Development of erosion prediction tool for sustainable soil management

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Predict-Er

Deliverable D1.3

Report on sampling campaign

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1 Introduction

As part of the implementation of the Predict-Er project, a comprehensive field sampling campaign was carried out in the Malčanska River catchment, encompassing both soil and sediment sampling. The campaign aimed to collect representative soil and sediment samples to assess the intensity of soil erosion, identify sediment sources, and characterize the physicochemical properties of soils within the catchment.

Soil samples were collected across the catchment area according to a 500 m sampling grid, which was carefully designed in GIS to represent the spatial distribution of different land cover types proportionally. Also, sampling locations were selected to reflect undisturbed and representative conditions of each land use class, while avoiding areas recently affected by anthropogenic activities. Furthermore, reference locations for ^{137}Cs inventory were carefully selected within the catchment, in areas where no signs of erosion or deposition could be detected. These sites are essential for establishing baseline cesium levels to quantify erosion rates.

River sediment sampling was also performed at multiple hydrological profiles throughout the catchment. Riverbed sediments were collected on a total of 16 locations, strategically selected to capture variability in land use, geology, and soil type across the main channel and its tributaries. Additionally, suspended sediments were sampled using artificial grass traps.

All samples were properly labeled, documented, and stored under appropriate conditions to maintain their integrity for laboratory analyses. The selection of sampling methods, spatial coverage, and procedural consistency ensures the quality and relevance of the data collected.

The soil and sediment sampling campaign has been completed in accordance with the project objectives, laying the foundation for further analytical work aimed at understanding erosion dynamics and sediment transport in the Malčanska River catchment.

All sampling activities were carried out in accordance with previously established internal project protocols and guidelines. Specifically, the procedures for soil and sediment sampling, sample labeling, and transportation were based on the "Instruction for Sampling and Transport of Samples". Fieldwork was also conducted in compliance with the "Safety Protocol – Potential Risks and Emergency Situations During Field Investigations and Corresponding Response Measures", as well as the "Safety Protocol for Minimizing the Impact of Field Investigations on the Local Population". These documents ensured standardized, safe, and ethically responsible sampling practices across the entire catchment.

2 Soil sampling based on a 500 x 500 m grid

Sampling was conducted based on a randomly generated 500 x 500 m grid to determine the physicochemical properties of the soil, the activity concentration of ^{137}Cs for erosion intensity assessment, and the content of stable elements to quantify sediment sources.

Soil sampling was initially planned at 139 locations. Following the protocol, samples were not always taken precisely at the grid points but in their close vicinity, when necessary, to ensure greater variability of samples concerning factors such as soil type, vegetation cover, slope gradient, and visually observed erosion intensity (Figure 1). The deviation from the predefined grid points was typically a few meters and at most several tens of meters, ensuring that the overall grid structure was effectively preserved. Sampling locations were adjusted prior to the field campaign using high-resolution satellite imagery. Such an approach enabled the identification of appropriate sites and precise planning before the commencement of on-site activities, facilitating fieldwork. Leaves, decomposed vegetation, humus, and other debris were removed from the soil surface before collecting samples.Sampling based on the 500 x 500 m grid included the collection of two distinct types of soil samples at each selected location, each serving a specific analytical purpose.

