

Article

Saline Soils: A Potentially Significant Geoheritage of the Vojvodina Region, Northern Serbia

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Abstract: Halomorphic (or saline) soils, are characterized by high concentrations of soluble salts or sodium, or both. Saline soils have unfavorable agricultural properties but provide the natural habitats for a variety of highly specialized plants, animals, and other organisms. It is these special interactions that create the typical landscape of saline soils, known as “slatina”. The aim of this study is to assess and evaluate the geotouristic potential of six of the most attractive slatina sites in the Vojvodina region, Northern Serbia: Jegrička, Slano Kopovo, Rusanda, Okanj, Pečena slatina, and Pašnjaci Velike Drolje. Overall, all analyzed sites have significant tourism potential, based on both natural and tourist values. In addition to the tourism potentials, analyzed sites have high value as a natural endemic ecosystem inhabited with highly specialized plants and birds.

Keywords: saline soil; slatina; Vojvodina region; geotourism; geoheritage

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1. Introduction

Although soil can be defined differently based on its specific purpose in nature or human society, in all definitions one fact remains the same—soil is one of Earth's most important natural resources. Throughout history, soils have provided the foundation for most of the critical aspects of civilization [1,2]. Soils are the basis of food production systems, and the cultivation of vegetation for food, fiber, and fuel. In addition, soils play a key role in regulating Earth's climate, and help to provide for clean water and help to preserve our cultural heritage and landscapes. Soils are the host to ≈25% of our planet's biodiversity, including most animals, plants, and many microorganisms [3].

Soils are complex and diverse natural systems, with broad spectra of chemical, physical and biological properties. Recently, pedodiversity has become a topic of some importance, while topics related to the role of soils in natural and cultural heritage are less commonly discussed [4,5].

Halomorphic (or saline) soils, are characterized by high concentrations of soluble salts or sodium, or both. These soils have minor importance for agriculture due to their saline characteristics [6–8]. Nonetheless, saline soils are widespread worldwide, occupying ≈950 Mha (≈7%) of Earth's total land, or nearly 33% of potential agricultural land area [9,10].

Despite the generally unfavorable agricultural properties of saline soils, they often serve as a unique ecosystem, as they are often inhabited by extremophilic organisms with very specific adaptation strategies. The true value of salty soils lies also in the treasurable endemic natural ecosystems which they host. Saline soils provide the natural habitats for a variety of highly specialized plants, animals, and other organisms. It is these special interactions that create the typical landscape of saline soils, known as “slatina”. Here, these landscapes are primarily located in the northern part of Serbia, i.e., in the Vojvodina region. This region is well known for its intensive agricultural production with $\approx 75\%$ of its territory under crops and other agricultural usage [11]. In the Vojvodina region, saline soils comprise only a small group of soils not influenced by agricultural production. Thus, slatina zones preserve many relict components of the natural landscape and provide high potentials for the development of geotourism and other sustainable activities important to rural development.

The aim of this study is to determine the current state and geotourism potential of six of the most attractive slatina sites in the Vojvodina region. To achieve this, the first step was to create a methodology encompassing all the important elements necessary for such an assessment. Therefore, the principal goal of this paper was to construct a unique soil assessment model for the assessment of soil sites as tourism destinations. By applying this methodology on the six selected slatina sites, the main intention was to detect and show which sites have the largest potential for future geotourism development and to provide information about key elements of the current tourism offer that still require improvement.

2. The Main Characteristics of Saline Soils in Vojvodina

Saline soils typically develop in arid and semi-arid climate zones, as well as in coastal regions in all climate zones. However, the occurrence of saline soils in Vojvodina (Figure 1) is not completely related to the climatic conditions. Instead, the formation of saline soils in the Vojvodina region is primarily dependent on local geomorphological and hydrological characteristics.

In this region, salts derive from the Alps and Carpathian Mountains, which surround the Pannonian Plain on the eastern, northeastern and northern sides. Salts are primarily produced after weathering of the different eruptive and metamorphic rocks, and transported by rivers to the alluvial lowlands of the Vojvodina region. In Vojvodina, saline soils on alluvial plains of the Danube, Tisa, Sava, Begej, and Tamiš Rivers, as well as on river terraces, are especially endangered. Saline soils here can be considered hydrogenic in origin, having formed due to the ascending and descending movement of salts in saline groundwater [12]. During the seasonal fluctuations of groundwater or during the upwelling of salinized deep thermo-mineralized waters, significant amounts of salts accumulate in the upper layers of soils, particularly in depressional areas [13]. For that reason, saline soils in Vojvodina are mostly found in alluvial river plains or in depressions of relict fluvial land forms, characterized by shallow water tables. Here, saline soils are widespread within wetlands, where they are intermixed with salt lakes, salt marshes, and salt flats.

