

Spatial analysis of land degradation sensitivity in Romania using the multi-criteria MEDALUS methodology – Scientific report 2019 –

The scientific activities conducted in 2019 were aimed at meeting the project's general objective (which essentially consists of a multicriteria analysis of land sensitivity to degradation in Romania based on the MEDALUS methodology), as well the five concrete objectives mentioned in the funding application:

- identifying/purchasing all geographic data sets (pedological, climatic, hydrological, biotical) deemed necessary for the MEDALUS model, in accordance with the regional/national specificities of this environmental process (I);
- processing the data as the main biophysical indexes that represent the main causes of land degradation and obtaining a final index of land susceptibility to degradation (II);
- countrywide mapping/statistically analyzing lands with different degrees of sensitivity to this process, based on the final index of land susceptibility to degradation (III);
- validating the final sensitivity model using field investigations (IV);
- promoting the importance of a multicriteria/interdisciplinary analysis of this environmental issue in the national scientific and political spheres by disseminating the project's results (V).

According to the 2018 scientific report, during the project's first six months, in 2018, the project's first objective (I) was met, i.e. purchasing and processing all sets of geographical data in order to obtain the quality indicators. More specifically, the Climate Quality Index (CQI), Soil Quality Index (SQI), Vegetation Quality Index (VQI), Water Quality Index (WQI) and Management Quality Index (MQI) were processed nationally in raster format. These main indicators obtained in 2018, which assess land quality from multiple geographical perspectives (climatic, pedological, ecological, hydrological and anthropogenic), were the foundation of the entire 2019 scientific activity.

Therefore, as a continuation of the first objective, in 2019, **the next three objectives were met** (and, in part, the last objective as well, as explained below), **which essentially consist of obtaining the final product Land Degradation Sensitivity Index (LDSI), national mapping of LDSI classes and validating this final product's results based on field investigations.** More specifically, **in the approximately 12 months of activity in 2019, all**

activities of the mentioned objectives were conducted, as described in the funding application (in accordance with the working plan and the Gantt diagram).

In concrete terms, for the project's second objective (II), 4 specific activities were successfully carried out (2.1. Calibration of acquired datasets; 2.2. Organizing and processing datasets as raster-type data; 2.3. Obtaining the main biophysical indicators CQI, SQI, VQI, MQI and WQI; 2.4. Obtaining the final product – LDSI), while the third objective (III) was met by conducting three specific activities (3.1. Mapping lands that are prone to degradation by generating a national map with LDSI sensitivity classes; 3.2. Geographically-based statistical analysis of sensitivity classes (landforms); 3.3. Administratively-based statistical analysis of sensitivity classes (development regions, counties, administrative-territorial units). For the fourth objective (IV), 2 specific activities were completed (4.1. Regular fieldwork and observations in key sectors indicated by the LDSI (areas that are highly-prone to degradation); 4.2. Establishing the relationship between field observations and the LDSI using statistical analyses (the ROC curve procedure), while some activities pertaining to the fifth objective (V) were finalized by disseminating results via scientific papers and presentations.

With regard to the actual scientific results, applying the MEDALUS model across Romania essentially showed that areas that are critically susceptible to degradation (>1.38, on the LDSI scale) cover extensive areas in Romania's extra-Carpathian region, especially in the Romanian Plain, Dobrogea Plateau and Moldavia Plateau, but also in the Inner-Carpathian region, especially in the Western Plain and, in part, in Transylvania Plateau (Fig. 1). Statistically, these critical areas (Critical 1, Critical 2, Critical 3) total in Romania ~68,600 km² or 29% of the national territory (Table 1). These synthetic results were obtained in accordance with the specific activities of objectives 2 and, partially, 3 (specific activity 3.1).

Table 1. The area, expressed in absolute and percentage-based (% of the total country area) values, which corresponds to the sensitivity classes of the final LDSI in Romania.

Class	Sub-class	Score range	Total area (km ²)	Total area (%)
Non-affected	N	<1.17	43031.31	18.18
Potential	P	1.17–1.22	38431.71	16.23
Fragile	F1	1.23–1.26	20191.73	8.53
	F2	1.27–1.32	24339.37	10.28
	F3	1.33–1.37	25608.12	10.82
Critical	C1	1.38–1.41	29487.09	12.45
	C2	1.42–1.53	38658.65	16.33
	C3	>1.53	446.36	0.19
Mask areas (artificial and aquatic areas)			16555.00	6.99

