Theme 3 | Soil data for policy and decision-making

The Russian ground-based monitoring system of the carbon stock in agricultural soils

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Introduction

- The Kyoto and Paris conferences outlined the scientific and legal framework for low-carbon economic development.
- It is now assumed, that agricultural soils have huge potential for greenhouse gasses (fig. 1)
- The scientific consortium "RHYTHM Carbon" is working since 2022 and has a subtopic "Development and scientific justification of a carbon budget accounting system in agroecosystems…"

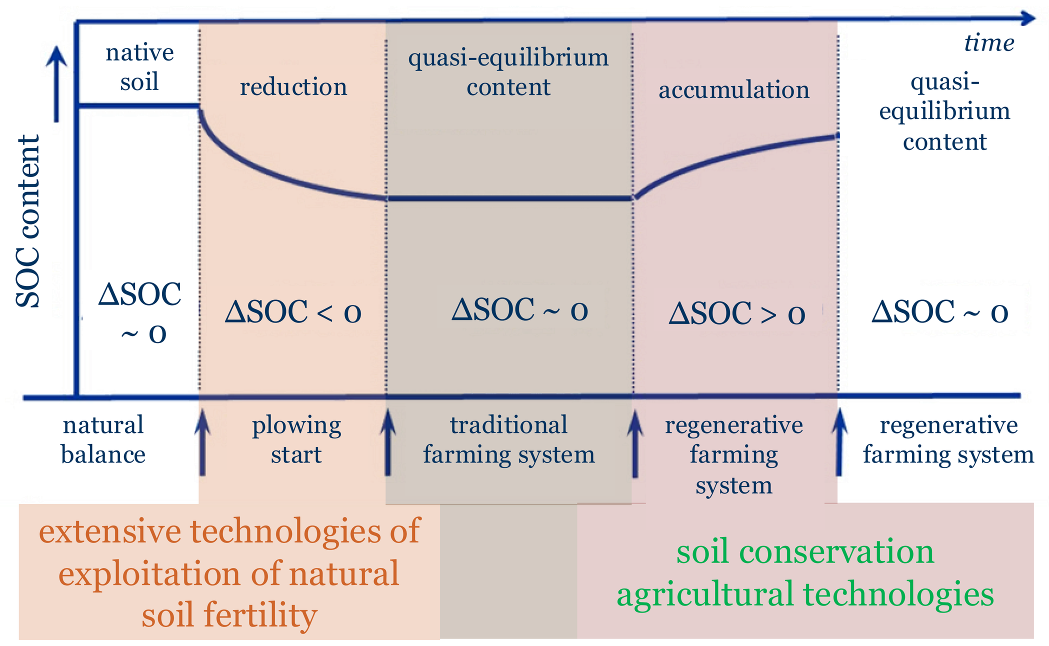

Fig. 1. Schematic diagram of the transition to carbon sequestration in agroecosystems

Study Areas

- It is supposed to create about 30 test polygons until 2030, nowadays 5 of them are in effect with 6-12 plots (fig. 2)