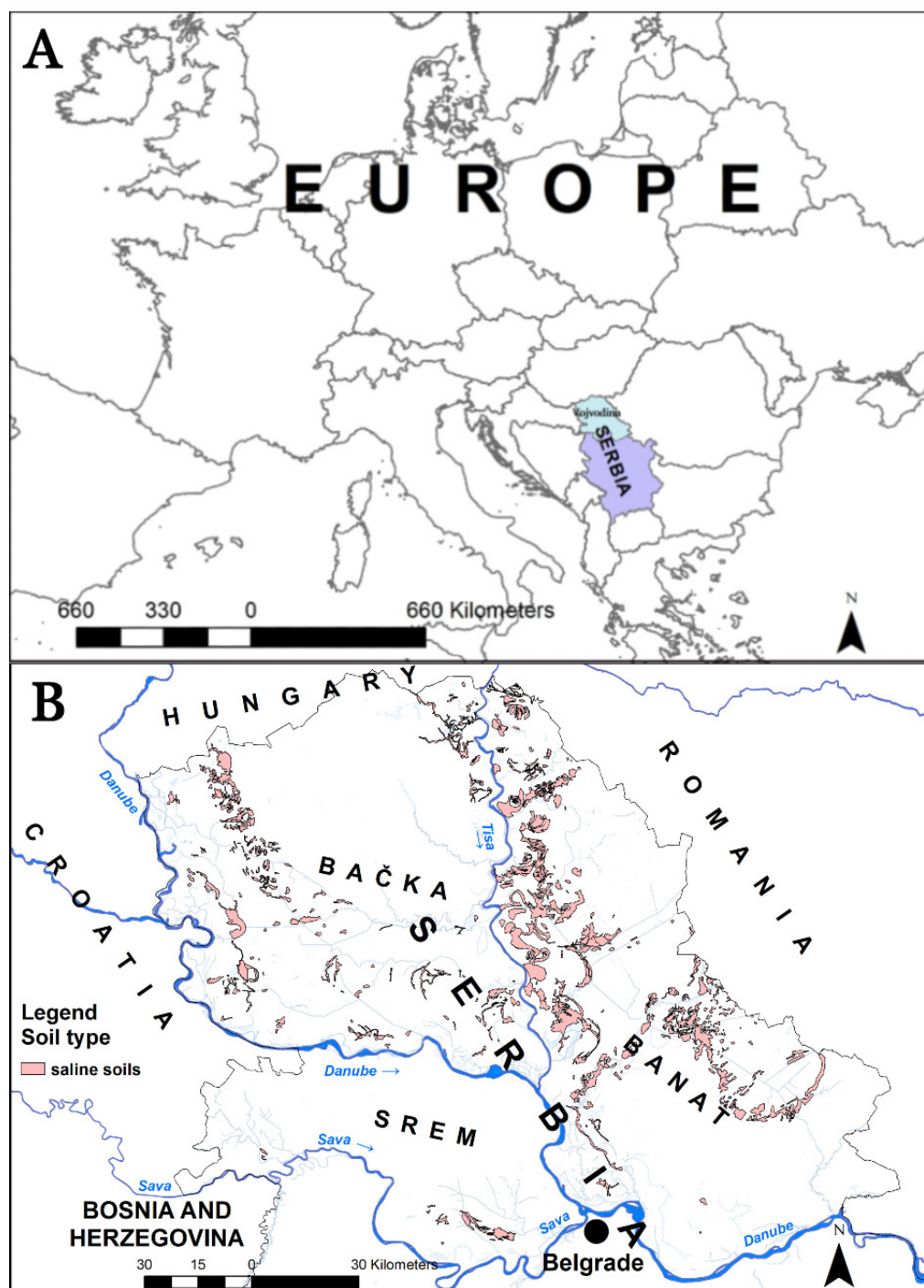


Figure 1. The geographical position of (A) Serbia and the Vojvodina region, and the distribution of saline soils across the Vojvodina region (B).

The investigations of saline soils in the Vojvodina region began in the second half of the 19th century, when the region was part of Austro-Hungarian Empire [14]. Successive studies were completed by Sigmond [15–17] and Treitz [18–20].

The systematic pedological mapping of Vojvodina accelerated the exploration of the characteristics of the region's saline soils. This endeavor was then boosted by the growth of intensive agricultural production [21,22]. In recent decades, this kind of research on soils has waned, even as the investigation of saline soils from different aspects, such as biological and environmental, started to grow.

Based on previous intensive research on saline soils, it has been estimated that halomorphic/saline soils cover $\approx 10.6\%$ of total territory of the Vojvodina Province [23]. However, because the process of salinization is more rapid than most of other pedogenic processes, saline soils are susceptible to changes in their soil taxonomy status, even over short timespans. In addition to the natural processes responsible for saline soils genesis, secondary salinization can occur due to human activities, mainly by irrigation with slightly saline water, or generally by irrigation coupled with poor drainage conditions. Because of the widespread occurrence of irrigation worldwide, coupled with global climate change toward (in many areas) increase aridity, salinization processes are increasing the extent of halomorphic soils every year [24].

According to Serbian soil classification [25], the morphology, i.e., thickness and distribution of pedogenic horizons, of halomorphic soils are not typically the best diagnostic criteria for their classification. Due to the strong influence of the Russian school of pedology in Serbia, saline soils here are typically classified within two general groups: solonetz and solonchak. Recent investigations confirm that in the Vojvodina region, the primary saline soils fall within the solonchak and solonetz categories. The main characteristics of solonetz and solonchak are summarized in Table 1.

Table 1. Main characteristics of solonetz and solonchak soils in Vojvodina.

Soil Type	Main Characteristics
Solonetz	<p>Salt content usually ranging 0.15–0.25% in Bt horizon.</p> <p>Characterized by relatively shallow surface A/E horizon and a thick Bt horizon with over 15% of adsorbed sodium ions (Na⁺).</p> <p>The surface A/E horizon has a weakly acidic pH reaction, as a result of leaching of carbonates and water-soluble salts.</p> <p>Occupy the surface of 75,000 ha in the Vojvodina Region.</p>
Solonchak	<p>Containing at least 1% of salt (chloride and sulfate salinization) or more than 0.7% (sodic salinization), in any horizon up to 125 cm of depth.</p> <p>The internal morphology is often structured as Asa/E-Bt-BtC and as Asa-AC-C.</p> <p>High alkaline pH values of soil in all horizons due to the intensive alkalization process.</p> <p>Characterized by extremely low microbiological activity and the low number of individual groups of microorganisms in the surface saline layer.</p> <p>Occupy the surface of 15,000–25,000 ha in the Vojvodina Region.</p>

All solonetz and the vast majority of solonchaks in Serbia have horizonation of A/E-Bt-BtC and have generally formed in either alluvium or loess deposits. The soil depth in solonchak soils is usually limited by a high water table, with high salt content (Figure 2).

