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SYSTEMATIC ANALYSIS OF THE SOIL COVER AND PEDOLOGICAL CHARACTERISTICS IN THE PERIMETER OF TEREMIA MARE LOCATION, TIMIȘ COUNTY: DIVERSITY, DISTRIBUTION AND IMPACT ON LAND USE

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Abstract: *This paper delves into a comprehensive evaluation of the soils within the specified region, aiming to elucidate their diverse nature and pedological attributes. Through meticulous mapping and classification, the study identifies a dominant presence of chernozem, accounting for 73.05% of the area's surface, alongside other soil types like eutricambosol, gleiosol, and solonetz. These soil types are intricately influenced by a combination of natural and anthropogenic factors. Elements such as the region's relief and climate, coupled with human activities like drainage and irrigation, play a pivotal role in shaping and evolving these soils. The analysis conducted on the soils of Teremia Mare is critical in evaluating their agricultural suitability, thus shaping strategic land use planning in agriculture and forestry sectors. The paper underscores the pressing need for sustainable management of soil resources, especially when faced with contemporary challenges linked to environmental conservation and the drive for enhanced economic efficiency in land utilization. In conclusion, the research highlights the urgency of adopting effective agricultural practices and informed land use policies. Such measures are essential to safeguard natural resources, ensuring that their use aligns with the principles of sustainable development. The findings emphasize that the future of the region hinges on implementing strategies that balance environmental conservation with economic growth, ensuring the longevity and health of its soil resources.*

Keywords: *soil diversity, pedological characteristics, sustainable use, land planning.*

INTRODUCTION

Pedological studies and research constitute the fundamental basis for a comprehensive understanding of soil resources, which are essential for sustainable development in agriculture and environmental management. Pedological mapping, as an integrative method, captures the entirety of observations, studies, and investigations conducted in the field, laboratory, and office, serving as an indispensable tool for identifying and delineating soil units, as well as for the development of pedological maps (FAO, 2006; MUNTEANU, 2010). This process involves a systematic series of operations encompassing morphological, physical, chemical, hydrophysical, and biological examinations, aimed both at utilizing the soil as a medium for plant production and as a construction material or a space for various socio-economic, cultural, and recreational activities.

An important aspect of agricultural land management is soil bonitation, which quantifies and assesses the growth and yield conditions of plants, as well as their suitability for specific land uses or crop cultivation. This process is conducted through a system of technical indicators and bonitation notes, contributing to the establishment of effective measures for land amelioration and optimal utilization (TEACI et al., 1987; OPREA, 2018; NIȚĂ L. et al., 2013).

The productive capacity of land is influenced by both natural factors and human interventions. In this context, soil improvement activities via agro-pedo-ameliorative works aim to enhance the intrinsic properties of the soil to increase the productivity of low-yielding lands (BRÂNZĂ, 2004; SMITH & JONES, 2015). Additionally, progressive compaction of cultivated soils is observed due to intensive and continuous use, leading to issues such as soil stratification, reduced permeability, hardpan formation, and consequently, a decline in available water resources for planting (POPESCU et al., 2012; MUNTEANU et al., 2011).

This work aims to analyze the current state of research in the field of pedology, emphasizing the applicability of knowledge in the planning and management of agricultural lands in Romania, as well as the importance of sustainable practices for conserving and valorizing soil resources in the future. In Romania, a significant proportion of agricultural land is affected by excess moisture, primarily due to a heavy, water-impermeable layer at depths of 40-50 cm, which facilitates flooding and drainage problems (Institutul de Pedologie și Agrochimie, 1971; IOAN et al., 2016). Studies indicate that over 36% of the country's surface is impacted by temporary water excess or high water table levels, negatively affecting agricultural productivity (FLOREA and MUNTEANU, 1971). Historically, practices such as deep loosening with specialized plows have proven effective in mitigating these issues; however, the need for more complex and modern amelioration interventions becomes imperative for sustainable soil resource management (COJOCARU, 1989; DOBRESCU et al., 2000).

Consequently, pedological assessment and mapping activities play a crucial role in the rational planning and management of land. In the current socio-economic context, characterized by global population growth and the necessity to conserve food supplies and natural resources, the sustainable use of soil resources has become a priority for experts in pedology and agrochemistry (FAO, 2012; PETRESCU & VASILESCU, 2019). International studies underline the importance of integrating environmental protection policies with agricultural development strategies to ensure sustainable land use (TILMAN et al., 2011).