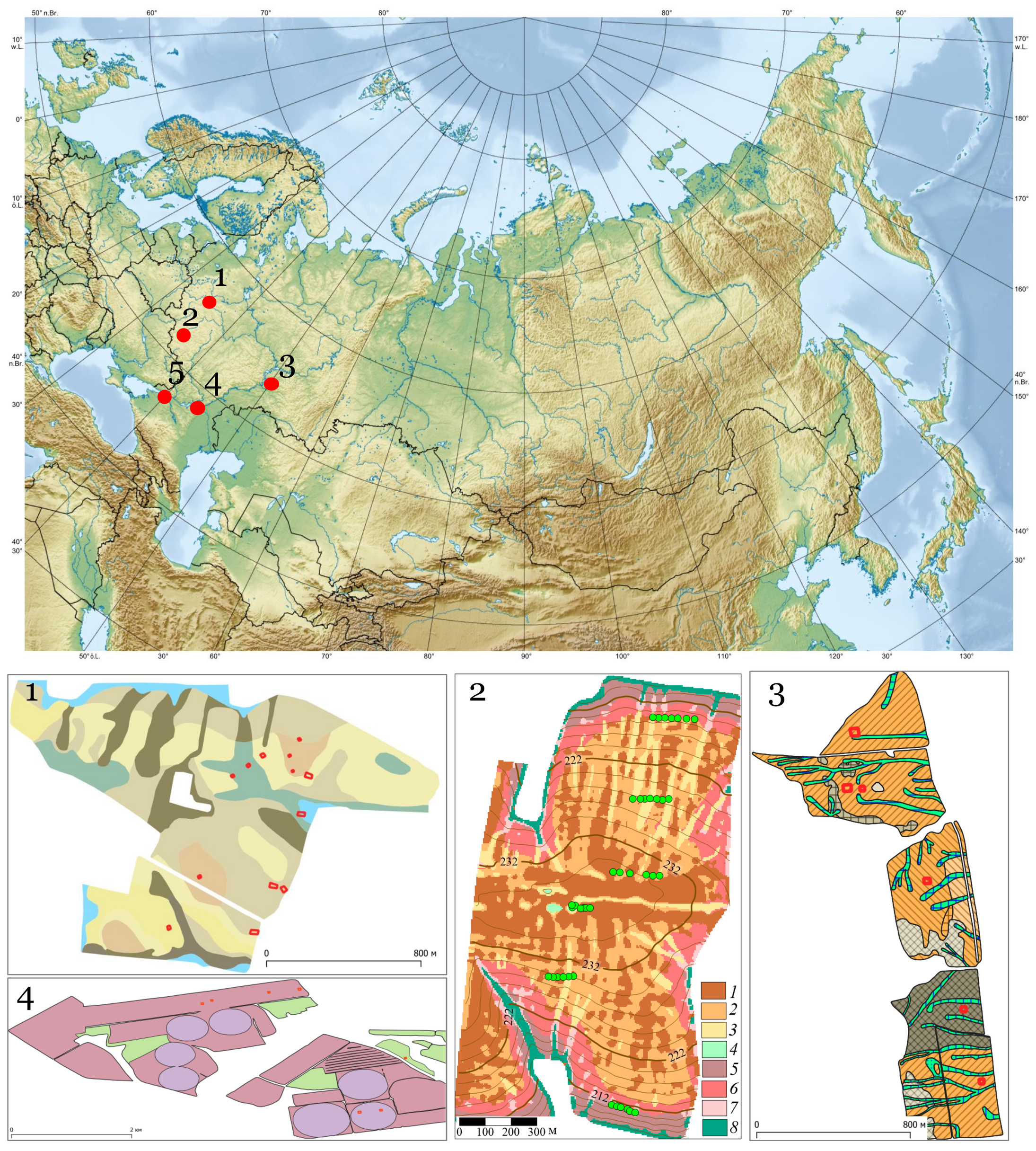

Fig. 2. Location of study areas (test polygons): 1 – Tver; 2 – Kursk; 3- Samara; 4 – Volgograd; 5- Rostov.

Materials and Methods

The monitoring system consists of (fig. 3):

1) Test polygon (about 2x2 km) or more;
2) Plot 30×30 m;
3) 9 individual sampling points with sampling by layers.