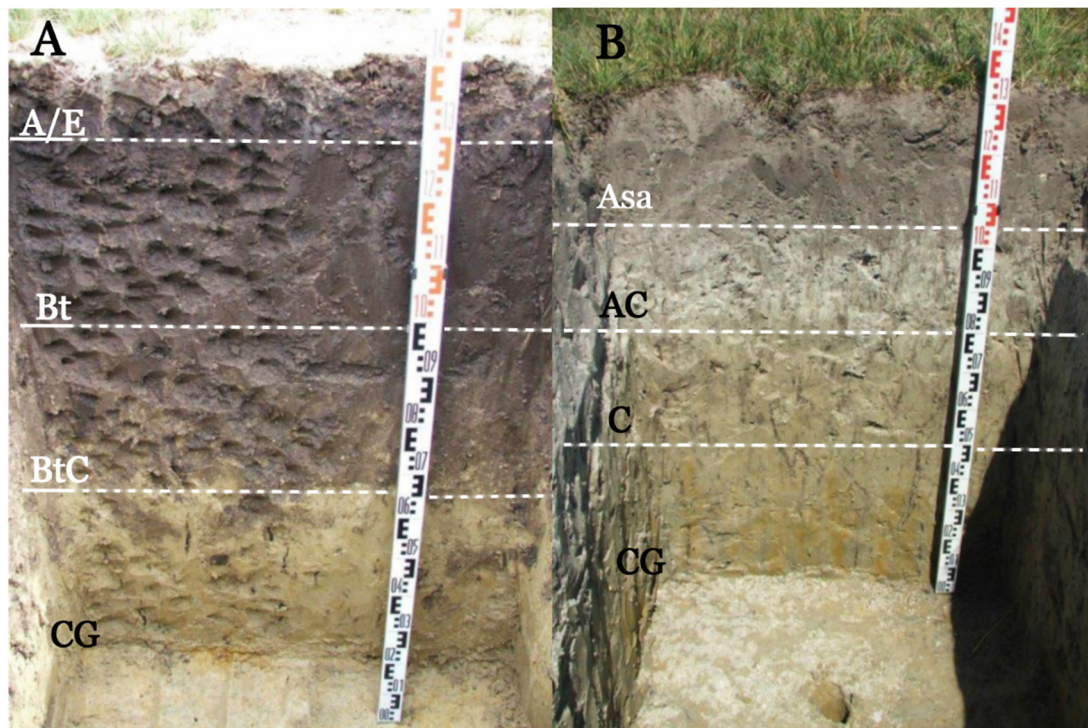


Figure 2. Internal morphology of a solonetz (A) and a solonchak (B) soil in the Vojvodina region. The highest salt concentrations are present in A/E soil horizons. Photos by Jovica Vasin.

Saline soils are important as habitats for highly specialized vegetation communities. This abiotic–biotic coupling creates a characteristic slatina landscape (Figures 3 and 4).



Figure 3. The slatina landscape at the Slano Kopovo locality, showing saline soils as patches of white. Intervening area with vegetation also have less-salty but still saline soils. Photo by Lazar Lazić.



Figure 4. The slatina landscape at the Slano Kopovo locality. Note the white salt crust on the soil surface, and the general lack of macrovegetation. Photo by Lazar Lazić.

Halomorphic vegetation has clear endemic characteristics. For example, succulent plants like *Salicornia europea* L. (Figure 5) Slano Kopovo is the only remaining habitat in Serbia, while *Suaeda pannonica* (G. Beck) Ascherson & Graebner was confirmed at only three localities—Slano kopovo, Rusanda and Okanj bara [26]. Those two species plus *Suaeda maritima* (L.) Dumort. and *Salsola soda* L. are characterized for solonchak soils.



Figure 5. *Salicornia europea*. Photo by Dubravka Milić.

In the past, significant effort has been made to protect and preserve saline soil habitats as biologically valuable areas. Figure 6 shows that minor areas of slatina landscapes are now included in protected zones. We argue that more of these landscapes should be evaluated and protected in the future. Examples of areas currently protecting saline soils are the Special Nature Reserves Slano Kopovo and Okanj bara, as well as Nature Park Rusanda (Figures 6 and 7), which represents one of the last preserved areas with endangered ecosystems such as salt pans and marshes, as well as saline and steppic meadows with specific pannonic endemic diversity, involving primarily euhalophytic

flora [26]. These protected areas also have international importance; as IBA areas (important bird area), IPA areas (important plant area), and as proposed for a NATURA 2000 area. Beside this, Slano Kopovo is a Ramsar site (wetland of international importance) and Emerald network (declared an Area of Special Conservation Importance (ASCI)).

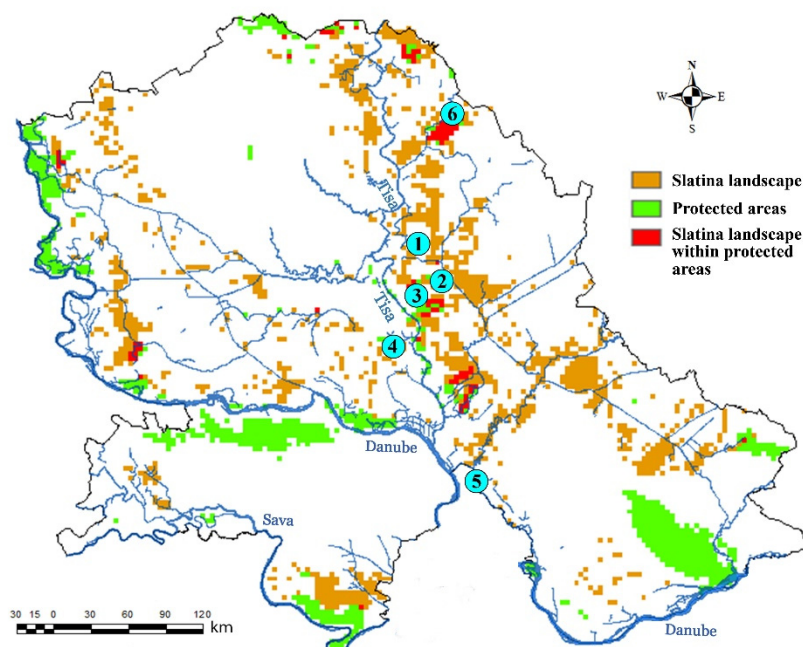


Figure 6. Map of slatina landscapes in the Vojvodina region within and outside of otherwise protected areas: ①—Slano Kopovo, ②—Jegrička, ③—Rusanda, ④—Okanj Bara, ⑤—Pečena Slatina, ⑥—Pašnjaci Velike Droplje.

3. Study Area

In this study, we selected six of the most attractive sites in the Vojvodina region: Jegrička, Slano Kopovo, Rusanda, Okanj, Pečena slatina, and Pašnjaci Velike Droplje (Figures 6 and 7).

Slano Kopovo is located at the northern part of the Vojvodina region, between regional roads Novi Bečej-Novo Miloševo-Kikinda and Novi Bečej-Bašaid (Figure 6 –①). The saline soils here have been preserved in paleomeander on a terrace of Tisa River [27,28]. This relict fluvial landform is worthy of the attention of a variety of natural science scholars, as well as other types of visitors (Figures 3, 4 and 7). Until now, Slano Kopovo was mostly known as an important ornithological site, protected as a Ramsar wetland habitat (<https://www.ramsar.org/>, accessed on 25 March 2021). However, geomorphological, hydrological, pedological and other biological characteristics of this Special Nature Reserve also have great potential for ecotourism. Particularly interesting is the experience during the summer dry season, when the shallow surface water evaporates and the basin becomes completely white with salts, contrasting well with the surrounding green to yellow agricultural fields. We regard this site as an ideal interpretative example of the soil salinization process. Slano Kopovo is also famous due to its unusual atmospheric effects, such as Fata Morgana (superior mirage) and local turbulent air circulation [29,30].