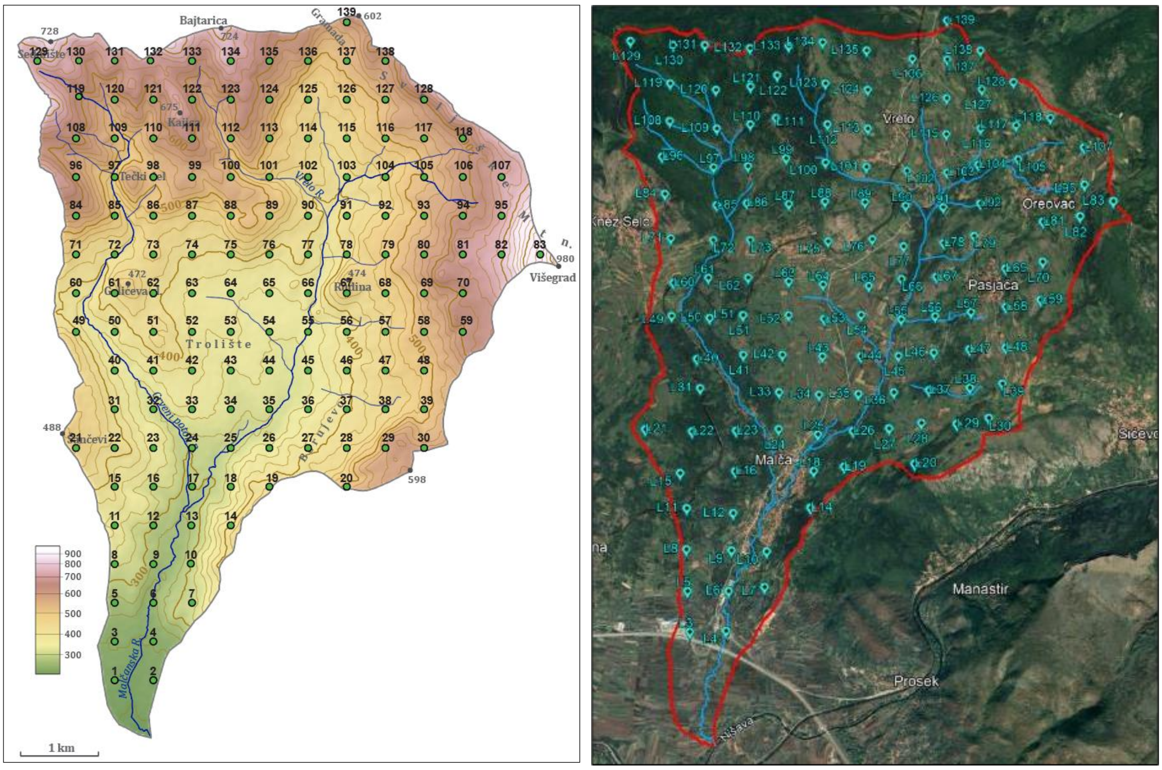

Figure 1: Overview of predefined 500 x 500 m sampling grid (left) and actual sampling locations overlaid on Google Earth background imagery (right)

Out of the 139 initially planned locations, soil samples were successfully collected at 132 points, while 7 locations were excluded from sampling. Two of these were omitted because the automatically generated points fell outside the boundaries of the largest sub-catchment and could not be meaningfully integrated into the study area. The remaining five locations were excluded due to their position within rural settlements, where the soil was highly disturbed or erosion processes had been significantly altered by human activity. These excluded locations are marked with red dots in Figure 1 (left).

2.1 Soil sampling for the determination of physico-chemical properties, including ^{137}Cs concentration for erosion intensity assessment

At grid points defined by the 500 x 500 m sampling network, one composite sample per location was collected using a spade to a depth of 20 cm, with the depth verified using a ruler or measuring tape and the sample taken evenly along the vertical profile. If the soil layer was shallower than 20 cm, the maximum possible depth was recorded and noted as a remark in the field documentation.

Approximately 2 kg of soil was collected per location, with a larger quantity taken when skeletal content was high. Samples were stored in high-quality plastic bags, labeled properly with location codes, and placed in backpacks or transport containers to avoid damage, leakage, or contamination (Figure 2). In cases where the soil contained sharp stones, the plastic bags were additionally protected using fabric pouches. After sampling, all locations were restored to their original state as much as possible to minimize disturbance of the terrain.

Figure 2. Packed soil samples in labeled plastic bags; wooden transport containers for metal cylinders

During the soil sampling, the field data were systematically collected. A detailed field logbook was maintained, recording relevant information including location code, geographic coordinates, slope gradient, and morphological characteristics of both the soil surface and profile. These included soil type, quality and condition of the vegetation cover, microrelief, soil depth, visible skeletal content, soil consistency, moisture level, and other relevant observations. For clarity and easier reference, key entries from the logbook were summarized in an Excel document (Figure 3).

	A	B	C	D	E
1	Name	Latitude	Longitude		Description
2	L1	--------	--------	--------	--------
3	L2	--------	--------	--------	--------
4	L3	43°19'2.52"N	22° 0'57.58"E	43.317367, 22.015994	Nagib 11 stepeni, livada, okolo uglavnom slične livade ali i gusta žbunasta vegetacija i šikara, trava dosta gusta, opšti nagib terena mali, brojne terase između parcela
5	L4	43°19'2.71"N	22° 1'17.87"E	43.317419, 22.021631	Nagib 9 stepeni, šuma uglavnom šikara ali ima i jakih stabala, bez trave, lišće, zemljište vlažno, lepljivo, korenje i malo skeleta
6	L5	43°19'18.71"N	22° 0'55.92"E	43.321864, 22.015533	Nagib 11 stepeni, bagremova slaba šuma, trave gotovo da nema, zemljište uglavnom ogoljeno ili pokriveno lišćem
7	L6	43°19'18.59"N	22° 1'18.12"E	43.321831, 22.021700	Nagib oko 5 stepeni ali se razlikuje puno, šumarak/drveće, žbunje, zemljište pokriveno lišćem, nešto trave, dubko, tamno smeđe, rastresito, skeleta ima dosta
8	L7	43°19'19.44"N	22° 1'41.51"E	43.322067, 22.028197	Nagib oko 10 stepeni ali se razlikuje, nekada njiva, vinograd možda, danas jako gusta visoka trava, zemljište duboko, malo skeleta, tamno smeđe, tvrdo, izdvaja se na grudve

Figure 3: A snippet from a tabular summary of field observations compiled from the field logbook.

