



HOW TO PROTECT LOESS-PALAEOSOL SEQUENCES? PROPOSAL OF LOESS GEOPARK IN VOJVODINA PROVINCE (NORTH SERBIA)

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INDRODUCTION

Loess-palaeosol sequences preserve the most important continental record of climatic and environmental changes during the Quaternary. As loess deposits in the Vojvodina region (North Serbia) could be regarded as one of the most important European terrestrial records of climatic and environmental changes during the last million years that makes them valuable scientific resource. Unfortunately, these sites, due to their economic (e.g. agriculture and brickyards) and functional (e.g. remote sections as waste disposals) values, are constantly endangered by numerous causes and could be degraded or exploited permanently (Table 1).

This study will give proposal of establishing loess geopark as protected area that would include the most significant loess sections in the investigated area. The study is based on analytical, theoretical and practical suggestions and rules according to the general Guidelines and Criteria for National Geoparks seeking UNESCO's assistance to join the Global Geoparks Network. Loess and loess like sediments cover more than 60 % of the area and are preserved in six separate loess plateaus: Bačka, Srem, Tamiš, Banat, south-east Banat, and Titel Loess Plateau, which make it a surface large enough to serve local economic and cultural development. As the dissemination of loess in Vojvodina has a dispersed character, the potential Geopark should also have a certain number of separate locations. A fragmented approach should require less effort during the geoconservation practice, with separate processes, but identical aim. Therefore, one the initial steps of protection and recognition of (loess) geosites should be first achieved by national or provincial legislation and/or by management policies before inscription on the World Heritage List of recognition as a Global Geopark because these organisations by themselves do not provide any protection.



Titel loess plateau is a unique geomorphologic feature, an isolated loess island at the south of Bačka region, in the confluence area of Tisa and Danube Rivers (C). Thick loess deposits of between 35 and 55 m are intercalated by five main pedocomplexes likely deposited through the last five glacial/interglacial cycles. Steep loess cliffs expose several sections (profile in "Big gully" near Mošorin village, "Feudvar" section, "Dukatar" section, "Rogulić" gully, "Titel" old brickyard section, "Kalvarija" important section for understanding climatic and environmental change in the region during the Middle and Late Pleistocene. This isolated loess island and unique geomorphologic phenomenon, with a rich diversity of the loess landforms (e.g. loess "cave", pyramid, gully, cliffs, etc), dominates its lower surroundings which makes it aesthetically and visually attractive.