Figure 7. The various saline soil landscapes discussed in this paper (A)—Slano Kopovo, (B)—Jegrička, (C)—Rusanda, (D)—Okanj Bara, (E)—Pečena Slatina, (F)—Pašnjaci Velike Droplje. Photos by Slobodan Marković, Lazar Lazić and Tijana Đorđević.

The Jegrička River basin covers $\approx 60,000$ ha in the central part of the Vojvodina region (Figure 7B). Large paleomeanders associated with the Jegrička River indicate that they are relict features from the last glacial (paleo-Danube) channel. The original Jegrička watercourse has become an integral part of a complex canal network of the multi-functional Danube–Tisa–Danube hydro-system. Jegrička has a conductive regime, notably in the upper and middle parts, where its bed is partly regulated. The length of the watercourse is approximately 65 km, with a mild longitudinal fall of approximately 4–5 cm/km. The channel width varies in the range of 2–3 m (in the upper part) to >100 m, where the watercourse spills over the surrounding natural depressions and becomes stagnant in wetland areas. The water depth in most watercourse sections is in the range

of 1–2 m, and therefore, the gravity inflow into Tisa River is supported by a pumping station with a capacity of $2.0 \times 8.0 \text{ m}^3/\text{s}$ [31].

In this study we focus on the saline soil landscape in Jegrička valley between Žabalj on the west and Tisa River in the east. Here, the Jegrička River has been transformed into a fish pond near the regional road Novi Sad-Zrenjanin.

Rusanda (or Velika Rusanda) is one of the largest alkaline salt lakes in Serbia (Figure 7C). It is located in the central part of the Vojvodina region, near western side of Melenci settlement, 16.5 km northwest of the City of Zrenjanin. Like Slano Kopovo, this site also has formed in a paleomeander of a Tisa River terrace [27,28]. The lake at Rusanda has, therefore, slightly elongated and curved shape (Figure 7). It is a shallow, semistatic water body with a maximum depth of less than 1.5 m, which is achieved during the spring season. The approximate aquatoria of Lake Rusanda is 1.5 km². The noteworthy characteristic of this lake is its muddy springs on the lake bed. Unlike most freshwater lakes, this saline lake is a closed system (without outflow) fed by surface inflow (runoff), direct precipitation and different ground water sources including the upflow of abyssal waters [32].

Spa “Rusanda” is the rehabilitation resort located on the northern shore of Lake Rusanda, in the Melenci settlement. Since it was founded in 1867, the spa has had a reputation for rehabilitation, based on the assumed healing properties of the mineral peloids (mud), extracted from the lake. Local peoples believe that this mud is one of the best in the country for its healing properties. The bottom of the lake is covered in an extremely pure, non-organic mud, the scent of which resembles sulfure-hydrate. The lake’s water is like sea water—high in salt and alkaline. The spa also hosts a thermal, mineral water well, with a water temperature of 32 °C. The thermal water, classified as having sodium hydro-carbonate sulfide hemotherms, is used for hydro-therapeutic purposes [33]. Development of the geotouristic site will further enhance the existing tourist appeal of this specific destination.

Several other paleomeanders, located between Taraš, Kumane, Melenci and Elemir settlements, are preserved on the terrace of Tisa River [27,28]. Okanj bara represents one of the last preserved areas, with its endangered ecosystems of salt pans and marshes, and steppe meadows with endemic Pannonian biodiversity that includes primarily euhalophytic flora, rare insects, amphibians, birds and mammals (Figure 7D). Because of its natural values, the Institute for Nature Conservation of Serbia proposed in 2008 that Okanj bara be set aside for protection as an exceptionally significant natural domain [26]. Okanj, Čikoš and Crvenka lakes, as well as several former Tisa river channels, represent good examples of different stages in development of several generations of paleomeanders [27].

Pečena Slatina and Slatina are also within paleomeanders of the former Tisa River and these sites are currently situated in the Tamiš River valley (Figure 7E). During the Holocene, the Tisa River shifted its channel westward, significantly prolonging the length of the Tamiš River and moving the confluence towards the Danube River. Thus, in this area one can find a wide diversity of fluvial landforms, such as point bars, meanders, and fossil river channels [29]. These meanders are located in the southern part of the Vojvodina region, near the western margin of Baranda settlement (Figures 6 and 7). Fužinato et al. [34] reported on the occurrence of some cyanobacteria in salty puddles in Pečena Slatina and Slatina localities, which previously were only known to exist in tropical regions in Africa and Asia. The species identified typically inhabit of salty alkaline lakes in Africa, indicating the unique environmental conditions of the Pečena Slatina site. Slatina lake is partly used as a fish pond. These lakes are also well-known ornithological sites. During the last several years, the owners of the local fishpond began to promote ecotourism at Pečena Slatina and Slatina, as potential attractive ecotourist destinations.

Special Nature Reserve Pašnjaci velike droplje (Figure 7F) contains a unique mosaic of different lowland landscapes and is the only habitat of the Great Bustard (*Otis tarda*) in Serbia [35]. The reserve is in the northern part of the Vojvodina region, on the alluvial

plane of the Zlatica River, east of the City of Kikinda. The Zlatica River most likely represents an abandoned channel of the Paleo Moros River, given that the Zlatica River could not have formed its current alluvial plain [27,36]. The diverse fluvial geomorphology of the site has led to the formation of many different, mostly grassland, ecosystems on saline soils of low agricultural productivity. Development of ecotourism here is primarily based on endangered birds, its heterogeneous fauna, which has been integrated into an educational theme. Possibilities also exist at this site for organizing photo safaris, as well as voluntary and educational camps [37]. Additional touristic values can be derived from the interpretation of interactions between abiotic and biotic natural processes, especially the relationship between pedogenesis of saline soils and endemic halophytic vegetation.

4. Methodology

In order to assess the six sites mentioned above, and evaluate their current state and tourism potential, we propose a novel approach for the assessment of saline soil sites. This new methodology has its roots in previous assessment models and studies, all mainly related to resources such as geoheritage [4,38–42], spas and hot springs [43] and cultural heritage [44–48], and their use for tourism. These methods have been successfully applied numerous times in the assessment of various geosites [49–68], spas [43,69–71], and sites of cultural heritage [44,47,48]. The majority of tourism related subindicators were derived from these existing models and been adapted in this study for saline soil assessment, while the subindicators Geomorphological attractiveness, Pedodiversity, Biodiversity, Endemic and relict plant species and Ambience were introduced by the authors of this paper, based on the opinion of experts. Eight tourism and soil experts (researchers and professors from these fields of expertise) were asked to suggest the subindicators they consider important for the assessment of the current state and tourism potential of soil sites. These subindicators proved to be essential when assessing the tourist potential of saline soil sites, because they affect the quality of the tourist experience. The complete subindicator list and structure of the model are presented in Table 2.