MATERIAL AND METHODS

The research material was obtained through direct field explorations, sampling in various representative zones of the study area, and laboratory analyses. Nine genetic soil types were identified, characterized by soil profiles strategically located to cover the principal soil classes and subtypes within the analyzed territory.

Samples were collected from soil profiles, including from pristine natural areas as well as anthropogenically modified zones.

Laboratory samples were gathered in metal cylinders and containers for assessing physical, chemical, and microbiological properties.

Agrochemical samples were collected from the soil layer used for specific chemical and biological analyses.

For characterization, identification, and classification of the material, the Romanian Soil Taxonomy System (2012) and methodologies developed by ICPA Bucharest (SOIL STUDY PREPARATION

METHODOLOGY, Vol. I, II, III, 1987) were employed. These methodologies describe the morphological, physical, and chemical characteristics of each soil type, including morphological structure, texture, porosity, water table depth, pH, humus content, calcium carbonate, salinity, reactivity, infiltrability, permeability, and microbial activity.

To assess production potential and identify limiting factors for soil fertility, multidisciplinary analysis methods were applied, incorporating the following steps:

Evaluation of limiting factors, indicated by specific indicators such as salinization, alkalinity, acidity, textural composition, water table depth, and flooding susceptibility. These indicators were assessed using corresponding coefficients, and the results contributed to the development of potential and limitation maps for the agricultural land.

Analysis of relationships between factors through statistical and analytical methods, aimed at correlating indicators with ecopedological conditions, ensuring accurate interpretation of the results and identification of the most significant limiting factors.

Following the evaluation of indicators and bonitation (soil grading), the land parcels were grouped into suitability classes based on unified and standardized criteria according to national and international methodologies:

Fertility class and suitability class for various crops (e.g., cereals, fruit trees, vineyards);
Classification based on production potential and favorability degree, using numerical calculations and evaluations (bonitation notes).

The data and information utilized include climate data (annual average temperature, precipitation, gleization index, salinity, alkalinity, compaction, moisture levels); edaphic data (texture, pH, reactivity, humus and carbonate content, total porosity, water table depth); hydrogeological data (water table level, flooding, drainage, salinization); and anthropogenic data (ameliorative interventions, infrastructure works, modifications of soil profiles).
The research methodology employed in this pedological study is comprehensive, tailored to provide precise characterization of soil resources and to evaluate their agricultural potential and limitations.

The approach includes:

- Field observation (identification and delineation of land units and representative soil profiles);
- Sampling and laboratory analysis (from natural and human-modified areas);
- Laboratory determinations according to national and European standards, including chemical, physical, and microbiological analyses;

Application of bonitation methodology (to quantify and valorize production potential, accounting for natural and anthropogenic factors).
These methods enable a multifaceted, detailed, and comparable evaluation, serving as a fundamental basis for sustainable soil resource management, as well as for developing strategies for soil improvement and rational utilization.

RESULS AND DISCUSSIONS

Natural Conditions of Formation and Evolution of Soils in the commune of Teremia Mare, Timiș County

Relief

The territory of Teremia Mare commune in Timiș County is geographically situated within the expansive extracarpathian relief zone called the "Tisza Plain," a major geomorphological unit in the region. It is located at the easternmost boundary of this unit, within the central part of Romania's Western Plain, also known as the Banato-Crișana Plain. Specifically, the area lies within the Nordic Banat Plain, positioned on the interfluve between the Mureș and Bega rivers, which influences local hydrological and ecological dynamics. The terrain exhibits features typical of a divergence, accumulation, and subsidence plain, with distinct alluvial terraces that are arranged in an alternating step-like pattern. These terraces follow the course of the Aranca River, which has shaped the landscape through ongoing sedimentation and erosion processes. The entire investigated region can be classified as the "Aranca Plain," a zone characterized by its flat topography, rich alluvial deposits, and significant geomorphological activity driven by fluvial dynamics. This landscape creates favorable conditions for agriculture due to its fertile soils and layered terraces, while also highlighting the complex sedimentation history driven by water flow, climate, and geological processes.