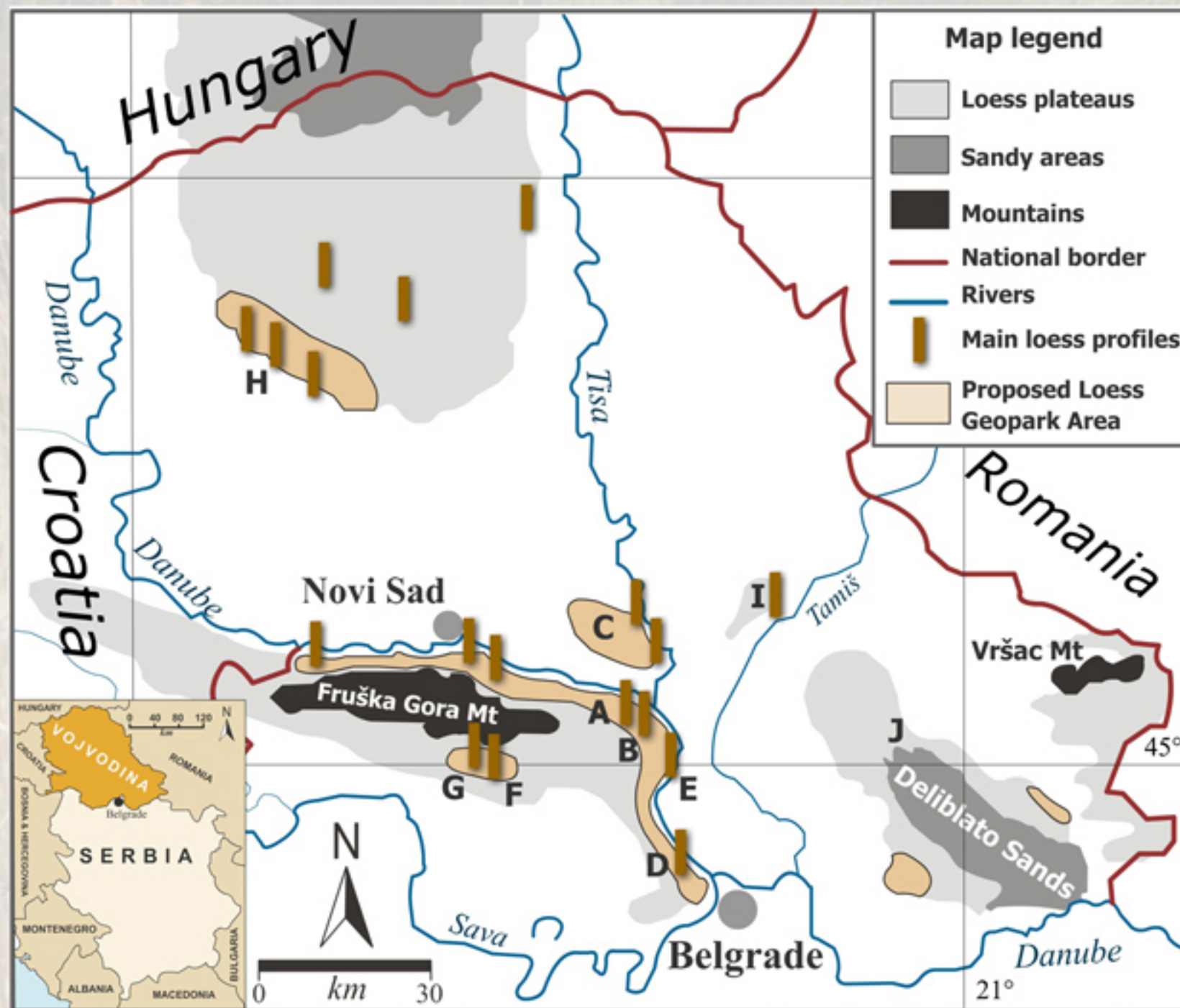


Initial research results of loess-palaeosol sequences of Bačka loess plateau (H) indicate the great importance of investigated sections at Crvenka section



Two important loess sections of Srem loess plateau are located on the southern slopes of Fruška Gora Mountain. The first one is the Ruma loess section (F) at the excavation area of the local brickyard. The Ruma loess section preserves palaeoclimatic and palaeoecological evidence of environmental fluctuations during the last 350,000 years. During the investigation remains of the large Pleistocene mammals *Ursus deningeri* and *Mamuthus primigenius* were excavated. The second loess section is located also at the brickyard, in Irig village, 11 km north from Ruma (G). Malacological analysis indicated that during the last glacial cycle stable, dry and relatively warm glacial climate dominated, compared with other central European loess localities. Furthermore, these data suggest that the southern slope of Fruška Gora was a refugium for warm-loving and xerophilous mollusc species during the glacial cycle of the Late Pleistocene.

Photo: M. Jovanović



Distribution of the loess deposits and proposed Loess Geopark area in the Vojvodina region; key loess sections are labeled by capital letters



The exposure of Surduk loess section (b) provides a 20 m thick pedosedimentary record of the last interglacial-glacial climatic cycle (Upper Pleistocene). The loess cliffs on the Danube River bank near the village of Surduk preserve both a unique archive of Quaternary climate change, and also exhibit diverse and short-lived landforms associated with the erosion of the deposits. One such landform is a very rare type of pseudokarst feature in the Vojvodina region, a loess cave (a).

Why protect loess sediments?

Loess sediments form parent material for very productive soils such as chernozems, which is why many loess sediments are exposed to agricultural activities. These actions can permanently exploit or devastate loess exposures, as Vojvodina is mainly an agricultural region. Also, great problems are represented by exploitation of loess sections for brickyard industries and uncontrolled urbanisation. Apart from human-induced devastation, natural processes could also present a threat. Some loess landforms in the Vojvodina region, such as loess "caves", wells, cliffs, depressions, gullies and natural bridges could be aesthetically attractive, but these relief forms have limited periods of existence due to their vulnerability to erosion. Except these, there are numerous possible threats to geodiversity, both human and natural induced, of which several could be identified for loess sediments in the Vojvodina region and are shown in Table 1. These threats, with certain amendments, depending on local conditions, could also be applied to loess sites worldwide. However, threats are not the only reason to conserve geodiversity. Geodiversity should be conserved for two main reasons: its values and threats, which leads to simple formula:

$$\text{Value} + \text{Threat} = \text{Conservation Need}$$

Throughout centuries, human civilisation has become "brilliantly resourceful in exploiting the geodiversity of the planet and modern society could not function without this complexity of georesource use" (Gray, 2008). This demonstrates that geodiversity should not be protected only for its fragility or potential irreversible loss, but for the entire variety of values, ranging from cultural, aesthetic, economic, to functional and educational. Accordingly, Table 2 shows the summary of identified values of loess-palaeosol sequences in the Vojvodina region.