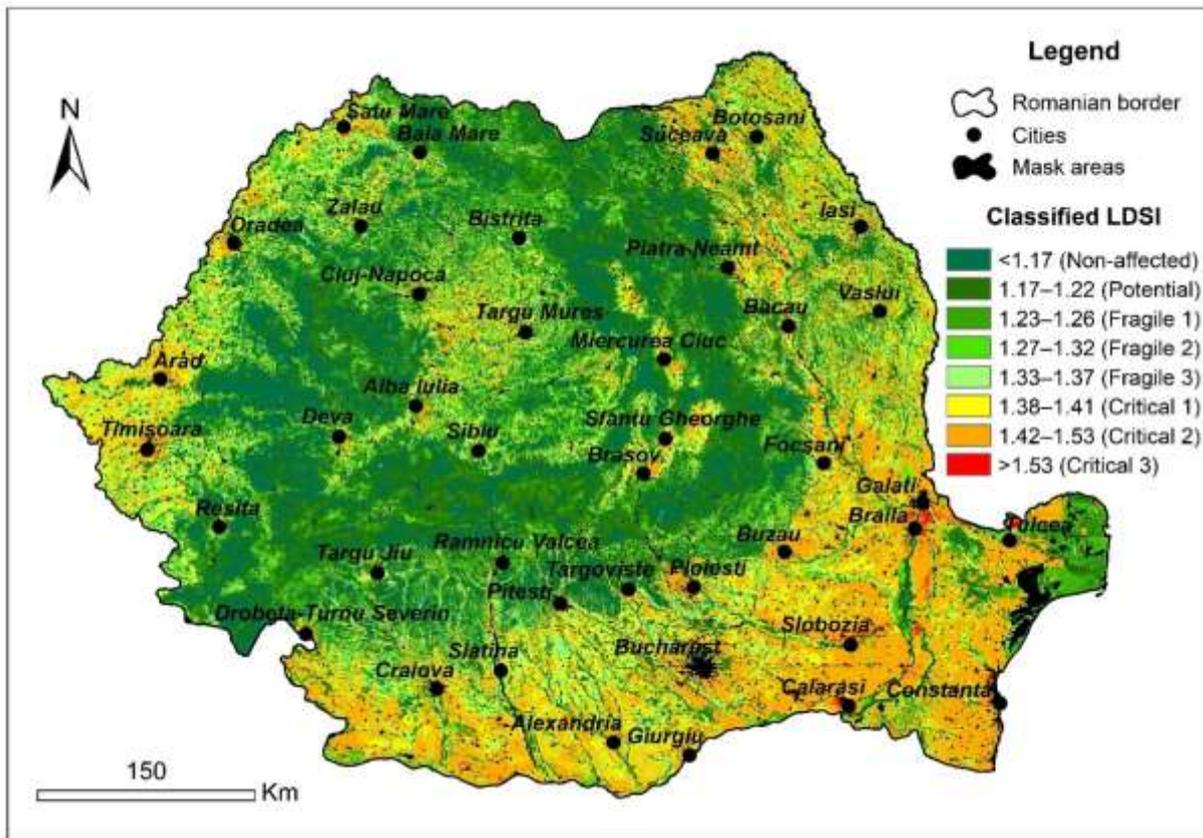


Fig. 1. Spatial representation of classified Land Degradation Sensitivity Index (LDSI) in Romania, considering all the quality indicators.

The results are also interesting in terms of the main geographic and administrative units (Fig. 2). Geographically, the results indicated that the extra-Carpathian region is by far the country's most heavily affected geographic area, as it is highly exposed to degradation especially in the Romanian Plain (Fig. 2). Administratively, the observations showed that the south and south-east development regions (NUTS 2) are the most vulnerable to degradation, while the counties (NUTS 3) making up these development regions are generally the most heavily affected nationally (Fig. 2). This final statistical data can be useful primarily to policymakers that can implement concrete actions for fighting land degradation and desertification in these hotspot areas marked by high land degradative conditions. These results were obtained in accordance with the specific activities 3.2 and 3.3 of the third objective of the project.

