GIS environment, reprojected into the coordinate system used for the analysis, and cropped to match the geographical boundaries of the area of interest (CLMS, 2026).

Data processing included the classification and regrouping of CORINE classes relevant to the study objectives, as well as generating spatial statistics to assess the distribution and weight of different land-use types. To increase the accuracy of the interpretations and to assess possible fine-scale changes, the CLC data were compared and validated against the CLC+ Backbone 2023 product, a 10 m resolution dataset based on the Sentinel-2 series and updated in a two-year cycle (CP, 2025). This product provides additional details on the land-cover structure, complementing the information provided by the traditional CLC inventory. The entire methodological process aimed to ensure the reproducibility, consistency and robustness of the analysis, using a standardised data framework at the European level and recognised for its reliability in studies on spatial transformations, territorial management and ecological assessments (GAF, 2024).

Results and discussion

In recent years, saline ecosystems in Romania, including Lacu Sărat Brăila, have been facing increasing pressures from climate change, particularly repeated severe droughts, excessive evaporation, and diminished groundwater supplies. The phenomenon of drying up of salt lakes has also been observed in other areas of Brăila County, such as the case of the lake at Movila Miresii, where the decrease in water level favors the development of halophilic algae and the alteration of the color of the water during hot periods. Media studies and observations by specialists indicate that these changes are the direct result of reduced water volume and high salinity, which confirms the increased vulnerability of halophilic ecosystems to climate stress. Hydrological problems affect not only biodiversity but also the lake's balneoclimatic value. During periods of severe drought, Lacu Sărat can fragment into small pools of water, which leads to the degradation of the therapeutic mud, a local resource with tradition and socio-economic importance. In such contexts, authorities and specialists discussed intervention measures, including replenishing the lake with Danube water through the canal irrigation system, to prevent ecosystem collapse.

Figure 2 shows the spatial distribution of land cover according to the CORINE Land Cover (CLC) classification, using the standard scheme of the 44 thematic classes. The structure of the image reflects the functional organisation of the landscape within a peri-lacustrine territory, highlighting clear contrasts between natural areas, agricultural areas and anthropised units. Cartographic representation enables a technical analysis of the degree of fragmentation, habitat continuity, and the pressures exerted by dominant land uses.

From a morphotopological perspective, the central component of Figure 2 consists of water bodies (CLC class 512), marked in shades of blue. They form the primary hydro-ecological element of the landscape, with a relatively complex geometry, specific to areas with lake accumulations or aquatic systems with irregular banks. The aquatic perimeter is surrounded by several successive bands of land cover represented by shades of light green, turquoise green and medium green, corresponding to humid, halophilic habitats or riparian vegetation, classified in classes 3xx or 4xx of the CLC nomenclature. The presence of these multiple ecotonal transitions indicates a high degree of ecological heterogeneity, characteristic of areas with active hydrological dynamics.

Outside these riparian systems, a massive expansion of agricultural areas is observed, marked by shades of yellow, cream and light purple, corresponding to CLC classes 2xx. The area associated with agricultural lands exhibits a relatively compact distribution, with clear boundaries at the interface with natural areas. The cartographic texture indicates the presence of large-scale agricultural parcels characteristic of intensive agricultural systems. This land-occupation pattern suggests a marked uniformity in the landscape matrix, with direct consequences for the continuity of natural habitats and ecological flows.

Figure 2. Classification of macro-landscapes Lacu Sărat, Brăila County
Source: Land use data: CORINE Land Cover 2023
https://land.copernicus.eu/en/map-viewer?dataset=0407d497d3c44bcd93ce8fd5bf78596a

Urbanised areas are represented by shades of red, pink and orange, corresponding to CLC 1xx classes. They are arranged predominantly in the upper and northeastern part of the map, in the form of compact polygons, indicating the presence of a well-defined urban front. The structure of urban discontinuities, namely the alternation of built-up areas with agricultural spaces, reflects the characteristics of a peri-urban area, in which anthropogenic pressures are unevenly distributed but increase towards the northern limits of the analysed area. The distribution of woody vegetation fragments – visible in shades of dark green – is reduced and dispersed, which indicates a high degree of forest fragmentation. Such isolated patches, framed between agricultural areas and wetlands, may serve as ecological corridors, but their density and reduced continuity limit landscape connectivity.

