Status of soil, climate and digital mapping information in Serbia

Dragana Vidojević
Ministry of Agriculture and Environmental Protection of the Republic of Serbia – Environmental Protection Agency, Ruže Jovanovića St. 27a, 11160 Belgrade, dragana.vidojevic@sepa.gov.rs;

Jovica Vasin
Institute of Field and Vegetable Crops, 30 Maksima Gorkog St. 21000 Novi Sad, jovica.vasin@ifvcsns.ns.ac.rs

Nenad Marković
PC „Srbijašume“, 113, Mihajlo Pupin Boulevard, 11070 New Belgrade, nenad.markovic@srbijasume.rs

1st Interim Meeting of the REAWG on ANC, Andrevlje 29.6-1.7.2016.
Republic of Serbia
Ministry of Agriculture and Environmental Protection

Serbian team

1st Interim Meeting of the REAWG on ANC, Andrevlje 29.6-1.7.2016.
- The Republic of Serbia is located in southeastern Europe in the heart of the Balcan Peninsula.
- Large heterogeneity in geological substrate, climate, vegetation cover and soil fauna had resulted in the formation of a large variety of soil types.
- The area of Serbia was divided into nine edaphic-climatic regions.
- Each region includes several soil types whose combination defines the general characteristics of these regions.
**Climate**

Mean annual air temperature for the 1981-2010 base period

- Moderate-continental with more or less pronounced local characteristics.

Average precipitation totals for the 1981-2010 base period

- The mean annual air temperature across much of Serbia (at 22 principal meteorological stations) range between 11°C and 12°C.

- The mean annual precipitation sums across Serbia are in a range from 557 mm in Kikinda up to 1,018 mm on Zlatibor Mountain.
Soil degradation

- Soil erosion (of various degrees) affects about 80% of agricultural soil.
- In the central and hilly-mountainous regions water erosion is predominant.
- In the Vojvodina province in the north of Serbia, eolic erosion prevails, affecting approximately 85% of the agricultural soil.
- A number of conservation measures have been defined in agriculture as well as a related law aiming the protection of agricultural land from the harmful effects of erosion (Law on Agricultural Soil, Articles 18, 19 and 20).
- Soil quality is also affected by uncontrolled and inadequate dumping of waste and by contamination stemming from industrial complexes.
Land use

- Based on the statistical data for 2014, utilized agricultural area covers 3,506,830 ha or 45.2 % of the total territory of the country (Statistical Yearbook of the Republic of Serbia, 2015).

**Agricultural land – statistical data for 2014 (ha)**

<table>
<thead>
<tr>
<th>Arable land (ha)</th>
<th>Permanent grassland (ha)</th>
<th>Permanent plantations (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>1,819,188</td>
<td>Fruit plantations</td>
</tr>
<tr>
<td>Pulses</td>
<td>7,830</td>
<td>163,310</td>
</tr>
<tr>
<td>Potatoes, early and late</td>
<td>51,987</td>
<td>Vineyards</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>64,112</td>
<td>22,150</td>
</tr>
<tr>
<td>Industrial crops</td>
<td>346,524</td>
<td>Nurseries</td>
</tr>
<tr>
<td>Vegetables, melons and strawberries</td>
<td>52,680</td>
<td>1,531</td>
</tr>
<tr>
<td>Flowers</td>
<td>343</td>
<td>Other permanent plantations</td>
</tr>
<tr>
<td>Fodder crops</td>
<td>242,041</td>
<td>524</td>
</tr>
<tr>
<td>Other crops on arable land</td>
<td>1,713</td>
<td>Total</td>
</tr>
<tr>
<td>Fallow land</td>
<td>19,655</td>
<td>187,515</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,606,073</strong></td>
<td><strong>713,242</strong></td>
</tr>
</tbody>
</table>

Total
Utilized agricultural land (%)
CORINE Land Cover 2012

<table>
<thead>
<tr>
<th>Categories/CLC classes</th>
<th>2012</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td><strong>AGRICULTURAL AREAS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>211 Non-irrigated arable land</td>
<td>2,173,145</td>
<td>28.01</td>
<td></td>
</tr>
<tr>
<td>221 Vineyards</td>
<td>10,417</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>222 Fruit trees and berry plantations</td>
<td>24,248</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>231 Pastures</td>
<td>165,578</td>
<td>2.13</td>
<td></td>
</tr>
<tr>
<td>242 Complex cultivation patterns</td>
<td>992,857</td>
<td>12.80</td>
<td></td>
</tr>
<tr>
<td>243 Land principally occupied by agriculture with significant areas of natural vegetation</td>
<td>948,246</td>
<td>12.22</td>
<td></td>
</tr>
<tr>
<td>Sub-total</td>
<td>4,314,491</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FORESTS AND SEMINATURAL AREAS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>321 Natural grasslands</td>
<td>205,013</td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>4,519,504</td>
<td>58.24</td>
<td></td>
</tr>
</tbody>
</table>