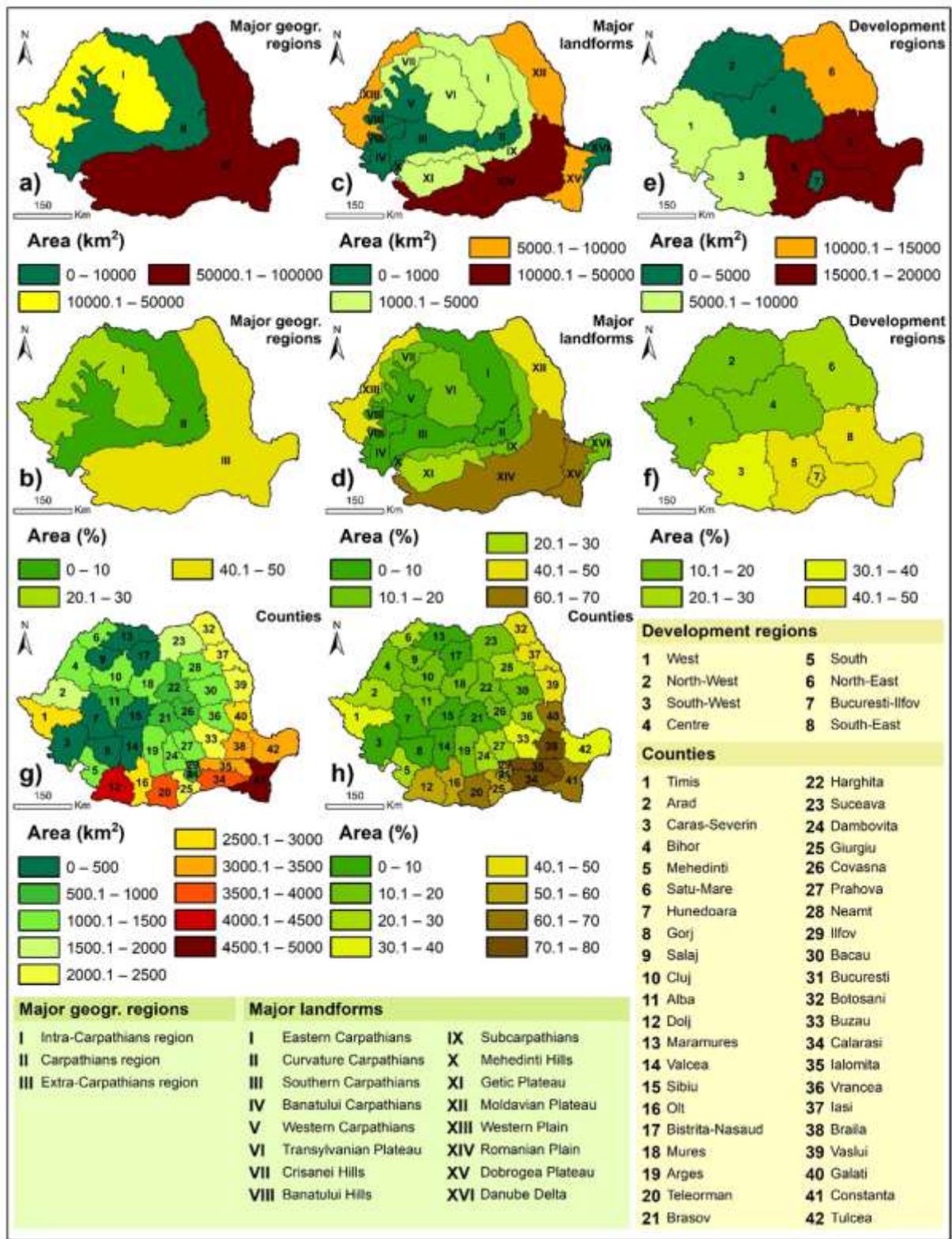


Fig. 2. Geostatistical representation of areas (absolute and percentage-based) of critical LDSI classes (Critical 1, Critical 2 and Critical 3) in Romania, in terms of major geographic (geogr.) regions (a, b), major landforms (c, d), development regions (e, f) and counties (g, h). Note: percentage data were computed by relating absolute areas to the total areas of reference spatial units; the in-map numbering was made from west to east, based on increasing longitude coordinate values of the spatial units' western boundaries.

At the same time, countrywide field observations, especially in the areas critically sensitive to degradation, revealed that, indeed, extensive critical areas (Critical 1, Critical 2, Critical 3) are already highly degraded in reality (Fig. 3), as a result of their being subjected to a strong decline in economic and ecological land productivity. In situ observations confirmed that areas that are highly susceptible to degradation are affected by multiple degradation processes, which directly or indirectly generate a decrease in the lands' biological and agro-ecological productivity – from various forms of erosion to salinization or degradation of vegetation (Fig. 3). The validation of LDSI results was conducted in accordance with the specific activities set for the project's fourth objective.

