A geographic information system for assessing the suitability of Romanian land to crops and land use

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1. What is land suitability?
2. GIS for land suitability assessment
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Land suitability (LS)

The **fitness** of a given type of **land** for a **defined use**

- Favorability according to the environmental conditions
- Specific purposes
- Practical nature

- Favorability of a crop or land use
- Production capacity
- Land improvements
- Pedo-ameliorative actions
Why is important?

33% of world agricultural land has disappeared or is severely degraded

- Continuous plowing of the fields
- Use of chemical fertilizers
- Monocropping / Inappropriate rotation of crops
- Overgrazing
- Natural processes (climatic, erosion, etc.)

2.5 cm of soil = 500 years

Very high risk

the trend is almost irreversible without major changes in farming practices
Intensity of processes affecting soil quality

- Intensive negative processes
- Minor negative processes
- Bare areas
- Positive processes
- Water

Romanian methodology for LS

- based on in-depth knowledge of the plant growth conditions

- designed as a relational database = tables with suitability values
Environmental conditions of the land

- slope
- landslides

17 Ecopedological indicators

Conditions for plant growth

- mean annual temperature
- average annual precipitation

hydrologic

- groundwater level
- flooding risk
- humidity excess

soil

- humus content in 0-50 cm
- edaphic volume
- soil pH in 0-20 cm
- carbonate content
- soil pollution
- soil texture in 0-20 cm
- salinization/alkalinization
- gleization
- pseudogleization
- total porosity of restrictive horizon

ICPA and OSPA
### Uses

<table>
<thead>
<tr>
<th>PS</th>
<th>Pasture</th>
<th>FN</th>
<th>Hayfield</th>
<th>AR</th>
<th>Arable</th>
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### Pomiculture

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<tr>
<th>MR</th>
<th>Apple tree</th>
<th>PN</th>
<th>Plum tree</th>
<th>CS</th>
<th>Apricot tree</th>
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<tbody>
<tr>
<td>PR</td>
<td>Pear tree</td>
<td>CV</td>
<td>Cherry tree</td>
<td>PC</td>
<td>Peach tree</td>
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<tr>
<td>VV</td>
<td>Grapery for wine</td>
<td>VM</td>
<td>Grapery for food</td>
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</table>

### Crops

<table>
<thead>
<tr>
<th>GR</th>
<th>wheat</th>
<th>SF</th>
<th>sugar beet</th>
<th>CN</th>
<th>hemp</th>
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<tbody>
<tr>
<td>OR</td>
<td>barley</td>
<td>SO</td>
<td>soy</td>
<td>LU</td>
<td>alfalfa-lucerne</td>
</tr>
<tr>
<td>PB</td>
<td>corn</td>
<td>MF</td>
<td>pea/bean</td>
<td>TR</td>
<td>clover</td>
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<tr>
<td>FS</td>
<td>sunflower</td>
<td>IU</td>
<td>linseed for oil</td>
<td>LG</td>
<td>vegetables</td>
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<tr>
<td>CT</td>
<td>potato</td>
<td>IF</td>
<td>linseed for tow</td>
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</table>
### LS assessment

**Non-spatial point with measurements**

**Each indicator suitability coefficient**

0 – unsuitable; 1 - optimal

**Formula**

Multiplication of 17 indicators coefficient x 100

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<table>
<thead>
<tr>
<th>Crop / Use</th>
<th>Mean annual temperature</th>
<th>Average annual precipitation</th>
<th>Gleization</th>
<th>Pseudogleization</th>
<th>Salinization/alkalinization</th>
<th>Soil texture (0-20 cm)</th>
<th>Soil pollution</th>
<th>Slope</th>
<th>Landslides</th>
<th>Groundwater level</th>
<th>Total porosity of restrictive horizon</th>
<th>CO3 content</th>
<th>Soil pH (0-20 cm)</th>
<th>Edaphic volume</th>
<th>Humus content (0-50 cm)</th>
<th>Humidity excess</th>
<th>Suitability grade</th>
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Coefficient: 51.2
<table>
<thead>
<tr>
<th>Favorability</th>
<th>Suitability grade</th>
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<tbody>
<tr>
<td>Not suitable</td>
<td>&lt; 10</td>
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<tr>
<td>Marginally suitable</td>
<td>10 - 30</td>
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<tr>
<td>Moderately suitable</td>
<td>30 – 40</td>
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<tr>
<td>Suitable</td>
<td>40 - 60</td>
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<tr>
<td>Highly Suitable</td>
<td>&gt; 60</td>
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</table>
Romanian methodology

- quantitative
- parametric

conceptualized to be implemented as a computer based tool

GIS application
- calculate suitability grades for crops and land use
- mapping, spatial and attribute query, spatial analyses, etc

is missing spatial component

computer application
- data storage and update
- calculation of suitability grades

partially implemented
**Objective:** development of a GIS application for calculation and mapping of the land suitability relevant to the Romanian crops and land use

Evaluate LS at regional and local scale in a region from north-western Romania
Data

- Digital elevation model
- Landsat imagery
- Sentinel-2 imagery
- Climate data
- Agricultural yield data
- Conventional soil maps
- Georeferenced soil profiles (physical and chemical analyses)
- Pedological studies
The document discusses the derivation of soil covariates relevant to ecopedological indicators. Spatial prediction of ecopedological indicators leads to the creation of digital maps that assign suitability values across the study area. A spatial database facilitates querying and mapping the desired information - suitability maps and their limitations for each indicator; suitability maps for each crop and land use.

Quantitative comparison with conventional maps and actual agricultural yield is performed using GIS applications.

The image illustrates the process of digital soil mapping, starting with input geospatial data and ending with resulting maps. The input data includes soil profiles, altitude, slope, precipitation, and lithology. The prediction model employs various techniques such as linear regression, logistic regression, regression kriging, classification trees, random forests, and fuzzy logic. Expert knowledge is also utilized.

The resulting maps show soil types and soil properties at a scale of 30 meters.

Digital soil mapping
Quantitative comparison with conventional maps
Quantitative comparison with actual agricultural yield
Applications of land suitability at national scale
Land use options: crops / pastures
Potential yield of potato
Applications of land suitability at county level

Land suitability for sunflower
Applications of land suitability at locality level

Land suitability for cherry tree
Potential yield of cherry tree

Potential yield (kg/ha)
- < 2000
- 2000 - 4000
- 4000 - 6000
- 6000 - 8000
- > 8000
Results of the application

- Spatial database
- Soil property maps
- Complex spatial and attribute query
- Suitability maps
- Tables with land unit area and suitability grades
- Maps of land limitations
- Auxiliary maps (relief units, lithology, erosion)
Land suitability using GIS

- Digital maps → could be used in field navigation
- Faster
- Could be continuously updated and improved
- More accurate results
- Overcome subjectivity
Discussion

• availability of input data

• data resolution and accuracy

• GMO ?
Thank you!