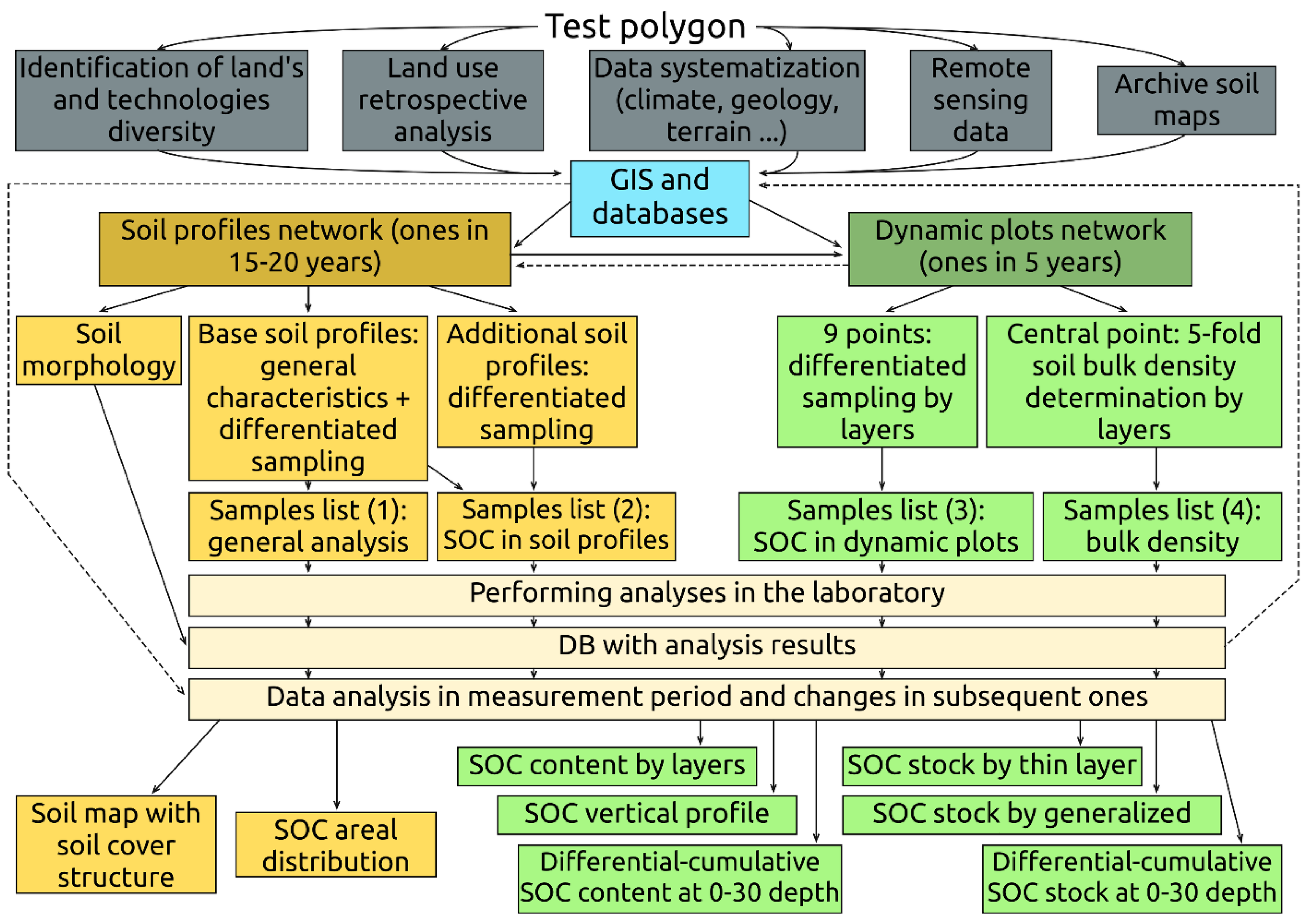

Fig. 3. Scheme of the ground-based monitoring system for soil organic carbon in soils of agroecosystems at the test site

- Plots within test polygon have to represent regional soil cover structure and agricultural land use types and consist of at least two repetitions;
- 9 individual soil sampling points may be located by 4 different variants according to soil area (fig. 4);
- samples are taken to measure soil bulk density and carbon content, at the central point, while at the other points, only carbon is measured.

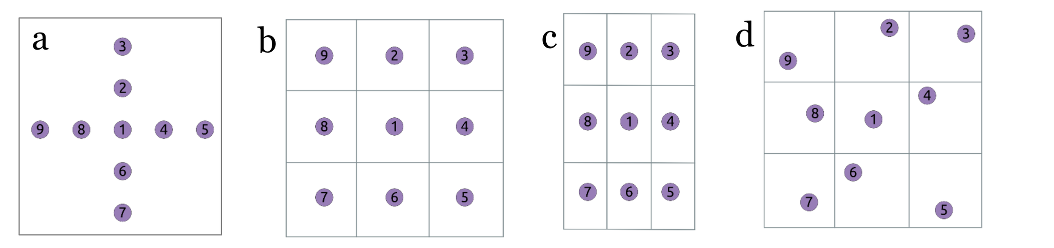

Fig. 4. Schemes for soil sampling at the dynamic monitoring plot: (a) cross, (b) regular square grid, (c) regular rectangular grid for narrow areas, and (d) stratified random with a fixed stratum (cell) step.