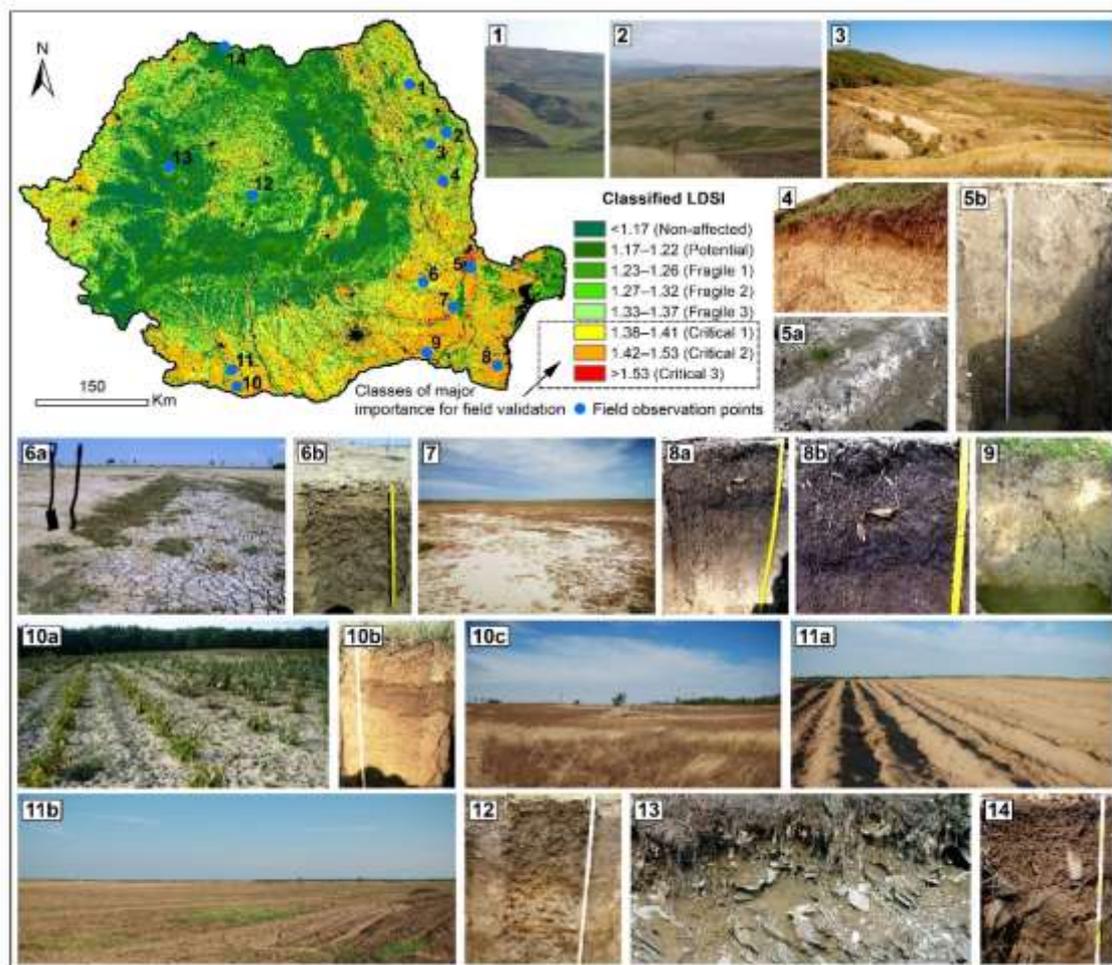


Fig. 3. Examples of local land degradation pathways based on field investigations carried out especially in the areas critically sensitive to degradation in Romania. Note: most field observations were made in areas Critical 1, 2 and 3, except for several cases where observations were made in classes Fragile 1, 2 and 3; all photographs highlight various forms of local land degradation, which directly or indirectly generate a decrease in the lands' biological and agro-ecological productivity – active landslides, gullies, rill and inter-rill erosion (photos 1, 2, 4), gleization and secondary salinization processes (photos 5a, 5b, 6a, 6b, 7, 9, 12), granular structure degradation processes (photos 8a, 8b), presence of sandy soils with poor textural characteristics (photos 10a, 10b, 11a, 11b), presence of underdegraded pastures and withered underdeveloped vegetation (photos 3, 10c), partially developed soils (with low morphological thickness) (photo 13) and soils with high skeletal content and low edaphic volume (photo 14).

Although the information is presented extremely briefly in this report, much more detailed results can be consulted at length in a **paper that was recently accepted for publication in the scientific journal Catena**:

Prăvălie R., Patriche C., Săvulescu I., Sîrodoev I., Bandoc G., Sfică L., 2020. *Spatial assessment of land sensitivity to degradation across Romania. A quantitative approach based on the modified MEDALUS methodology*. Catena, doi: 10.1016/j.catena.2019.104407.

Also, other important result dissemination forms (in accordance with the project's objective 5) consisted in **attending 2 international conferences** (abroad):

- **Prăvălie R.**, Bandoc G., 2019. *Assessment of the sensitive areas to land degradation in Romania using the MEDALUS method*. "ICLDSSM 2019: International Conference on Land Degradation and Sustainable Soil Management", June 20–21, Vienna, Austria (presentation in direct connection with the project objectives);
- **Prăvălie R.**, Bandoc G., 2019. *Spatial analysis of solar energy potential at global level. Evidences from a new high-resolution worldwide climate database*. International Conference "7th World Congress and Expo on Green Energy", June 24–25, Barcelona, Spain (presentation indirectly related to the project objectives).