Our methodology consists of two groups of indicators: Main Values (MV) of the soils and Tourist Values (TV). Each of these groups consists of 12 different subindicators, yielding 24 subindicators in the model which are fully listed and described in Table 2.

In the assessment process, every subindicator was rated by experts on a 5-point likert scale, with each subindicator given a value from 1 to 5. These values and how they are rated are explained in more detail in Table 2. Upon the rating of each subindicator, the values are added up separately, first the 12 subindicators from the *Main Values (MV)* group, and then the 12 subindicators from the *Tourist Values (TV)* group. Finally, the sum of Main Values and the Tourist Values are added together. The results are presented in a matrix (Figure 8) which consists of Main Values axis (X) and a Tourist Values axis (Y). The matrix is divided into nine fields and each analyzed site is then placed into one of the fields, depending on the additive score of its Main Values (MV) and Tourist Values (TV). For example, if the sum of Main Values is 27 and of Tourist Values is 47, the analyzed soil site would be in the S₂₃ field of the matrix, indicating a medium level on Main Values and a high level on Tourist Values.

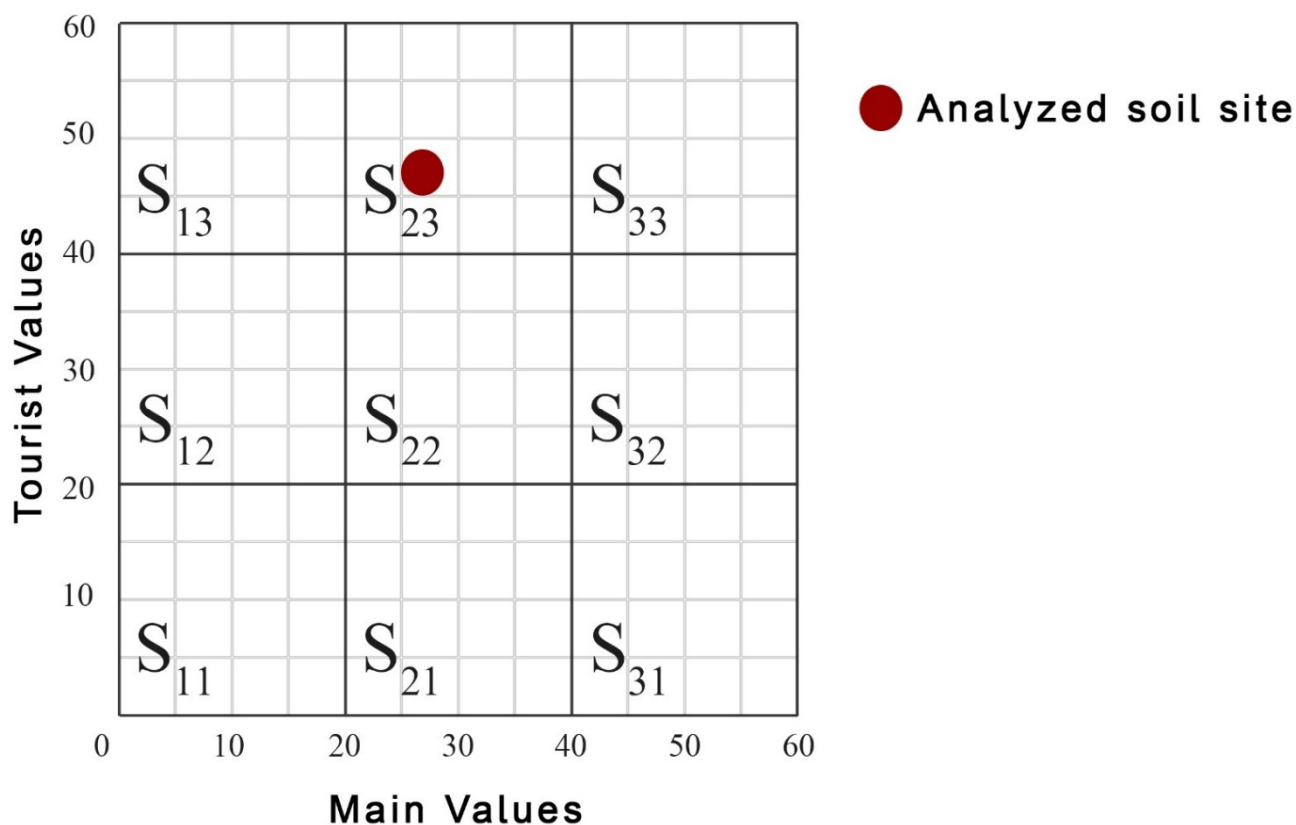


Figure 8. Example of the soil site assessment matrix and its axis variables.

Table 2. The structure of the soil site assessment model.

Indicators/Subindicators	Description
Main values (MV)	
1. Rarity	Number of sites nearby with similar overall characteristics
2. Possibilities for interpretation and education	Level of interpretive possibilities on pedological processes and pedogenesis
3. Geomorphological attractiveness	Number of existing micro-landforms (meanders, point bars, old river valleys, etc.)
4. Pedodiversity	Number of different soil types and varieties
5. Biodiversity	Number of different vascular plant and bird species (must inhabit the site for at least a part of the year)
6. Endemic and relict plant species	Total number of endemic and relict plant species as well as those included in the world red list of threatened species and the red list of Serbian flora.
7. Ambience	The character of the site as it relates to its visual experience for potential visitors—contrast of colors, appearance of shapes, etc.
8. Surrounding landscape and nature	Panoramic view quality, presence of water and vegetation, absence of human-induced deterioration, vicinity of urban areas, etc.
9. Therapeutical value	Therapeutical value of the soil (related to perceived utility as a treatment of medical conditions and how often it is used for such purposes).
10. Protection level	Protected status by local or regional groups, national government, international organizations, etc.
11. Vulnerability	Vulnerability level of soils (their risks from natural processes and anthropogenic influences)
12. Suitable number of visitors	Proposed number of visitors that can sustainably utilize the site at the same time, based on surface area, vulnerability, and the current state of the site
Tourist values (TV)	
13. Accessibility	Ease with which the site can be reached
14. Additional natural values	Number of additional natural values (within a radius of 5 km)