- The number of soil samples and depth of their collecting varies depending local conditions (fig. 5)

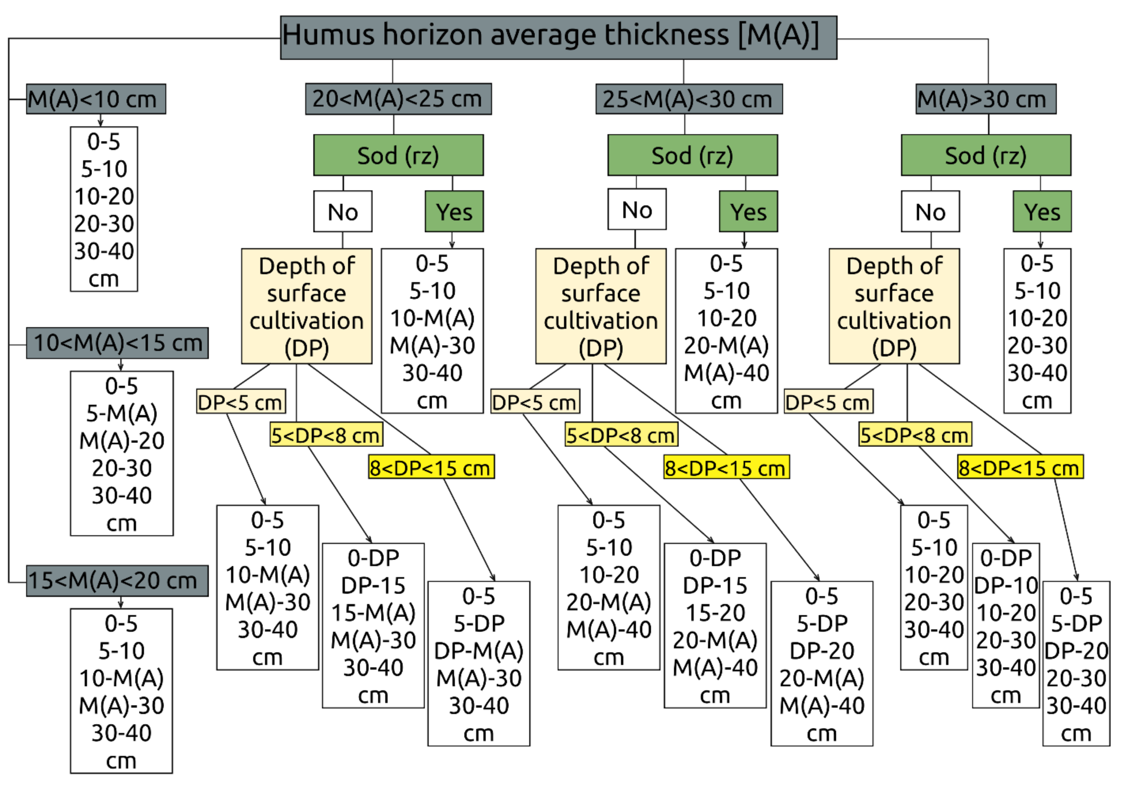

Fig. 5. Scheme for selecting the recommended depth of differentiated soil sampling of surface soil horizons (0-40 cm) to determine the carbon content and bulk density of soil.