There is a significant difference in land use statistical data and data from Corine Land Cover 2012 data base.
Altitudinal zonation of agricultural land and natural grasslands

<table>
<thead>
<tr>
<th>Altitude (m)</th>
<th>ha</th>
<th>km²</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-200</td>
<td>2,618,749</td>
<td>26,187</td>
<td>33.75</td>
</tr>
<tr>
<td>200-400</td>
<td>920,139</td>
<td>9,201</td>
<td>11.86</td>
</tr>
<tr>
<td>400-600</td>
<td>411,141</td>
<td>4,111</td>
<td>5.30</td>
</tr>
<tr>
<td>600-800</td>
<td>213,331</td>
<td>2,133</td>
<td>2.75</td>
</tr>
<tr>
<td>800-1000</td>
<td>130,756</td>
<td>1,308</td>
<td>1.69</td>
</tr>
<tr>
<td>1000-1200</td>
<td>128,567</td>
<td>1,286</td>
<td>1.66</td>
</tr>
<tr>
<td>1200-1400</td>
<td>64,024</td>
<td>640</td>
<td>0.83</td>
</tr>
<tr>
<td>1400-1600</td>
<td>21,374</td>
<td>214</td>
<td>0.28</td>
</tr>
<tr>
<td>1600-1800</td>
<td>9,350</td>
<td>93</td>
<td>0.12</td>
</tr>
<tr>
<td>1800-2000</td>
<td>1,931</td>
<td>19</td>
<td>0.02</td>
</tr>
<tr>
<td>&gt;2000</td>
<td>143</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>4,519,503</td>
<td>45,195</td>
<td>58.24</td>
</tr>
</tbody>
</table>

Altitudinal zonation of agricultural land was calculated using Digital Elevation Model (DEM)
Analyses of the national capacities for data management
Institutional Framework

- The Ministry of Agriculture and Environmental Protection
  - The Directorate for Agricultural Land
  - The Directorate for Water
  - The Forestry Directorate
  - SEPA
- The Sector for Rural Development within the Ministry of Agriculture and Environment Protection includes the Department for Rural Development
- The Directorate for Agrarian Payments
- The Provincial Secretariat for Agriculture, Water Management and Forestry
- The Republic Hydrometeorological Service (RHMS)
- The Republic Geodetic Authority
National policy assessments and policy recommendations
Legal Framework

• Law on Agriculture and Rural Development (OGRS, No. 41/09, 10/13)
• Law on Agricultural Soil (OGRS, No. 62/06, 65/08-other low, 41/09 and 112/15)
• Law on Incentives in Agriculture and Rural Development (OGRS, No. 10/13, 142/14, 103/15)
• Law on Environmental Protection (OGRS, No 135/04, 36/09, 36/09-other low, 72/09-other low, 43/11 decision adopted by the Constitutional Court and 14/16)
• Law on State Administration (OGRS, No. 79/05, 101/07, 95/10, 99/14),
• Strategy for Agriculture and Rural Development of the Republic of Serbia for the period 2014-2024 (OGRS, No. 85/2014)
• The National Strategy for Sustainable Development (OGRS, No. 57/2008)
• The National Strategy for Sustainable Use of Natural Resources and Goods (OGRS, No. 33/2012)
Status of Soil Data
Soil map according to the WRB classification
1st Interim Meeting of the REAWG on ANC, Andremlje 29.6-1.7.2016.
1st Interim Meeting of the REAWG on ANC, Andrevlje 29.6-1.7.2016.
Limited soil drainage

Areas which are water logged for significant duration of the year

- Wet within 80 cm from the surface for over 6 months, or wet within 40 cm for over 11 months
- Poorly or very poorly drained soil
- Gleyic colour patter within 40 cm from the surface

Cartographic units representing soil surfaces which belong to **Eugley**, **Pseudogley**, and specific mapping units belonging to **Fluvisol** soil types will be selected from the Digitalized Soil map of Serbia.
### Shallow rooting depth

| Shallow rooting depth | Depth (cm) from soil surface to coherent hard rock or hard pan | ≤30cm |

Analytical data on soil depth for the entire territory of the Republic of Serbia don’t exist.