15.	Additional anthropogenic values	Number of additional anthropogenic values (within a radius of 5 km)
16.	Promotion	Level and number of promotional resources
17.	Organized visits	Annual number of organized visits to the site
18.	Vicinity of visitor's centers	Closeness of visitor center to the site
19.	Interpretative panels	Interpretative characteristics and value of text and graphics, material quality, panel size, suitability to surroundings, etc.
20.	Number of visitors	Annual number of visitors
21.	Tourism infrastructure	Level of additional infrastructure for tourists such as pedestrian pathways, resting places, garbage cans, toilets etc.
22.	Tour guide service	If local expertise exists, the level, knowledge of foreign language(s), interpretative skills, etc. of the experts
23.	Hostelry service	Hostelry services close to the site
24.	Restaurant service	Restaurant services close to the site

Grades (1–5)					
	1	2	3	4	5
1.	Common	Regional	National	International	The only occurrence
2.	None	Moderate level of processes, difficult to explain to non-experts	Good example of processes but difficult to explain to non-experts	Moderate level of processes but easy to explain to a common visitor	Good example of processes and easy to explain to a common visitor
3.	1	-	2–3	-	More than 3
4.	1–2 types/varieties	3–4 types/varieties	5–6 types/varieties	7–8 types/varieties	More than 8
5.	Up to 100 species	101–150 species	151–200 species	201–300 species	More than 300 species
6.	1 or 2 species	3–4 species	5–6 species	7–8 species	More than 8 species
7.	-	Low	Medium	High	Exceptional
8.	-	Low	Medium	High	Exceptional
9.	Not used for treatment	Occasionally used for treatment by the locals	Often used for treatment by the locals	Intensively used for treatment by the locals	Organized treatment in the form of a spa
10.	None	Local	Regional	National	International
11.	Irreversible (with possibility of total loss)	High (could be easily damaged)	Medium (could be damaged by natural processes or human activities)	Low (could be damaged only by human activities)	None
12.	0	0 to 10	10 to 20	20 to 50	More than 50
13.	Inaccessible	Low (on foot with special equipment and expert guide tours)	Medium (by bicycle and other means of man-powered transport)	High (by car)	Utmost (by bus)
14.	None	1	2 to 3	4 to 6	More than 6
15.	None	1	2 to 3	4 to 6	More than 6
16.	None	Local	Regional	National	International
17.	None	Less than 10 per year	11–12 per year	13–14 per year	More than 14 per year
18.	More than 50 km	50 to 20 km	20 to 5 km	5 to 1 km	Less than 1 km
19.	None	Low quality	Medium quality	High quality	Utmost quality
20.	None	Low (less than 100)	Medium (101 to 150)	High (151 to 200)	Utmost (more than 200)
21.	None	Low	Medium	High	Utmost
22.	None	Low	Medium	High	Utmost
23.	More than 50 km	25–50 km	10–25 km	5–10 km	Less than 5 km
24.	More than 25 km	10–25 km	10–5 km	1–5 km	Less than 1 km

5. Results and Discussion

The assessment results of the six saline soil sites are shown in Table 3 and Figure 9. The Slano Kopovo saline soil site stands out significantly above the other sites, with the highest Main Values (56). Jegrička and Rusanda are tied at second place with a score of 45 for Main Values while Pečena Slatina has one point less (44). The lowest score of Main Values belongs to Okanj Bara and Pašnjaci Velike Droplje, which are tied at 42.

A further analysis of the Main Values of all sites shows that Slano Kopovo has almost the maximum scores. The only subindicators within this group with below maximum values are Surrounding landscape and nature, Therapeutical value, and Vulnerability. Based on these results, it is evident that this site possesses all the necessary natural values for high value tourism. Its high “nature-related” values make it the most suitable site for future tourism development and promotion. However, these natural values need to be accompanied by high Tourist Values as well, in order to have a robust and complete tourism product that would attract a large number of tourists.

Regarding the subindicator related to the possibilities for interpretation and education, almost all the analyzed sites have high scores (4 or 5). Only Pašnjaci Velike Droplje and Okanj Bara have lower scores (3 and 2). Another important element for tourism is the aesthetic value of a site or destination, which are evaluated using the subindicators Ambience and Surrounding landscape and nature. As can be seen in Table ..., 5 out of 6 of the analyzed sites have a high value (4) for the Ambience variable. Slano Kopovo stands out, however, with the highest value (5) for this subindicator. With regard to surrounding landscape, Jegrička has the highest value, while Slano Kopovo has a value of 4. Furthermore, looking at the protection level of each site, it can be noticed that only Slano Kopovo is protected on an international level, given that it is a Ramsar wetland. Most of the other sites are protected on a national level; Pečena Slatina remains unprotected on a national level.

The therapeutical and healing properties of soil and mud in a certain area are often linked to an increase in visitor numbers. When it comes to our sites, Rusanda has the longest tradition of utilizing this type of resource. It is the only site that has a spa where mud is regularly used for healing purposes. At the other sites, such mud is also used, however to a less extent than at Rusanda.

One of the elements that also attracts many visitors to these types of destinations is the biodiversity, particularly the number of rare bird and plant species. Once again, Slano Kopovo has the highest score among the analyzed sites. It possesses remarkable biocenological characteristics and it is recognizable by the specific brinish communities of the Tero-Salicornietea class. The features of the microrelief, together with the mutual dependence of ground moisture and salinity, are reflected in the nature of the ecological row of communities and in the flora. Plant species here are mostly annual succulent halophytes. The species *Suaeda pannonica* is a Pannonian endemic species and is on the Red List of Serbian Flora as well as Common Glasswort (*Salicornia europaea*) and they both are critically endangered taxon. Another endemic species is the Schwarzenberg's Plantain (*Plantago schwarzenbergiana*) which is a Transylvanian-Pannonian species from the World Red List of Plants. Besides its diverse flora, this site has 210 bird species (63% of the total number of known species in the Vojvodina region) and 25 species of mammals, such as the Slender-billed Curlew (*Numenius tenuirostris*), the Red-breasted goose (*Branta rufcollis*) and the Imperial Eagle (*Aquila heliaca*) [72]. During the migration period in the autumn, here in Slano Kopovo about 20,000 grey cranes (*Grus grus*) can gather in just one moment [73]. The sites of Jegrička, Okanj Bara and Pašnjaci Velike Droplje have a slightly lower biodiversity values (4), but still rank high enough to appeal to certain tourism market segments. Jegrička has three species coded as strictly protected by a national legal act (Code on declaration and protection of strictly protected and protected wild species of plants, animals and fungi (“Official Gazette of RS”, no. 5/2010)): the Marsh Fern (*Thelypteris palustris*), White Water Lilly (*Nymphaea alba*) and North

Africa grass (*Ventenata dubia*), while two species (*Salvinia natans* and *Trapa natans*) are in Appendix I of Bern Convention as strictly protected.