Geology and Lithology of Surface Deposits

From a geological perspective, the perimeter under study is situated within the complex processes of formation and evolution of the Western Romania Plain, which is part of the extensive Pannonian geomorphological unit. This region has experienced multiple phases of genesis and development driven by both climatic and tectonic factors over geological timescales. After the waters of the ancient Pannonian Lake receded, the resulting dry land was precariously shaped by subsequent fluvial and alluvial processes. For a prolonged period, this landmass was continually exposed to flooding episodes caused by waters descending from nearby mountains and hilly terrains, which transported abundant alluvial sediments from traversed areas. Over time, as the riverbeds stabilized and the watercourses established their current courses, the quantity of alluvial sediment deposition markedly decreased. Nonetheless, sedimentation did not cease entirely; it was supplemented by significant aeolian processes, with wind-blown dust particles continuously settling in the area. This ongoing sedimentation, through the accumulation of fine dust and silt, contributed to the formation of loess-like deposits, which are characterized by their fine-grained texture and pale coloration. These geological processes collectively contributed to shaping the landscape, establishing fertile soils, and influencing the region's geomorphological and pedological characteristics. This dynamic sedimentation history highlights the region's importance as a geomorphologically active area with a legacy of both fluvial and aeolian influence.

Climate

The climatological characterization of the Teremia Mare area was based on data from meteorological stations: Sânnicolau Mare and Timişoara, and was cross-referenced with the "Romanian Climatological Atlas." The meteorological data used span the periods 1896–1955 and 1992–2023.

The average annual temperature recorded at Sânnicolau Mare was 10.8°C during 1896–1955 and 10.9°C during 1992–2023.

Hydrology and Hydrogeology

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Hydrologically, the studied territory lies within the arched boundaries of the Aranca River basin, which is an integral part of the larger Aranca drainage system. Historically, this basin overlaps extensively with the ancient, parallel courses of the Mureș River, which prior to the construction of embankments, were prone to frequent and often severe flooding caused by high water levels. Today, the Aranca basin still remains under the influence of the Mureș's high waters, with an underground hydraulic connection ensuring continuous water exchange between these two water bodies. The springs of the Aranca River are situated near Felnac, an important hydrological node where the left bank of the Mureș River originates, highlighting the complex subterranean and surface water dynamics in the region. Its principal watercourse traverses the national border with Yugoslavia and ultimately discharges into the Tisa River south of Denta, at Padeș. The entire Aranca system drains an area of approximately 1,016 square kilometers within Romania, and its main channel extends for about 108 kilometers to the border. The basin can be described as a dynamic divergence zone, characterized by significant alluvial deposits resulting from ongoing sedimentation processes. Despite this, the basin benefits from natural and artificial protections that shield it from large-scale floodwaters, thus maintaining a delicate hydrological balance crucial for regional land use and ecosystems.

Vegetation

The territory of Teremia Mare commune is situated at the interface between the Danube Steppe zone and the forest-steppe subzone.

Initially, the species diversity was very high; today, only a few associations remain, including *Phragmites australis*, *Calamagrostis pseudo-praghmites*, *Carex*, *Juncus*, etc., and these are increasingly rare.

Alongside water drainage and the reduction of excessive soil moisture in the Western Plain, the vegetal cover has contracted, giving way to forest-steppe formations, composed of herbaceous and woody associations.

Owing to the hydrological, pedo-phyto-climatic changes described earlier, the steppe vegetation is increasingly establishing and consolidating within the studied area, characterized by mesophilic and halophilic plant communities.

Mesophilic vegetation is most frequently represented by species such as *Festuca sulcata, Koeleria cretica, Salvia pratensis, Salvia austrica, Centaurea mironithus*, etc.

Exophytic, herbaceous vegetation includes xerophyte elements like *Agropyron cristatum*, perennial *Lolium, Bromus inermis, Pca bulbosa, Cynodon dactylon, Euphorbia clarkii*.

Halophilic vegetation occupies the saline and alkaline soil surfaces and is represented by a very limited number of species, such as *Festuca pseudovina, Poa bulbosa var. vivipara, Nostoc halodes, Aster tripolium, Atriplex littoralis, Gypsophila muralis, Poa annua, Statice gelleri, Artemisia monogyna, Salina variants, Pacinelia distans, Champhorosma ovata, Hordeum histrix, Matricaria chamomilla* var. *salina, Polygonum aviculare, Atriplex littoralis, Tripolium ordinopoides, Lathyrus tenuis* etc.

Cultivated woody vegetation includes common acacia, Japanese acacia, mulberry, plum, walnut, Canadian poplar, as well as plants along road edges and within village centers.

Anthropogenic influence

The ongoing development of agriculture has led to increasingly intensive utilization of soil resources. Coupled with extensive mechanization, fertilization, and hydroameliorative land improvements within the investigated perimeter, these activities have significantly altered the natural conditions for pedogenic processes and soil properties.