Table 1.
Identified threats to loess-palaeosol sequences in Vojvodina as the elements of geodiversity

Threat	Cause	Location
Ignorance	Lack of information or education, no sense for nature protection and intrinsic values of geodiversity	All loess sections in the Vojvodina region
Erosion	Sections near rivers are directly influenced by fluvial erosion	Titel Loess Plateau near Dukatar village (Tisa river), all profiles at Fruška gora mountain (Danube river), etc.
Waste disposal	Some features in loess influenced by pluvial erosion Former brickyard outcrops often used as waste disposal locations Local, small, junkyards on remote and hidden loess sections near settlements or fishing locations Waste accumulated by river currents	"Loess cave" near Surduk village Old Brickyard in Ruma serve as Municipality junkyard Loess profiles in Stari Slankamen, Surduk, etc.
Extraction of construction materials	Brickyards exploiting loess sections for brick industry	All profiles in river valleys Loess profiles in Ruma, Irig, Crvenka, Novo Orhovo, Orlovat
Agriculture	Vegetation change caused by agricultural activities Mechanical devastation of loess exposures	Vegetation on the loess plateaus substituted by crops Titel loess plateau, profiles near Danube river
Land development and urban expansion	Illegal construction of cottage (fishing) settlements Unplanned urban expansion Traffic constructions on loess land slides	Loess slopes of Fruška gora, Mošorin, Surduk Sremska Kamenica, Stari Slankamen, Loess slopes of Fruška gora Mišeluk Tunnel, Belka bridge, Bežanijska kosa
Uncontrolled vegetation	Uncontrolled weed growth reduces visibility of loess sections	All loess sections in the Vojvodina region
Recreation and tourism pressures	Garbage, fires, barbecue places, flora and fauna degradation, etc. caused by fisherman, recreationists, local people, visitors	All loess sections in the Vojvodina region
Removal of geological specimens	Mechanical removal at brickyards, urbanisation, constructions	All loess sections in the Vojvodina region
Military	Practice fields	Irig

Table 2
Summary of values of geodiversity by Gray (2004)
applied to loess-palaeosol sequences in the Vojvodina region.

Values	Value Subgroups	Examples
Cultural Values	Folklore & Tradition Archaeological	Vojvodina as one of the most multicultural regions in Europe Feudvar site (Bronze and Iron Age; Titel Loess Plateau) Kalvarija (Eneolithic Age; Titel Loess Plateau) Petrovaradin Fortress site (Palaeolithic Age)
	Historical Palaeontology	Ariminicum – Roman settlement (Stari Slankamen) Petrovaradin Fortress, Schmidtmayers' Chapel (Titel Loess Plateau) Ursus Deningeri – Middle Pleistocene Bear (Ruma), <i>Mammothus Primigenius</i> (Crvenka, Ruma, and Petrovaradin), and many mollusc shells in the loess horizons.
	Spiritual Local Landscapes Leisure Activities	Spring of Holy Water near Lok village (Titel Loess Plateau) Titel Loess Plateau, deep loess gorges, steep and high loess profiles, "loess caves" Paragliding (Titel Loess Plateau), hiking, biking, free-climbing
	Remote Appreciation Artistic Inspiration Energy	Loess profiles distanced from big towns such as Novi Sad, Belgrade, Subotica, etc. Not at present Brickyard quarries in Ruma, Irig, Crvenka, Novo Orhovo, Orlovat
Economic Values	Construction Materials Soils Platforms Storage & Recycling Health	Not at present Brickyard quarries in Ruma, Irig, Crvenka, Novo Orhovo, Orlovat Agriculture and vegetation For agriculture, traffic and constructions Waste disposals (unfortunately) Loess contains many nutritional minerals that eliminate fatigue and skin diseases. It also cuts off the electromagnetic radiation and the release of far-infrared. Implication in beauty and medical skin treatments, pillow and mattress industry. Graveyards of all settlements near loess deposits
	Functional Values	Burial Water Chemistry Soil Functions Scientific Discovery
	Earth History	Slanača – Saline water spring in Stari Slankamen; Spring in Lok near Titel Loess Plateau; springs on Fruška gora Loess sediments form parent material for very productive soils like chernozems Significant palaeoclimatic shifts represented by succession of interglacial from humid to dry environments during the last 1Ma.
	Research & Education Values	History of Research Environmental Monitoring Education & Training