Based on the presence of a great number of species of international importance, in 2005, the area was proclaimed as an IPA area. The site Okanj Bara also has several Pannonian endemic plant species, such as *Limonium gmelini*, *Plantago schwarzenbergiana* and sub-endemic species (*Pucinellia distans* ssp. *limosa*, *Roripa sylvestris* ssp. *kernerii*). Pašnjaci Velike Droplje is best known for its Great Bustard bird habitat. Additionally, there are also many rare plant species, especially endemic species like Schwarzenberg's plantain (*Plantago schwarzenbergiana*), Sadler's bachelor button (*Centaurea cyanus*), and also the White Sticky Catchfly (*Silene viscosa*), found only in a few places in North and Middle Banat. Because of its limited aerial, it is one of the most significant of the protected plant species in the Great Bustard habitat [72].

Another element that was assessed in our study was pedodiversity. For this assessment, an area of 3000 square meters was considered. The data was based on the pedological maps of the Military Geographical Institute of Serbia. The sites of Slano Kopovo, Pečena Slatina and Pašnjaci Velike Droplje have the highest pedodiversity and have thus obtained the maximum score of 5. The soils that are present here mostly belong to the following types (and their varieties): Solonetz, Solonchak, Antraquic Gleysol (Eugley), Mollic and Haplic Gleysol, Chernozem, and Fluvisol.

Regarding Tourist Values, the analyzed sites can be categorized into two groups. The first group includes Jegrička, Slano Kopovo and Rusanda, which have very similar scores. Rusanda has a slight overall advantage with a score of 54, while Slano Kopovo and Jegrička have scores of 53. The second group includes the remaining three sites, with Pašnjaci Velike Droplje having a slight advantage with a score of 43 (Okanj Bara is at (40) and Pečena Slatina is at (42)).

Most of the sites are accessible by car or bus; Pašnjaci Velike Droplje and Okanj Bara are partially accessible by car and require some walking (≈500 m). All of the sites are located within or near protected areas, so they possess additional natural values such as rivers, lakes, swamps, bird habitats, IBA areas and other protected areas. Notably, all of the sites are located within a few kilometers of smaller settlements, at which people can encounter cultural attractions such as historic monuments, ethno-houses, local gastronomy and culture.

Regarding promotional activities, apart from Slano Kopovo, none of the analyzed sites are currently being promoted at a high level. The promotional activities for most of the sites are mainly on a local or regional level.

Another important element for tourism development includes visitor centers and tour guide services. Jegrička, Slano Kopovo and Pašnjaci Velike Droplje have a visitor center in the vicinity, while the other analyzed sites do not. Because Rusanda and Okanj Bara are located near the city of Zrenjanin, the nearest visitor center dedicated to Nature Reserves in the territory of Zrenjanin is within the city. When it comes to the quality of tour guide service, only Jegrička, Slano Kopovo and Rusanda have regular tour guide service in Serbian and English; the other sites do not offer the same quality of service. Quality and multi-lingual guide service is a very important factor in the development of tourism. Tourists are often people who know little about pedological processes, so proper interpretation is required.

Besides these elements, basic tourism infrastructure is also necessary at each site. Given the fact that Rusanda is located near the Rusanda spa in Melenci, all the existing infrastructure, as well as hostelry and restaurant services are currently available. Jegrička and Slano Kopovo also have high values for the tourism infrastructure subindicator, while Okanj Bara, Pečena Slatina and Pašnjaci Velike Droplje currently lack basic tourism infrastructure, such as information boards, signs, walking paths, parking, toilets, etc. Ideally, information boards, signs and panels should provide visitors valuable information and many important and interesting facts that supplement their overall impression of the site. Such amenities should help visitors understand the ecosystem and

the significance of saline soils at the sites, which will help them understand the surroundings better. Interpretive panels, in the absence of a guide, simplify complex natural processes and provide meaningful information about the soil sites. Therefore, for many of these sites, we argue that it is necessary to significantly improve the number and quality of interpretive panels, so as to increase the overall tourist experience. The other problem that these sites have involves language; most of the existing interpretive boards are written in Serbian.

Given the fact that promotional activities, infrastructure, visitor centers, interpretive panels, and tour guide services are one of the most important of human-induced amenities for successful tourism, these elements should be the primary focus of future tourism development, if the intent is to attract more visitors to the sites. Most of the sites possess high natural values. Nonetheless, besides these natural values, the human factor also plays a crucial role in tourism development and therefore more effort needs to be put towards this aspect in order to draw more visitors to the sites.

Table 3. Subindicator values, as applied by experts, for each site.

	Values Given by Experts (1–5)					
	SS1	SS2	SS3	SS4	SS5	SS6
Main Values (MV)	Jegrička	Slano Kopovo	Rusanda	Okanj Bara	Pečena Slatina	Pašnjaci Velike droplje
1. Rarity	3	5	4	3	4	3
2. Possibilities for interpretation and education	4	5	4	3	4	2
3. Geomorphological attractiveness	4	5	4	3	4	3
4. Pedodiversity	3	5	3	2	5	5
5. Biodiversity	4	5	3	4	3	4
6. Endemic and relict plant and animal species	4	5	3	3	2	2
7. Ambience	4	5	4	4	4	4
8. Surrounding landscape and nature	5	4	3	4	3	3
9. Therapeutical value	2	3	5	3	4	2
10. Protection level	4	5	4	4	3	4
11. Vulnerability	3	4	3	4	3	5
12. Suitable number of visitors	5	5	5	5	5	5
Sum of Main Values	45	56	45	42	44	42
Tourist Values (TV)						
13. Accessibility	5	4	4	3	4	3
14. Additional natural values	5	5	5	5	5	5
15. Additional anthropogenic values	5	5	5	5	5	5
16. Promotion	2	5	3	2	2	3
17. Organized visits	5	5	5	4	4	3
18. Vicinity of visitor's centers	5	5	3	3	2	5
19. Interpretative panels	3	5	5	5	3	4
20. Number of visitors	5	5	5	4	4	4
21. Tourism infrastructure	4	4	5	3	3	3
22. Tour guide service	4	4	4	2	2	2
23. Hostelry service	5	3	5	2	4	3
24. Restaurant service	5	3	5	2	4	3
Sum of Tourist Values	53	53	54	40	42	43

Finally, we note that the overall scores, on the Main and Tourist Value axes for the sites, add additional insight. As shown in Figure 9, Slano Kopovo, Jegrička and Rusanda

fit well within the S_{33} field of the data matrix, indicating that they have very high Main and Tourist Values. Slano Kopovo has the highest overall score and therefore the largest potential for tourism development. Its high score is mostly the result of high Main Values while Tourist Values still have room for improvement. Okanj Bara, Pečena Slatina and Pašnjaci Velike Droplje are in the same field but rank slightly lower. Based on these data, Slano Kopovo, Jegrička and Rusanda should be the primary focus for future tourism development, as they have a good balance of Main and Tourist values but also provide opportunities for enhanced tourist attractions. As these types of destinations are of interest for smaller segments of the tourism market, mainly scientists and nature lovers interested in pedology and biodiversity, significant effort should be made towards attracting other segments of the tourism market. This can initially be done by promoting the unique ambience these areas offer as well as the most significant species of flora and fauna.