Cartographic units representing soil surfaces which belong to Lithosol soil types, and certain lower level units classified according to national soil classification system as Rendzina, Terra Rosa and Cambisols will be selected from the Digitalized Soil Map of Serbia.
Unfavourable soil texture and stoniness

| Coarse material (volume %) fractions | ≥15% of the topsoil is coarse material, including rock outcrop, boulders |

Analytical data on content of coarse material (stone and gravel) for the entire territory of the Republic of Serbia don’t exist.

Cartographic units representing soil surfaces which belong to Lithosol soil types, and certain lower level units classified according to national soil classification system as Rendzina, Terra Rosa and Cambisols will be selected from the Digitalized Soil Map of Serbia.
Analytical data on texture of the soil surface for the entire territory of the Republic of Serbia are not available.

This type of information will be derived from the cartographic units classified as Arenosol soil type, and at certain lower level units as Regosols and Fluvisols will be selected from the Digitalized Soil map of Serbia.

Further fields check-ups may be done, depending on funding resources.
Unfavourable soil texture and stoniness

<table>
<thead>
<tr>
<th>Relative abundance of clay</th>
<th>Topsoil texture class is heavy clay (≥60%)</th>
</tr>
</thead>
</table>

Analytical data on texture of the soil surface for the entire territory of the Republic of Serbia are not available.

But, this handicap for the ANC project could be resolved either by identifying the clayey soils from the soil map of Serbia looking at Vertisols (locally known as Smonitzas) or at soils with vertic properties.

Moreover, the Serbia team propose to lower the clay % value from 60 to 50.
Unfavourable soil texture and stoniness

<table>
<thead>
<tr>
<th>Relative abundance of organic matter</th>
<th>Organic soil (organic matter ≥ 30%) of at least 40 cm</th>
</tr>
</thead>
</table>

According to the analysis of the soil map, the soils of Serbia store $695.31 \times 10^{12}$ g (Tg) of organic carbon at 0-30 cm and $1142.42 \times 10^{12}$ g (Tg) at 0-100 cm. The map of soil organic carbon distribution is available to the depths of 0-30 cm. National estimates of the content and spatial distribution of soil organic carbon in topsoil are available for different land use categories.

According to the analysis of 96,011 soil data from the State Soil Fertility control program, the average rate of Soil Organic Matter (SOM) expressed as humus content in the top 30 cm of the agricultural soils is 3.4 %. Only 4.3 % of samples has the rate of soil organic matter beyond 6 %.

Nevertheless, the ANC methodology, as far as the SOM is considered, do not require data for soils with less than 30 % SOM. This information will be derived from the consider Digitalized Soil Map of Serbia for the soil mapping units classified as **Histosols**.
Soil organic matter in agricultural soil to the depth of 0-30 cm (%)
Poor chemical properties

<table>
<thead>
<tr>
<th>Presence of salts and exchangeable sodium</th>
<th>Salinity: ≥ 4 deci-Siemens per meter (dS/M) in topsoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodicity: ≥ 6 Exchangeable Sodium Percentage (ESP) in half or more (cumulatively) of the 100 cm of soil surface layer</td>
<td></td>
</tr>
</tbody>
</table>

No analytical data are available either for soil salinity nor sodicity for the entire territory of the Republic of Serbia.

This information will be derived from the soils classified as Solonchaks and Solonetz, and in certain cases by the lower level units such with saline subtypes mixed with Fluvisols, Eugley, Humogley (Hydromorphic Black soil).

This information will be derived from the Digitalized Soil map of Serbia.
**Poor chemical properties**

| Excessive acidity | Soil Acidity: ≤5pH (in water) in topsoil |

The starting point for defining the areas with acidity problems will the cartographic units belonging to **Dystric Cambisols** that will be selected from the Digitalized Soil map of Serbia. However, the large majority of this soil type is most frequently found among forest soils (not agricultural).

Constructing a map based on the results of analyses in the framework of soil fertility control in the forthcoming period would be a better methodology for the identification and delineation of the ANCs based on acidity.

According to the analysis of 90,515 soil data from the State Soil Fertility control program conducted in 2015, 6.86 % of analysed samples have a pH≤5 (in water).