Loess Geopark within GGN guidelines and instructions - a brief overview

1. Size and setting

The area of proposed Loess Geopark will include all significant loess sections and the surrounding area i.e. loess landscape. Boundaries of the large enough area would be clearly defined in accordance with Provincial Nature Conservation Institute and other relevant institutes. The Geopark would include several existing protected sites and areas, such as National Park Fruška Gora, Special Nature Reserve Deliblato Sands, Monument of Nature - loess profile in Stari Slankamen gorge (Fig. A, pronounced 1975, first in ex-Yugoslavia), and many other geosites proposed in the inventory in 1996, which unfortunately have not been put under formal protection yet. All these geosites are significant archives of geological history of Vojvodina region in the past million years. Loess Geopark is planned to include promotion and development of all other complementary resources, both natural and cultural - synergy between geodiversity, biodiversity and culture. As Geoparks may be located on the territory of more than one country this area might be extended to Croatian, Romanian or Hungarian loess sediments.

2. Management and local involvement

Guidelines clearly state that prerequisite to any Geopark proposal being approved is the establishment of an effective management system and programme of implementation as the presence of impressive and internationally significant geological outcrops alone is not sufficient to be a Geopark. Also, the management body or partnership should have an effective management infrastructure, adequate qualified personnel, and sustainable financial support. The initiative to create a Geopark must therefore come from local communities/authorities with a strong commitment to developing and implementing a management plan that meets the community and economic needs of the local population whilst protecting the landscape in which they live. All activities, including economic ones, within Geopark would be based on sustainability and carried out in cooperation with local communities.

3. Economic development

Loess Geopark should stimulate economic activity within the framework of sustainable development through employment of local community, enhancement of local products sale, secondary tourism incomes, creation of positive image and brand, etc. The philosophy is to create strong multidisciplinary cooperation between all sectors that could benefit on nature-based tourism, such as geotourism and ecotourism.

4. Education

Education of visitors would be provided through various in-situ and ex-situ facilities and services. For organized groups, there would be specialised guided tours. At all significant profiles there would be interpretative panel posted, with story (both graphic and textual) of particular section interesting and adopted to general public. Modern thematic museum and visitor center would be built at Čot profile Stari Slankamen (Fig. B), equipped with up-to-date facilities. Also, it is proposed to build visitor centres at Titel loess plateau and to enhance the exhibition at Provincial Nature Conservation Institute. Visitors could also be involved in sampling, analysing and other research methods, and education would also be possible through website (interactive content), printed guides, books and brochures, etc. Geopark would be the educational center for schools and universities (excursions for school classes and teachers, seminars, and scientific lectures) and also for community participation and capacity building on the local level (e.g. training of visitor guides) as the involvement of local people is of primary importance for the successful establishment and maintenance of a Geopark.

5. Protection and conservation

Loess Geopark is intended to be a protected area with loess as the main theme, with inclusion of all other attractive and significant geosites of protected area. Firstly, the authorities responsible for the Geopark must ensure its protection in accordance with national regulations and legislative obligations as it is each country's responsibility to decide how to protect the particular sites or areas. Furthermore, Geopark managing body must not participate directly in the sale of geological objects within the area and should actively discourage unsustainable trade in geological materials as a whole, including the intensive exploitation at brickyards.

6. The Global Network

The Geopark management would systematically and efficiently sustain cooperation and exchange between experts and practitioners in geological heritage matters, especially with other geopark's staff. As unique protected area of this kind in Europe and wider, role model for this loess geopark could be China, the region with one of the most important Quaternary continental records in the world, where key loess sections are profoundly protected and promoted via Geoparks (e.g. Luochuan, Huoshi Chai, Kungdongshan, Jingtai, Yellow River). Additionally, the Geopark should work on exchange of knowledge and expertise, experience and staff between other Geoparks in the region and even wider. "This international partnership developed by UNESCO, brings the advantage of being a member of, and profiting from, this worldwide network, as compared to a local isolated initiative".