The most significant modifications to pedogenic conditions are primarily attributable to land regulation works, drainage, and irrigation systems, alongside embankment efforts. Subsequently, these interventions have been complemented by the replacement of natural vegetation with cultivated crops, the increasing application of mineral fertilizers, intensive soil tillage using mechanical methods, often without careful discernment of equipment use on insufficiently dried land, and the reduction of areas occupied by perennial grasses and legumes, among other practices.

All these human interventions have impacted the regime of nutrients and the hydrological cycle within the soil profile. Changes have been observed in the circulation of water both at the surface and within the soil, thus affecting the element cycle and nutrient budgets in the soil layers. These processes have altered their rates of development or are currently in the process of modification in response to evolving environmental conditions.

Of particular importance for enhancing the productive potential of soil resources within the studied area are measures aimed at preventing and combating excess groundwater (phreatic) moisture and surface runoff from precipitation.

Hidroameliorative works that commenced over two centuries ago have gained substantial magnitude in recent times, with nearly the entire researched area traversed by an extensive network of drainage canals. These interventions have had a positive effect on pedoclimatic processes; however, they have not entirely resolved issues related to excess moisture, especially surface excess moisture.

To ensure sustained production and improve soil quality through active management, humans must promote processes within the soil that lead to the concentration of nutrients and organic matter. Therefore, to prevent physical degradation of the soil, it is necessary to minimize soil preparation works to the essential level, carry out agronomic activities at optimal soil moisture conditions, and ensure a soil structure conducive to the cultivation of ameliorative plant species.

Distribution of Soils by Types

The main soil types encountered within the perimeter of Teremia Mare locality, Timiș County, are summarized in Table 1.

Table 1

Soil Types

Soil Type	**Surface Area (ha)**	**Percentage (%)**
Chernozem	5516.6	73.05%
Eutric Cambisol	110.25	1.46%
Gleysol	42.12	0.56%
Solonetz	74.34	0.99%
Vertisol	545.95	7.23%
Alluvial Soil	150.48	2.00%
Associations	1019.66	13.50%

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TOTAL	**7551.18**	**100.00%**

Chernozem (73.05%) is by far the most widespread soil type in the area, covering over 73% of the surface. This soil type is extremely significant for agriculture, recognized for its high fertility, making it ideal for the main crop productions.

Vertisols (7.23%) rank second in distribution, covering more than 7% of the land. Characterized by cracking and swelling effects, these soils also hold agricultural importance, although they may require liming and other ameliorative measures to improve productivity.

The soil associations (13.50%) include groups of soil types that are less homogeneous or more complex, which cannot be definitively categorized under a single soil type, and they occupy a substantial proportion (over 13%) of the area.

The other soil types (Eutric Cambisol, Gleysol, Solonetz, Alluvial Soil) cover relatively small areas, each less than 2%, indicating a moderate diversity of soils, with specific types associated with particular pedoclimatic or geological conditions.

The dominance of Chernozem indicates a zone with high agricultural potential, where the main crops can be supported across most of the territory.

The relatively low presence of saline soils and Gleysol suggests that areas with salinization or excess moisture issues occupy smaller land portions but could significantly impact agricultural activities if not managed properly.

The diversified distribution within the associations reflects a range of pedogeographical conditions, which may necessitate tailored solutions for soil improvement and sustainable use.

For agricultural planning and land management, this distribution provides a foundational basis for selecting suitable crops, implementing soil amelioration measures, and establishing soil conservation strategies.

The studied area should primarily focus on the utilization and preservation of Chernozem zones, while paying considerable attention to areas with special soils, such as salinized soils and Gleysol, to ensure sustainable and productive land use.

Description of the Morphological Properties of Representative Soils in the Studied Area

Alluvial Gley Soil (Aluviosol Gleițificat), formed on medium deposits, clay-loamy/sandy-loamy

Ap (0–17 cm)-Granulometric composition predominantly clayey-sandy, light brown color, granular structure with moderate development, excessively porous, weakly compacted, friable, with a stepwise transition.

Ao (17–29 cm)-Granulometric composition mostly clayey-sandy, light brown color, medium-developed granular structure, weakly compacted, friable, with a gradual stepwise transition.

ACg (29–41 cm)-Granulometric composition clayey-sandy, yellowish-brown color with rare purple spots, massive polyhedral structure, low degree of compaction, moist, with a smooth transition.

CGO (41–66 cm)-Granulometric composition clay-loamy, light brownish-yellow color with traces of purple, large polyhedral structure, medium porosity, slightly compacted, slightly moist, with a smooth transition.

