



Soil priorities in Russia

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1. Introduction

Soil science is believed to originate from Russia (Brevik and Hartemink, 2010). Though many researchers worldwide worked with soils, the birth of soil science as a separate scientific discipline is associated with the seminal works of Vasilii Dokuchaev (Rusakova et al., 2022). Also, the Russian and Soviet soil science leadership was internationally recognised up to the 1930s (Hartemink, 2021). However, in the Soviet Union, the development of soil science was strongly biased for political reasons because some scientists used Marxist ideology for supporting their doubtful theories (Soyfer, 2001). Western researchers were criticised for “bourgeois” and “conservative” views and mainly ignored, only in the 1970s and especially after the fall of the Soviet Union in the 1990s, regular exchange of ideas between Russia and the outer world was restored. A specific feature of the development of soil science in the Soviet Union was its focus on soil genesis and classification. Although the study of soil composition and properties was also valued, many important fields in current soil research, such as digital soil mapping (DSM) or spectroscopic analysis, were disregarded or underdeveloped in Russia. After the fall of the Soviet Union in the 1990s, the economic collapse of the agricultural sector strongly affected the demand for applied soil research. Soil survey completely disappeared, and agricultural survey strongly reduced its activities in these years. Many soil scientists left the country, while the others changed their occupation to more profitable professions. The situation is getting better now, on a step-by-step basis. Until recently, many Russian researchers were involved in international projects. The number of Russian publications in international journals gradually increased. Finally, the authorities, businesses, and society in the Russian Federation understand the importance of soil science in the country's sustainable development.

2. Research

In the past few decades, soil research in Russia followed the trends of international science. In some areas, such as soil degradation assessment, the Russian approaches corresponded well with the research on the international level (Krasilnikov et al., 2016). Currently, soil researchers all over the world face new challenges. In recent decades, there has been a large-scale transformation of soils and their functions due to global climate change, soil pollution and the construction of soils with specified properties. We should obtain fundamental knowledge about changes in the biogeochemical cycles of carbon, biogenic and toxic elements under the influence of climatic changes, point and diffuse pollution of soil cover, to establish patterns associated with changes in the properties, modes and functions of soils as a result of the transformation of the natural environment occurring under the direct or indirect influence of human activity. An urgent task required is to study of soils modified or completely constructed by man to learn about the functioning of soil-like bodies that previously did not exist in nature (Dvornikov et al., 2021). It is necessary to study the soil microbial community by modern metagenomic methods, which will allow us to advance in understanding the changes in the microbial pool under the influence of anthropogenic factors. The main challenge of our time is in developing a system of sustainable management of soil resources based on modern digital technologies, taking into account the economic feasibility of land-use strategies. The solution requires a combination of theoretical and applied studies. In Russia, a progressive approach based on adaptive-landscape farming systems has been developed (Kiryushin, 2019). Unfortunately, its application is relatively expensive and thus its distribution is limited to few progressive agricultural enterprises.

In 2019, the Russian Foundation for Basic Research (RFBR) opened a

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call “Fundamental problems of soil research and soil resources management in Russia”. The expert community outlined the following topics for the call, which reflect the priorities in soil science research in Russia:

- The impact of global and regional climate changes on the state of Eurasian soils in the past, present and future;
- Mechanisms of soil organic matter stabilization at the molecular and ecosystem levels;
- Technogenic and agrogenic soil pollution;
- Construction of improved and artificial soils;
- Study of the microbiome and metagenome of Russian soils as the basis for effective agriculture and soil protection;
- Digital agriculture, soil information systems, remote and proximate sensing methods of soil and soil cover research;
- The economics of land degradation.

Though the funding was not large (50,000–100,000 USD equivalent per year per one project), the call had a good response, with 265 proposals submitted, with a total 46 projects supported by the RFBR with an overall annual budget of 2.8 million USD equivalent. After two years of work, the researchers involved in the projects published more than 400 peer-reviewed papers and presented numerous talks at scientific conferences. The groups supported by the RFBR and many other scientists followed the priorities outlined in the call. In classical pedology, the concept of extreme pedogenesis brought a fresh stream to the study of soil genesis under unusual environments (Goryachkin et al., 2019). It is especially important to note significant progress in the development of the areas previously underdeveloped in Russia. Lozbenev et al. (2021) successfully combined hydrological modelling with spatial interpolation of soil properties thus incorporating processes in the factors–properties DSM approach. In digital soil morphometrics, a spectral database has been developed for the soils of the mixed forest zone of European Russia (Kirillova et al., 2021). Novel results were produced in soil metagenomics (Semenov, 2021): differences in the structures of prokaryotic communities in A, AB, and B horizons of Chernozems under forest, fallow, and arable land.

3. Education and extension

The situation with higher education in the area of soil science in Russia seems better than in many other countries. In M.V. Lomonosov Moscow State University, there is a Faculty of Soil Science, the only faculty with such specialisation in the world, which releases annually 60 bachelors and 40 masters in soil science. Also, many students are studying in the Russian State Agrarian University – K.A. Timiryazev Moscow Agricultural Academy, where education is more agronomy-focused. Also, many universities have soil science departments at the faculties and institutes of biology, geography, Earth sciences, agriculture and other related areas.

However, the state of education in soil sciences in Russia is not as good as it may seem to be. The interest of potential students in studying soil science is relatively low, as the demand for “pure” soil scientists in the labour market is not very high. Most of our graduates have to seek a job in related areas such as the environmental expertise, agronomy, chemical analyses etc. On the one hand, an educated soil scientist is a kind of “universal soldier” who has basic knowledge in many areas, from biology and agriculture to geology and chemistry. On the other hand, in most cases, after graduating from soil science faculty or department, young people have to adjust their knowledge to a new area if they do not continue a scientific career in soil science. However, in professional soil research, we observe a significant involvement of experts in other scientific disciplines in soil research. For example, the intensive

development of pedometrics attracted mathematicians and computer scientists in soil studies. The study of soil organic matter today is mainly in the hands of professional chemists. All these processes lead to the certain dissolution of soil science as an independent discipline. It is difficult to say if we can resist this process, and should we or should we not: in fact, natural scientific research is progressively becoming more interdisciplinary. We definitely should continuously update the educational programs to be in line with the current research and pressing practical challenges.

A big issue is the lack of soil education on the early levels of education. In most schools, soils are presented at a single lesson in physical geography. In some secondary schools, even geography is absent as a separate subject, and pupils attend a course of “natural sciences”, where soils are commonly neglected. There is an introductory course in soil science in colleges specialising in agronomy, forestry, and some other areas, but soil is an unknown part of the world for most professions. As a result, most people are entirely unaware of the existence of soil science and even about the importance of soils for agriculture and the environment.

4. Conclusions

Soil scientists in Russia have many practical issues they have to solve. Long-term underuse of fertilisers resulted in the substantial depletion of nutrients in most agricultural soils. The lack of investment in land reclamation and improvement has led to soil degradation phenomena such as erosion, nutrient mining, organic carbon and biodiversity loss. Currently, the challenge for reducing the carbon footprint of mining and industry made the politicians think about soil organic matter its important role as a carbon sink. Also, the geographical location and extensive territory makes essential the study of permafrost soils in taiga, tundra and Arctic regions of the country especially with the impacts of climate change on such soils. These practical issues require good knowledge of soil system functioning, and thus society requires well educated and active soil scientists.

Declaration of Competing Interest

None.

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