Overall, Figure 2 presents a stratified spatial structure, characterised by a clear ecological gradient: (1) aquatic core, (2) hygrophilous vegetation ring, (3) dominant agricultural matrix, (4) peripheral urbanised areas. This organisation highlights the functioning of an intensely anthropised landscape, in which land-use dynamics are strongly influenced by agricultural and urban pressures. The concentration of built-up areas near natural areas and the proximity of agricultural crops to water bodies indicate a high vulnerability of wetland ecosystems, underscoring the importance of implementing territorial management measures to reduce habitat fragmentation and protect riparian buffer zones.

Figure 3 indicates the detailed structure of land cover according to the CLCplus Backbone 2023 dataset (10 m resolution), provided by the Copernicus Land Monitoring Service. The representation uses a classification of 11 fundamental land cover classes, derived from analysis of the Sentinel-2 time series, and is designed for high-precision spatial mapping of land use at the European level. The analysis of the figure highlights a territorial matrix dominated by agricultural lands, rendered in shades of light yellow and cream. These areas occupy most of the cartographic frame, reflecting a structural uniformity specific to intensively cultivated agricultural systems. Their continuous distribution indicates a high degree of anthropisation and a significant reduction in landscape-scale ecosystem heterogeneity.

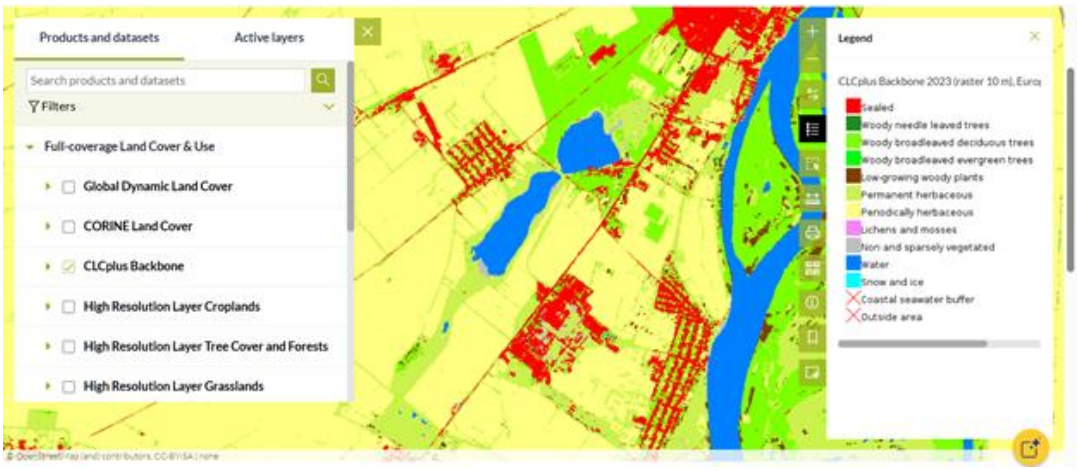

Figure 3. Zoning of Lacu Sărat landscapes, Brăila County
Source: Land use data: CORINE Land Cover 2023
https://land.copernicus.eu/en/map-viewer?dataset=0407d497d3c44bcd93ce8fd5bf78596a

In contrast, urbanised areas, represented in deep red, are distributed predominantly in the eastern and northeastern part of the figure. They form compact agglomerations associated with infrastructure and buildings, presenting regular geometries characteristic of urban developments. Their presence in the vicinity of agricultural lands and water bodies suggests a peri-urban gradient and heightened anthropogenic pressures on natural habitats.

A central geomorphological and ecological element is the water bodies, visible in blue, arranged in the central-eastern part of the figure. They define the main hydro-ecological axis of the area, serving as a hydrological retention area and supporting associated ecosystems. The cartographic configuration, characterised by clear contours and multiple connections among aquatic units, highlights active hydrological functioning at the local level.