IICGO (66–90 cm)-Granulometric composition clay-loamy, brownish-yellow with slight purple spots, well-defined polyhedral structure, normally porous, weakly compacted, contains small veins, moist, with a stepwise transition.

IICGO (90–125 cm)-Granulometric composition clay-loamy, light brownish-rusty color, slight purple hue, large polyhedral structure, weakly compacted, contains small veins, friable, with a smooth transition.

IVCGr (125–172 cm)-Granulometric composition clay-loamy, reddish-brown with a slight purple hue, slightly purple, massive well-defined structure, weakly compacted, contains small veins, slightly moist.

Chernozem, Weak Gleysol, Slightly Alkaline, Weak Demarcated Beneath 110 cm, Weakly Calcareous, Very Deep, on Loessoids of Medium-Fine Composition, Medium/Medium Loamy

Ap (0–24 cm)-Granulometric composition predominantly clay-loam, medium loamy, dark brown in wet conditions, with a similar color; disturbed structure, firm variable, cohesive, loose, containing rare fine roots, with a clear transition.

Aph (24–39 cm)-Granulometric composition medium loam-clay, dark brown, well-defined granular structure, densely compacted due to tillage, very firm, and moist, displaying medium cohesion when dry, with a distinct transition.

Am (39–51 cm)-Granulometric composition medium clay-loam, dark brown, small granulate structure but well developed, firm when moist, with a smooth transition.

AC (51–65 cm)-Granulometric composition medium clay-loam, light brown, with small polyhedral particles, moderately developed, slightly firm when moist, moderately cohesive when dry, effervescent at points.

Cak (65–79 cm)-Medium loam-clay granulometry, reddish-brown color, very firm, poor plasticity and hard, with concretions, efflorescences, and $CaCO_3$ spots, moderately effervescent.

Cca (79–98 cm)-Medium loam-clay granulometry, light yellowish-brown when wet, very firm, with poor plasticity and hardness, containing concretions, efflorescences, and $CaCO_3$ spots, with evident effervescence.

Eutric Cambisol on Medium Fluviatile Deposits

Ap (0–15 cm)-Granulometric composition medium loam-clay, dark brown, with particles arranged in a medium-developed, medium-compacted, friable, smooth transition granular structure.

Ao (15–34 cm)-Granulometric composition loam-clay, brown, with particles organized in a small, poorly developed subangular polyhedral form, densely compacted, friable, with a smooth transition.

Bv (34–59 cm)-Granulometric composition loam-clay, yellowish-brown, with particles arranged in a medium-developed, medium-porosity, compact, subangular polyhedral structure, containing small veins, friable, and with a smooth transition.

BC (59–83 cm)-Medium (loose) granulometry, light brownish-yellow, with particles of a poorly developed, medium-porosity subangular form, fairly loosened, with a smooth transition.

CG (83–106 cm)-Loosely granulometric composition, yellowish-brown with slight purple spots, with massive, compact particle arrangement, containing small veins, and a smooth transition.

IICG (106–129 cm)-Loamy granulometry, pale yellowish-muddy color, sometimes with slight purple hues, a massive, compact horizon, containing small veins, and a smooth transition.

Typical Gleysol on Fluvial Deposits, Loessic/Loess

Ao (0–21 cm)-Granulometric composition predominantly clay-loam, brown, with well-developed granular structure, medium compact, friable, and moist, with a smooth transition.

Aog2 (21–38 cm)-Granulometric composition clay-loam, light yellowish-brown, with medium-developed subangular polyhedral particles, moderately porous, fairly compact, friable, contains small veins, slightly friable, with a smooth transition.

AoG3 (38–66 cm)-Medium loamy granulometry, brownish-yellow, with medium-developed, medium-porosity, compact horizon, containing small veins, slightly friable, with a smooth transition.

G4 (66–89 cm)-Medium loamy granulometry, yellowish-brown with numerous purple spots, medium massiveness, compact, contains small veins, smooth transition.

G05 (89–111 cm)-Medium loamy granulometry, muddy yellowish-brown, slightly purple, massive and compact, contains small veins, friable.

Molic Solonetz, Proxicalcaric, Saline

Ațelnasck (0–14 cm)-Medium loam-gravel granulometry, dark brown, with granular particles, medium cohesion, slightly cemented, non-tillable, weakly effervescent, exhibits neoformations of $CaCO_3$, with a clear transition.