- The determining of organic carbon content is proceeding by dry combustion in oxygen flow method with Metavac CS30 after inorganic carbon removal for each individual soil sample

Results

- The results of the analytical determination of carbon showed high spatial and depth variability of carbon content, that depends on the texture and land use type (examples at fig. 6)

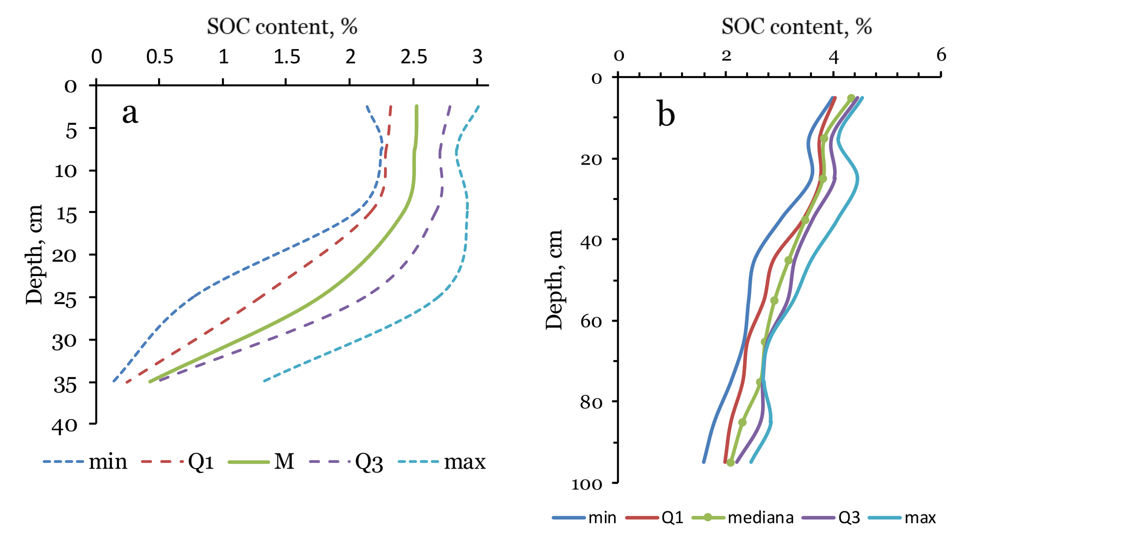

Fig. 6. The averaged vertical profile of SOC content in sandy loam podzols (a, area 1) and loam chernozem (b, area 3, no-till)

- Calculating SOC stock (fig. 7) in the arable soil horizon has shown that in the non-chernozem zone it varies from 30 to 70 t/ha, and in the Chernozem zone - from 100 to 250 t/ha and depends on genetic type of soil, soil texture and land use type (fig. 8)

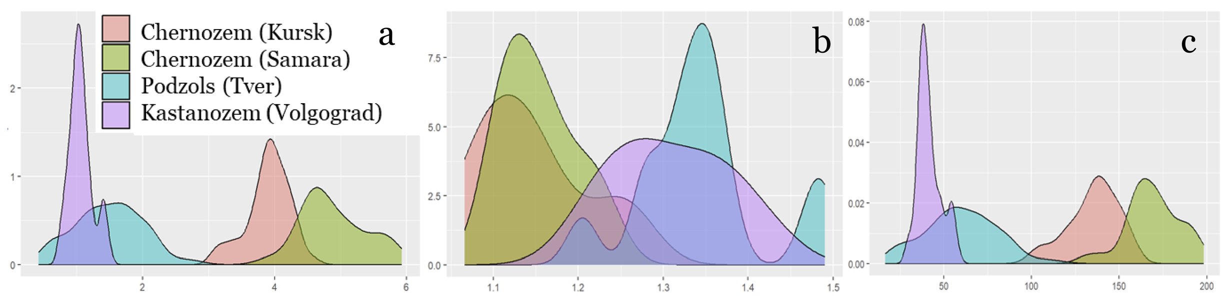

Fig. 7. The density plots of SOC content (a, %), soil bulk density (b, g/cm³) a SOC stock (c, t/ha) in arable horizons in different regions