The additional aim of this paper is to emphasize the tourism potential of saline soils landscapes throughout the Vojvodina region. Evaluated sites provide an excellent basis for establishing the first slatina landscape route in Serbia which requires relatively low financial inputs for creating interpretative panels, pedestrian pathways, or bicycle routes and promotion through websites and other media. However, these inputs would significantly increase the touristic attractiveness of evaluated destinations which is in line with the sustainable development of rural tourism in the Vojvodina region.

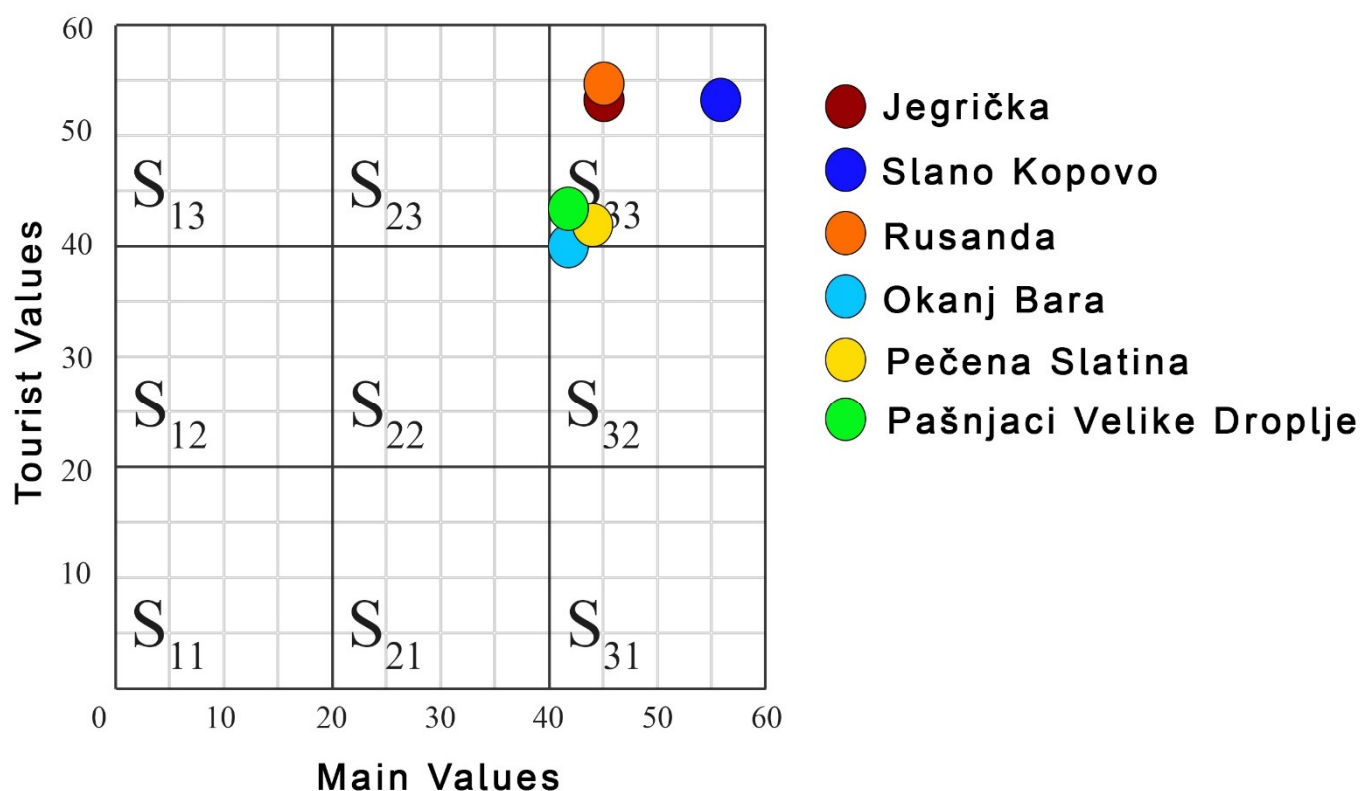


Figure 9. Position of the analyzed sites in the soil site assessment matrix.

6. Conclusions

The focus of this study was to assess and compare the current state, as well as tourism potential, of six sites in the Vojvodina region of Serbia, all of which have saline soils: Jegrička, Slano Kopovo, Rusanda, Okanj, Pečena Slatina, and Pašnjaci Velike Droplje. Overall, all analyzed sites have significant tourism potential based on both natural and

tourist values. In addition to the tourism potentials, analyzed sites have high value as a natural endemic ecosystem inhabited with highly specialized plants and birds.

Our results reveal a general lack of services and infrastructure, which is normally required for tourism development and necessary to attract larger groups of tourists. The sites with the largest room for improvement are Okanj Bara, Pašnjaci Velike Droplje and Pečena Slatina. These sites possess high Main Values meaning that they have the natural resources to attract tourists, however they lack basic tourism infrastructure as well as good quality tour guide service and better promotion. Therefore, these elements should be the primary focus in future tourism development. Jegrička, Slano Kopovo and Rusanda have significantly higher Main and Tourist values but with still some room for improvement. All three sites possess basic tourism infrastructure, tour guide service and other essential elements for tourism development. However, all of these require some minor improvement to raise the tourist experience to a higher level in the future.

One of the key issues related to future tourism developed is centered on the need for high quality tour guide services, interpretation signage and materials, and other forms of basic infrastructure. Indeed, because some of these sites can be visited through self-guided tours, signage and onsite interpretative materials must be improved before tourism can be expected to grow. Additionally, promotional activities such as brochures and a better internet presence are also essential. Local, regional and national tourist organizations must also promote these areas more readily. The development of tourism in these areas would enhance the currently poor tourist offerings in this part of Vojvodina, producing positive economic results and supporting community development endeavors.

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