Amnasck (14–29 cm)-Medium loam granulometry, very dark gray, with small, poorly developed subangular polyhedral particles, moderately cohesive, with medium-sized, frequent pores, weak effervescence, presence of $CaCO_3$ efflorescences, with a clear transition.

Btnak (29–79 cm)-Medium loam granulometry, pale yellowish-brown, with rare purple spots, with columnar particle arrangement, compacted, with clay films on structural faces, moderate effervescence, $CaCO_3$ concretions, and salts.

CnascGok (79–124 cm)-Medium loam granulometry, brownish-yellow, with frequent purple spots, with undefined particle arrangement, medium cohesion, poorly cemented, moderately compacted, small and frequent pores, strong effervescence, evident $CaCO_3$ concretions and salt efflorescences.

Vertisol, Moderately Debilitated, Decarbonatic, on Collapsing Clays, Loamy-Clay-Loam

Ap (0–15 cm)-Loam-clay texture, brown, with medium subangular polyhedral structure, moderately developed, small porosity, compact, friable, with gradual transition.

AoW2 (15–25 cm)-Granulometric composition clay-loam, brown with slight purple spots, with medium-developed, medium-porosity, slightly cemented, very small pores, compact, friable, with a smooth transition.

AbyW3 (25–38 cm)-Clay-loam granulometry, brownish with purple spots, with angular polyhedral particles, well-developed, very porous, very compact, friable, with a smooth transition.

BtyWs (38–49 cm)-Clay-loam, yellowish-brown with purple spots, with prismatic particles, very lightly porous, strongly compacted, friable-to-lilac, with a smooth transition.

Bt2yW4 (49–80 cm)-Loamy-clay-loam, yellow-brown, slightly purple, prismatic structure, small pores, very compact, friable-to-lilac, with a smooth transition.

Bt3yW5 (80–115 cm)-Loamy-clay-loam, yellow-brown, with prism-shaped particles with slip faces, friable-to-lilac, with a smooth transition.

BCyW5 (115–140 cm)-Loamy-clay-loam, yellowish, muddy purple-brown, with evident slip faces, very dense, friable-to-lilac, with a smooth transition.

CONCLUSIONS

The pedological analysis revealed a significant diversity of soil types within the studied area, with a clear dominance of Chernozems (over 73%), indicating a high agricultural potential and remarkable natural fertility. These soils, being rich in humus and possessing favorable physico-chemical properties, represent an essential resource for the sustainable development of local agriculture. However, to maintain and enhance fertility, the implementation of sound soil management practices—such as crop rotation, proper fertilization, and structural conservation measures—is imperative.

The presence of soil types such as Vertisols, Eutric Cambisols, Gleysols, and Solonetzes underscores the complexity of the pedological coverage. These soils are often more sensitive to climatic and anthropic factors and require specialized management approaches. In particular, Gleysols and Solonetzes are affected by excess moisture and salinization, necessitating specific interventions involving drainage and amelioration techniques to ensure efficient and sustainable land use.

The influence of natural factors on soil formation is reflected by the relief, characterized as a divergence plain with alluvial deposits and loessoid materials, which played a crucial role in the development and evolution of these soils. Sedimentation processes associated with alluvial deposits and aeolian sedimentation have led to the formation of well-developed soils with clay and loam horizons, favorable for both intensive and extensive agriculture. Moreover, the moderately temperate climate, with an average annual temperature around 11°C, supported the development and maintenance of these soil types.

Anthropogenic modifications and influences—such as hydromechanical works (canalization, drainage, irrigation), the use of fertilizers, and modern agricultural technologies—have significantly impacted soil quality and physico-chemical properties. These activities have contributed to both the mitigation of certain limitations and changes in nutrient cycling and soil physical structure. For example, the proper application of irrigation and soil aeration techniques has proven essential for controlling excess moisture and preventing excessive compaction.

Combined, human activities and natural factors have led to persistent issues such as relative salinization and gleying, which directly affect productivity. It is vital to adopt integrated management strategies that address soil compaction reduction, salinity mitigation, and proper moisture regulation to preserve the ecological and agricultural functions of these lands.

The integration of pedological, geomorphological, climate, and hydrogeological data allows for the development of sustainable management programs that optimize the agricultural potential of the area while minimizing degradation risks. In this context, clear differentiation of soil types and identification of specific limitations should guide land use policies, the implementation of amelioration technologies, and measures aimed at conserving natural resources.

The need for sustainable management and tailored interventions—promoting modern agricultural practices based on concrete pedological data and adhering to principles of environmental conservation—can ensure the maintenance and increase of agricultural productivity over the long term.

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