At each sampling location, photos were taken to document notable features of the soil and surrounding terrain (Figure 4). In addition, a short video recording was made to capture the broader context of the site. These visual materials serve as a valuable reference for later stages of analysis, providing more precise recall of field conditions and supporting the interpretation of the collected data. The Excel file, photographs, and video recordings are stored in the project's online repository and are accessible to all participants involved in the project. Each team member is responsible for uploading the materials they collected, ensuring comprehensive and up-to-date documentation of field activities.

Figure 4: Example of photographic documentation of soil characteristics and surrounding terrain at sampling locations

2.2 Soil sampling for the fingerprinting method aimed at identifying and quantifying sediment sources contributing to soil erosion

At each of the selected grid locations, fingerprinting sampling was carried out following the established protocol. Four individual soil samples were collected per location, arranged in a square pattern with a spacing of 2 to 3 meters between sampling points. This approach was used to reduce the influence of micro-site variability and to ensure that the sample set more accurately represents the general characteristics of the location. Before sampling, the surface was cleared of leaf litter, decomposed vegetation, and other materials.

Each sample was taken using a standard metal cylinder, 5 cm in diameter and 5 cm in height, with a guiding cylinder employed to prevent soil compaction and to ensure uniform sampling depth. After sampling, the cylinders were sealed with appropriate lids on both ends, labeled according to location number and sample designation, and returned to the wooden transport containers in the same order (Figure 5). As previously noted, each location was documented in the field logbook and accompanied by photos and a short video recording. After sampling, the site was returned to its original condition without difficulty.