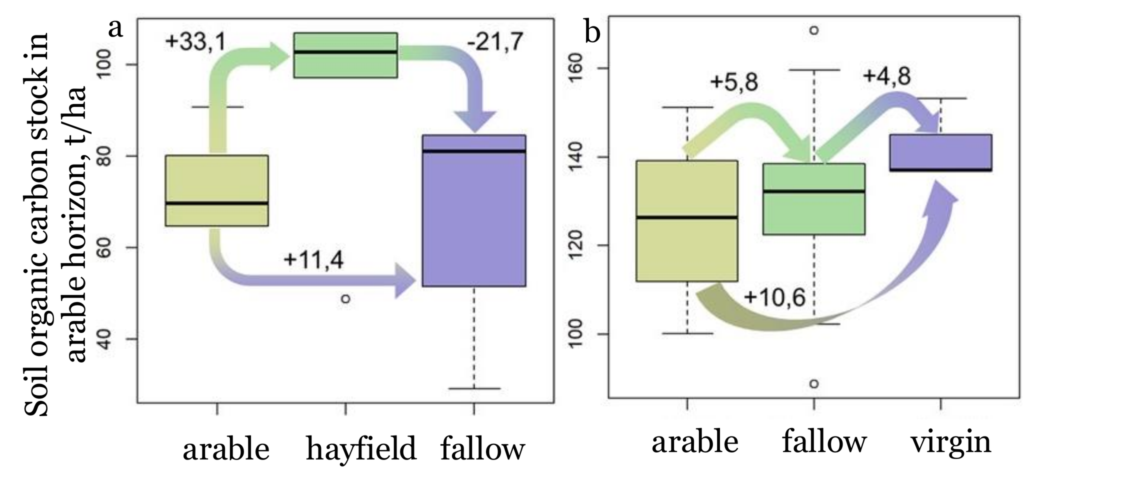

Fig. 8. The measured SOC stock (t/ha) in arable horizons in sandy loam podzols (a, area 1) and loam chernozem (b, area 2) in different land use types

- Estimates of the minimum significant difference in carbon content in the upper soil is 0.1 – 0.5% for chernozems and can increase to 0.8% in podzols.
- This will allow us to judge the SOC accumulation in 5-10 years (fig. 9)

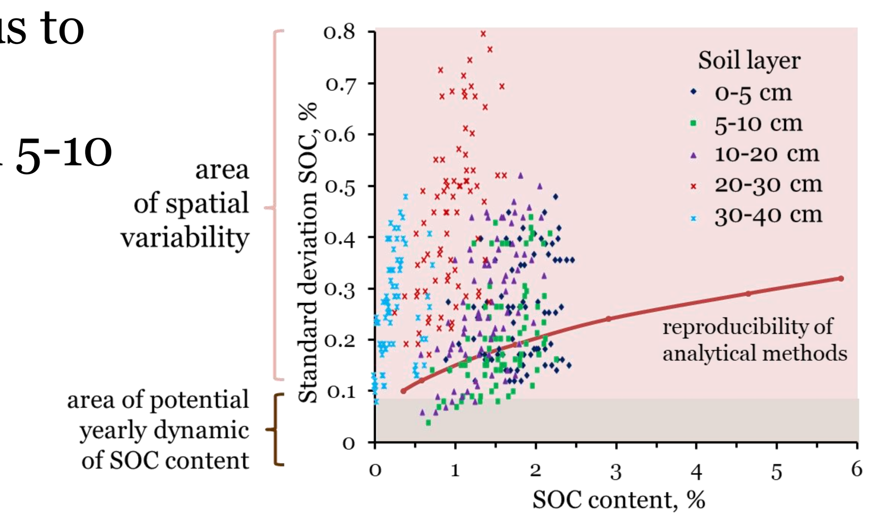

Fig. 9. The SOC content vs. standard deviation SOC content plot to determine the minimum significant difference and repeatability of monitoring

Conclusions

- System for monitoring of organic carbon in soils of croplands in Russia is presented: test polygons with plot 30×30 m with 9 sampling points inside is a key element of monitoring system;
- Differentiated soil sampling by depth in thin layers of 5 or 10 cm is proposed;
- In the non-chernozem zone, carbon reserves in the arable soil horizon vary from 30 to 70 t/ha, and in the Chernozem zone from 100 to 250 t/ha;
- No-till contributes to the formation of an accumulative vertical profile of SOC.

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