Soil acidity map (pH in water) is under preparation and the data processing will take some time until the map will be available after data quality control and assurance process. However, the soil acidity map (pH in nKCl) is available for the agricultural land of the whole territory of Serbia.
Poor chemical properties | Excessive acidity | Soil Acidity: ≤5pH (in water) in topsoil

pH value of agricultural soil to the depths of 0-30 cm
Status of Climate Data
Available data

- Republic Hydro-Meteorological Service of Serbia (RHMZ)
- Meteorological Yearbooks (pdf)
- Daily values for minimal, maximal and average air temperature and precipitation in digital format
- Potential evapotranspiration (PET), needed for calculation of aridity index (i.e. dryness), is calculated by RHMZ using the Hargreaves method
Monthly values published in Meteorological Yearbooks

- Air Pressure (mb) (7; 14; 21; average) **
- Air Temperature (°C) (min., max., ampl.; min 5cm; 7-14-21, average) **
- Vapor pressure (mb) (7-14-24; Average) **
- Relative Humidity (%) (7-14-24; Average; min) **
- Wind (m/s) (Average; >6B; <6B) ** (7-14-24; Average) for daily values
- Insolation (h) **
- Cloudiness (in 1/10) (7-14-24; Average) **
- Precipitation (mm) (Sum; Max; Day) **
- Snow (cm) **
- Number of Days with
  - Tmin <= -10
  - Tmax <0
  - Tmin <0
  - Tmax >=25
  - Tmax >=30
  - Tmin >=20
  - Cloudiness (<2 and >8)
  - Precipitation >= (0,1; 1; 10)
  - Frequency of directions and mean wind speed (m/s)
Spatial positions of the main and minor meteorological stations
Status of Geographical Information System (GIS) data
Projection

- GIS data for the territorial and administrative division of the Republic of Serbia are available in ESRI shape file compatible vector format in former nationally used projection with parameters listed on the right, but can be easily re-projected in WGS 1984 GCS or WGS 1984 UTM Zone 34N which is the new official projection for the Republic of Serbia.

Projection:
- Transverse_Mercator
- False_Easting: 7500000,000000
- False_Northing: 0,000000
- Central_Meridian: 21,000000
- Scale_Factor: 0,999900
- Latitude_Of_Origin: 0,000000
- Linear Unit: Meter (1,000000)

Geographic Coordinate System: GCS_Bessel_1841
- Angular Unit: Degree (0,017453292519943299)
- Prime Meridian: Greenwich (0,000000000000000000)

Datum: D_Bessel_1841
- Spheroid: Bessel_1841
  - Semimajor Axis: 6377397,15500000003000000000
  - Semiminor Axis: 6356078,962818188600000000
  - Inverse Flattening: 299,152812799999990000
The territorial and administrative division of Serbia

1. NUTS* 1 – Regions (2 in total)
   - Serbia North
   - Serbia South
2. NUTS 2 – Regions (5 in total)
   - Region of Belgrade
   - Vojvodina (Also administrative Province)
   - Region of Šumadija and Western Serbia
   - Region of Southern and Eastern Serbia
   - Kosovo and Metohija (Also administrative Province)
3. NUTS 3 – Areas (30 in total)
4. Administrative districts (29 in total)
5. Towns / Cities (24 in total)
6. Municipalities / City municipalities (198 in total)
7. Settlements (6158)

Further territorial division in cadastral sense is as follows:
8. Cadastral Municipalities
9. Parcels
Municipalities and Cadastral Municipalities
Digital terrain model

• The digital terrain model and the layers of slope and exposition will be derived from the Digital Elevation Model (DEM)

• Resolution and precision of DEM:
  – 2 m in lowlands and 6-7 m in highlands (VGI)
  – 1 Arc SECOND (approximately 20-30 m)
DEM(s) 1 Arc SECOND
Land Cover and Land Use Map

• Land cover map of Serbia is available in CORINE methodology (2012)

• The land use map of the Republic of Serbia does not exist at the present time and it could be generated after the cadastral parcels are completely digitized and their usage is defined. Nevertheless, this does not restrict the delineation of the ANCs, as the areas of interest for the ANC project will be derived from the CORINE land use/land cover cartography.
Data gaps, problems, and solutions
• There is a significant difference in land use statistical data and data from Corine Land Cover 2012 data base.

• If the daily climate data will not be available, the monthly data derived from the Meteorological Yearbooks will be used.

• Soil acidity map is yet under construction and data processing may take some time until the map will be available, obviously after data passing the quality control and assurance process.

• Soil map needs topological verification before being used for defining the ANCs.

• In practice Serbia has a limited number of examples of good practice with the mechanisms for horizontal and multi-stakeholder coordination. Efficient horizontal coordination functions mostly through personal contacts among civil servants.
Provision of recommendations for improved data management in the context of the Areas with the Natural Constraints

• Better cooperation and communication among the national institutions responsible for the production of data needed for the ANC project

• Exchanging the experiences in collecting and managing the data between the national teams involved in the project will have a crucial significance in further work.

• Therefore, more meetings of the national teams are hereby suggested.
Thank you for your attention!