Natural and semi-natural vegetation, represented by different shades of green, is found along the edges of water bodies and in dispersed patches. Areas with intense green indicate the presence of woody vegetation or compact arboreal formations, while light green suggests herbaceous vegetation, meadows or areas with discontinuous plant cover. The fragmentary distribution of these plant units indicates reduced ecological connectivity and a high vulnerability of natural habitats in the context of agricultural dominance.

The spatial arrangement of the land cover classes reveals a clear stratified pattern. Thus, (1) a central aquatic core is observed, (2) a perimeter ring of hygrophilous and semi-natural vegetation, (3) an extensive agricultural matrix, and (4) peripheral urbanised areas. This radial pattern sequentially reflects a landscape with a simplified ecological structure, in which natural elements are preserved as dispersed fragments within a territory dominated by anthropogenic uses. Through the texture, chromaticity, and geometry of the classes, Figure 3 suggests the presence of active processes of habitat fragmentation, particularly associated with agricultural expansion and urbanisation. The lack of continuous vegetated corridors within the agricultural matrix, as well as the direct proximity between built and natural areas, indicates increased vulnerability of wetland ecosystems and the need for territorial management measures to protect riparian areas and maintain ecological connectivity.

The simultaneous comparison of the two figures indicates that the investigated landscape is characterised by a dominant agricultural matrix, a central lacustrine component and a fragmented peri-urban area, with a differentiated but consistent distribution between the two datasets. The high resolution of CLCplus Backbone enables observation of parcel boundaries, vegetation micro-fragmentation, and fine-scale dynamics of wetlands, while CORINE Land Cover highlights clear macro-spatial structures, useful for interpreting territorial patterns at a regional scale. In both representations, agricultural areas appear as the dominant element of the landscape. The yellow and cream shades of CLCplus Backbone are compatible with the CLC 2xx classes (agricultural land), which in the CORINE figure are delimited by large polygons. The way in which CORINE aggregates agricultural areas in a generalised classification confirms their role as a primary territorial matrix, while CLCplus Backbone reveals a pronounced internal heterogeneity, specific to the fragmented agricultural systems characteristic of peri-urban areas. This contrast between detail and synthesis indicates an intensified agricultural structure, susceptible to interferences on ecological flows.

In both CLCplus Backbone and CORINE Land Cover, built-up areas (CLC codes 1xx) are represented by shades of red. The spatial pattern revealed by both figures indicates a concentration of these in the northeast and southeast of the area, with linear distributions suggesting the existence of mobility axes or an expanding urban front. In CLCplus, the 10 m resolution enables precise identification of the urban fabric and building density, while CORINE integrates them into a generalised layer, confirming the same spatial order. This parallelism highlights the compatibility of both products in detecting anthropogenic pressures, the essential difference being the level of detail. The parallel observation of the two products confirms the lack of ecological continuity, an important indicator for assessing landscape changes and the need for ecological restoration policies.

The integrated analysis of the maps reveals a landscape shaped by an intense anthropogenic gradient, in which the distribution of land uses follows a concentric structure: aquatic core, riparian ring and wetlands, dominant agricultural matrix, peripheral anthropised areas. The CLCplus Backbone enables detailed detection of spatial transitions and fragmentation at fine scales, essential for ecological analyses and local environmental planning. CORINE Land Cover, through its consolidated and scalable classification, provides a framework for territorial interpretation at regional or national level. Compared, the two products confirm the same territorial configuration, demonstrating the methodological robustness of the Copernicus tools for assessing landscape changes and anthropogenic pressures on natural ecosystems.