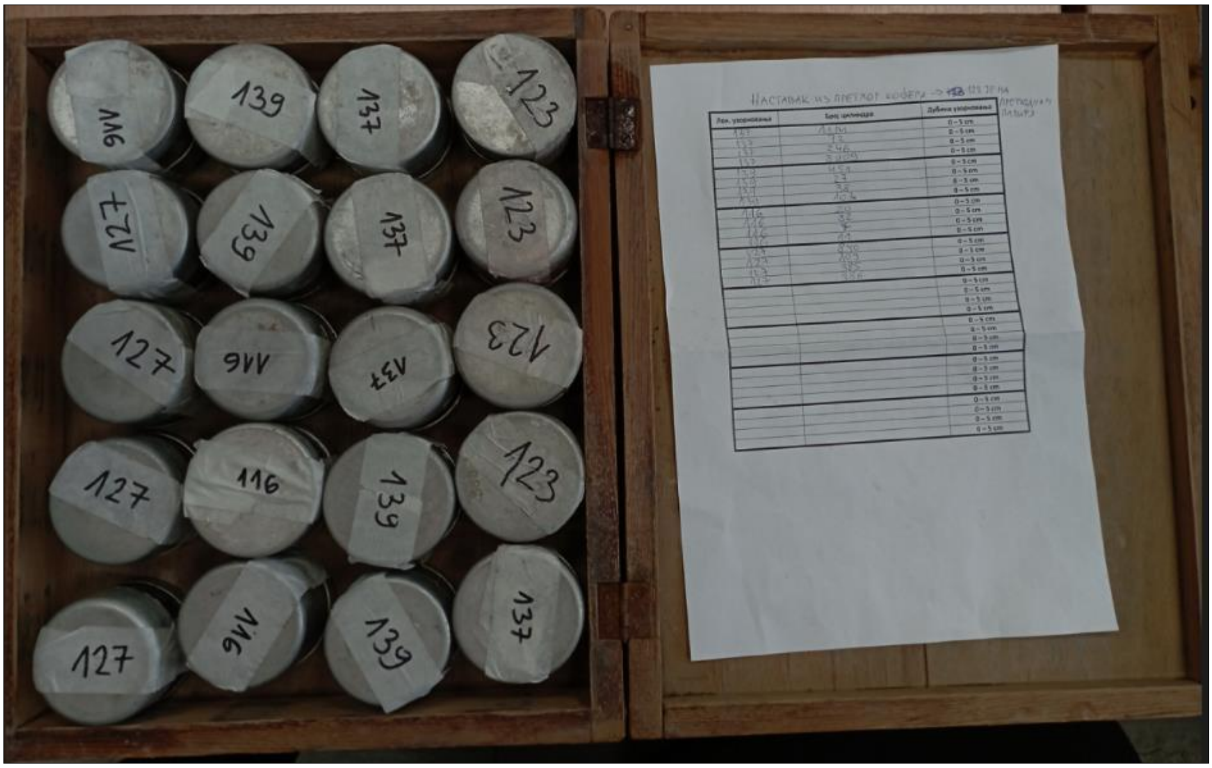

Figure 5. Wooden transport container containing metal cylinders and a field record sheet with corresponding location and cylinder numbers

2.3 Soil sampling for the determination of ^{137}Cs concentration at reference locations and along transects for erosion assessment

Corresponding reference locations were selected within the catchment area, based on the criterion that no visible signs of erosion or deposition were present. However, identifying suitable reference sites within the study area proved challenging, as the majority of the catchment is affected by either natural erosion and sediment accumulation processes or by human activities such as agriculture, land leveling, and construction. Despite these constraints, locations that most closely met the reference criteria were carefully selected to represent undisturbed background levels of ^{137}Cs and to serve as control points for comparative analysis.

Three reference locations were selected — two in the southeastern part of the catchment and one in the southwestern part. Additionally, sampling was conducted at a reference location in the northwestern part of the catchment, where previous sampling had already confirmed an undisturbed ^{137}Cs depth distribution in the soil profile, making it a validated site for reference inventory values.

At each reference location, the soil was sampled at 12 points. In cases where the soil was homogeneous, sampling was conducted using a corer to a depth of 25 cm. The core was sliced into 5 cm intervals to avoid mixing of soil layers. Where coring was not feasible, a soil profile was first opened with a spade, and standard cylinders were then used to collect samples at successive depths of 5 cm (Figure 6). All samples were labeled with the name of the reference site, the point number, and the sampling depth.

Figure 6. Soil sampling for ^{137}Cs analysis: core sampling with 5 cm interval slicing (left); cylinder sampling from an opened soil profile at successive 5 cm depths (right)

3 Sediment sampling from rivers for fingerprinting analysis

Sediment sampling was conducted at a total of 16 locations within the catchment area of the Malčanska River. Of these, 11 sampling points were located along the Malčanska River itself, four on its main tributary, the Crveni Potok stream, and one at the confluence of the Vrelo stream (Figure 7).

The selection of sampling sites was guided by the objective of ensuring representative coverage of the hydrological sub-catchments in terms of land use and land cover variability, as well as underlying geology and soil types. Particular attention was given to capturing spatial heterogeneity within the basin to facilitate accurate source attribution through the fingerprinting method.

Along the Malčanska River, the most downstream feasible profile was selected while avoiding sections influenced by ongoing major construction activities that could compromise sediment source assessments. Going upstream, one profile was positioned at the exit point of the river from the village of Malča, the largest settlement in the catchment. Two additional profiles were located within the village itself, one upstream and one downstream of the confluence with the Crveni Potok stream, the river's largest tributary. Another profile was selected upstream of the village, at the entrance to Malča. Further upstream, two profiles were established, one before and one after the confluence with the Vrelo stream. Additionally, sediment samples were collected from the two headwater branches of the Malčanska River, ensuring coverage of the uppermost parts of the basin.