Conclusions

The analysis of the CLCplus Backbone 2023 data highlights a pronounced anthropised spatial structure, in which the agricultural matrix dominates the landscape, and natural elements are fragmented and constrained to marginal areas, particularly in the vicinity of water bodies. The precise distribution of land cover classes confirms the existence of a clear ecological gradient, from aquatic cores to areas heavily transformed by agricultural and urban activities, a typical pattern for intensively used peri-urban landscapes. The presence of wetlands and fragments of semi-natural vegetation, although reduced in area, is of major ecological importance, as they represent the last functional connections between aquatic and terrestrial ecosystems. However, the visible fragmentation and the pressure exerted by urban expansion and intensive agricultural use indicate a high vulnerability of natural habitats, with

direct implications for the ecological continuity and functioning of habitats of community interest. Overall, the results suggest that maintaining and restoring ecological connectivity is a major priority for the long-term conservation of natural habitats in this region. Strengthening buffer zones around water bodies, limiting uncontrolled urban sprawl and promoting sustainable agricultural practices are essential measures to reduce anthropogenic pressures. The data analysed confirm that high-resolution geospatial tools, such as CLCplus Backbone, constitute indispensable support for monitoring habitat status, substantiating management decisions and guiding conservation policies in a coherent and scientific manner.

To ensure the long-term conservation of the biodiversity of Lacu Sărat, integrated measures are needed, based on scientific principles and European best practices. Among the most important areas of intervention are permanent monitoring of water levels, salinity and habitat status; implementation of adaptive management of hydrological resources; protection of halophilic habitats against uncontrolled anthropogenic interventions; prevention of pollution and eutrophication; as well as strengthening international collaborations for data exchange and implementation of solutions based on ecological restoration.

Lacu Sărat of Brăila remains an ecosystem of national and European interest, the protection of which requires a multidisciplinary scientific approach and close collaboration between researchers, authorities and the local community. The conservation of this special natural space involves not only protecting biodiversity but also ensuring the sustainable use of its therapeutic and ecological resources in an increasingly dynamic climate.

References

European Environment Agency. 2021. *Biodiversity and ecosystem services in Europe 2021: State and trends*. EEA Report.

Orusa, T., Cammareri, D., & Freppaz, D. 2026. *GeoAI Driven Land Cover Change Prediction Using Copernicus Earth Observation and Geospatial Data for Law Compliant Territorial Planning in the Aosta Valley (Italy)*. Land, 15(4), 533. https://doi.org/10.3390/land15040533

European Environment Agency. 2025a. *CLCplus Backbone 2023 – Algorithm Theoretical Basis Document, Version 1.2.1*. https://eea.github.io/CLMS_documents/main/products/CLCplus_Backbone_2023_ATBD_v1.pdf

Brăila Environmental Protection Agency (APM Brăila). 2024. *Annual report on the state of the environment for Brăila County*, 2024.

European Commission. 2020. *Natura 2000 and the European Green Deal: Strengthening the biodiversity strategy*. Publications Office of the EU.

European Commission. 2019. *Guidelines for the Management of Natura 2000 Sites*. Publications Office of the European Union.

Maiorescu, G., Tudorache, D., Niculescu, A., Rădulescu, A., and Lăzărescu, H. 2018. *Substantiation study for the certification of the Lacu Sărat area as a balneoclimatic resort (Chiscani commune, Brăila county)*. Bucharest, Romania.

Enviro Ecosmart SRL. 2023. *Environmental Report, Intercommunity Territorial Development Plan, Lacul Sărat Resort, Brăila County*

European Environment Agency. 2025b. *CLCplus Backbone 2023 (raster 10 m) – Metadata and Technical Specifications. Copernicus Land Monitoring Service*. https://sdi.eea.europa.eu/catalogue/srv/api/records/b0bd43c6-1fa1-4d88-9c45-98b13a95d0b2

Copernicus Land Monitoring Service. 2026. *CLCplus Backbone: Product Overview and Applications*. https://land.copernicus.eu/en/products/clc-backbone

Copernicus Programme. 2025. *CLCplus Backbone 2023 (raster 10 m), Europe – Data Access Catalogue*. https://www.copernicus.eu/en/access-data/copernicus-services-catalogue/clcplus-backbone-2023-raster-10-m-europe-2-yearly-may

GAF AG, GeoVille, e GEOS & Telespazio Ibérica. 2024. *CLC+ Backbone raster product updates for the reference years 2023 and 2025*. European Environment Agency. https://www.gaf.de/app/wp-content/uploads/2024/01/GAF_PR_CLCBackbone_fin_BB.pdf