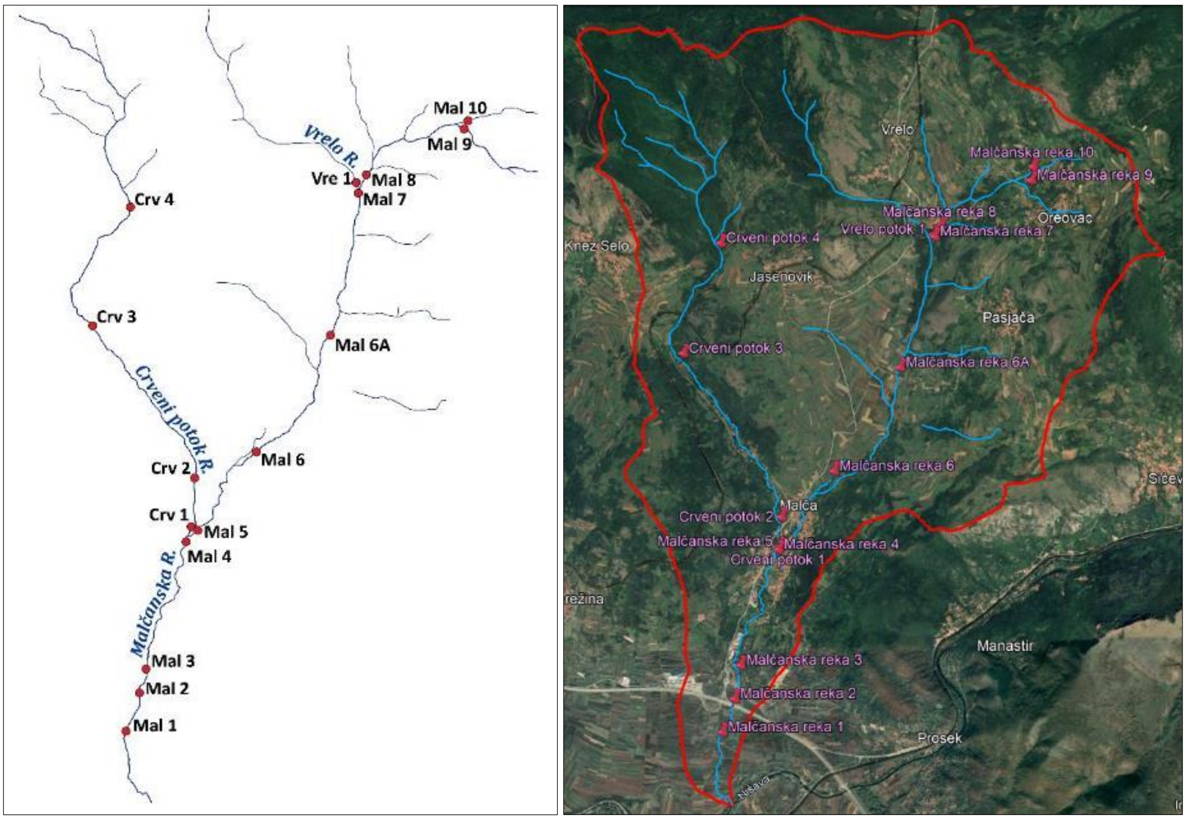

Figure 7. Overview of sediment sampling locations along the Malčanska River and its tributaries: simplified hydrological map (left) and satellite-based map with Google Earth background imagery (right)

On the Crveni Potok stream, the most upstream profile was chosen due to its position downstream of the large forested area characterized by distinctive geological formations, notably red sandstones, and corresponding soil types. The next profile was selected to include an area dominated by agricultural land use. The two most downstream profiles were positioned at the entrance to the village of Malča and the confluence with the Malčanska River, respectively. Finally, a sediment sample was collected at the confluence of the Vrelo stream with the Malčanska River to account for sediment input from this tributary.

Sediment sampling in the river included both the collection of riverbed sediment and the sampling of suspended sediment (silt) using artificial grass.

3.1 Riverbed sediment sampling

Riverbed sediment sampling was conducted at the predefined hydrological profiles throughout the catchment, by the established protocol. At each location, surface sediments were collected directly from the riverbed using a plastic cup, with a focus on obtaining the fine-grained, loose sediment fraction, while avoiding coarser gravel and cobble material and preventing the loss of fine particles during the sampling process. Approximately 1 kg of sediment was collected per site, based on a rough estimation. The samples were deposited into high-quality plastic bags, each clearly labeled with the sampling site code and location (Figure 8).

Figure 8. Riverbed sediment sampling and storage: plastic cup used for sediment collection (left); labeled plastic bags containing sediment samples (right)

3.2 Suspended sediment sampling

Suspended sediment samples were collected using artificial grass installed at selected hydrological profiles. The artificial grass was positioned near the riverbed, slightly above the water surface at normal flow levels, to ensure interception of suspended particles during elevated discharge events. Due to generally low water levels and limited turbidity throughout the sampling period, suspended sediment accumulation on artificial grass was observed at only a few locations. As a result, sampling was conducted on a single occasion, when hydrological conditions allowed for detectable deposition. At the time of sampling, the artificial grass mats were carefully removed and placed into labeled plastic bags to preserve the accumulated material. New, clean artificial grass was then installed at the same locations to enable potential future collection. In the laboratory, the trapped sediments will be washed from the grass using distilled water for further analysis.

Figure 9. The artificial grass used for suspended sediment collection: field placement near the river channel (left) and a close-up view showing accumulated fine sediment (right)