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Global climate and soil cover in Russia: function and role of the carbon landfill

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Abstract. One of the most discussed problems of the civilized world of the 21st century is the global climate and the world economy, their importance and influence on the problems of ensuring the environmental safety of the entire globe. This overview article is considering the EU's announcement of the introduction of a carbon tax on imported goods and Russia's readiness to develop suitable (unified) methods for calculating the CO₂ absorption capacity of the environment, which would be recognized by the world community, as well as the National System for accounting for greenhouse gas emissions by ecosystems (forest, steppe, tundra, farmland, bodies of water, etc.). Moreover, this article notes the importance of studying the emission and sequestration of greenhouse gases (creation of carbon landfills, farms) by different types of soils, the importance of which is characterized by the upcoming "carbon tax" on products exported outside our country.

1. Introduction

The trend of economic globalization that has conquered in recent decades and has turned into global problems and actualized isolation processes. The pandemic (COVID – 19) has only speed up the crisis, which "instantaneous" exacerbated the urgent problems of globalization; systemic, financial, and global crises of nature management. Therefore, the subject of greening consciousness is currently the issue of protecting the environment from the anthropogenic impact of man on the Earth, the implementation of which is possible provided that the critical importance of "ecological culture" and "ecological consciousness" is realized. However, despite the shift in information focus in 2020, the problems associated with global climate change remain a significant challenge, including for the agricultural industry additionally. It should be noted that Russia is a party to at least 4 UN conventions:

1. Ramsar Convention on Wetlands, Iran (February 2, 1987);
2. UN Convention to Combat Desertification (UNCCD), Spain, (September 3-14, 2007);
3. Convention on Biological Diversity, Japan, (October 29, 2010);
4. United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement, France (December 12, 2015);

The Paris Agreement provides the need to develop a long-term national strategy for "low-emission" development, reducing greenhouse gas emissions by at least 40% by 2030 (and further up to 55% by



2050) According to the Paris Agreement on climate change, “all Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies” to the United Nations Framework Convention on Climate Change (UNFCCC) by 2020 [1]. Low-emission development means the reduction of CO₂, CH₄, and N₂O emissions in agricultural production, using techniques that prevent irreversible mineralization and the maintenance and optimal accumulation of organic matter in the soil.

2. Materials and methods

It is fair to state that the Russian system for assessing anthropogenic emissions and absorption of greenhouse gases and the Russian register of carbon units were created back in 2006. The methodology of national reporting for the section that includes the soil fund of the Russian Federation and the requirements for accounting for emissions and absorption of greenhouse gases by different types of soils are set out in the National Report “The Global Climate and Soil Cover in Russia: Assessment of Risks and Environmental and Economic Consequences of Land Degradation. Adaptive systems and technologies for rational use of natural resources (agriculture and forestry)” [2, 3].

With the help of drones and satellites, it is possible to analyze how much CO₂ is absorbed or released on the surveyed plot of land. It is vital to consider how many greenhouse gases are emitted by various biotopes, depending on vegetation, living inhabitants, and many other factors. When calculating carbon sequestration or release, consideration should be given to weather conditions and soil composition, where national environmental standards can be developed based on the data obtained.

At the same time, the soils of our country remain insufficiently demonstrated in the global collection of soil data. The lack of national soil data at the international level leads to the fact that the assessment of our country's soil organic carbon reserves in global projects is based on averaged indicators of the content of soil organic carbon and the share of Russia in the soil fund of the World.

3. Results and discussion

Long-term observations show that soils of the Russian Federation contain six times more carbon than vegetation, and it can be stated that the use of soils to improve the country's carbon balance is justified and expedient. The total emission of carbon dioxide or CO₂-equivalents in Russia is estimated at 2500 million tons, which is about 681 million tons of carbon. The sequestration reserve in soils of the Russian Federation is about 3.67 billion tons of carbon (* GtC - gigatonne (1 * 10⁹) billion tons of carbon) or more than 13 billion CO₂-eq, which is more than 19 total annual greenhouse gas emissions [3].

In fact, the soil fund of the Russian Federation makes up about 12% of the soil fund of the entire globe, but the upper soil horizons accumulate at least 23% of the global reserves of soil organic matter. Also, there are cited data (calculations) on the concentration of soil organic matter for the main types of soils in Russia for the upper layer of 0-30 cm (Table 1.), where the highest (20.9 kg/sm⁻²) and the lowest (1.7 kg/sm⁻²) concentration of carbon sequestration were observed on organogenic and low-humus accumulative-calcareous soils, respectively (4, 5).

Table 1. Area-weighted average concentration (kg/sm⁻²) of organic carbon by layers (m) of native soils in Russia.

Types of soil formation	Organic (m)		
	0 – 0.3	0 – 1.0	0 – 2.0
Organogenic	20.9	81.3	134.1
Glezeems	17.6	23.1	24.1
Metamorphic	12.2	15.2	15.7
Humus-accumulative	11.7	20.2	22.4

Sod organo-accumulative	10.3	13.9	15.1
Volcanic	7.0	18.2	22.3
Textured differentiated	7.0	10.8	11.9
Lithozems	6.8	Undefined	Undefined
Al-Fe-humic	6.7	9.7	10.0
Alluvial	6.2	14.1	18.0
Halomorphic	5.0	9.0	10.4
Alkaline clay-differentiated	4.8	7.3	8.2
Cryozems	4.6	Undefined	Undefined
Low-power, underdeveloped	3.1	Undefined	Undefined
Low-humus storage-carbonate	1.7	2.6	2.9

As it is stated in the figure above (figure 1), there is also a decrease in carbon stocks (sequestration) in humus-accumulative chernozems and chestnut soils. In the textured differentiated podzolic soils, the accumulation of humus is noted, which is associated with the formation of the arable horizon.

The inventiveness of the Ministry of Education and Science of Russia is to create a chain of "carbon polygons - landfill" deserves unconditional support (Order on landfills for the development and testing of technologies for monitoring carbon balance dated 02/05/2021). It is necessary to develop methods for setting up and observing the productivity of ecosystems in such areas. A carbon landfill is a "etalon" section, where gas (CO₂) emissions and removals are measured and monitored. There are also "concepts" like a carbon farm, which is a land plot for agricultural purposes, on which the amount of absorbed and emitted carbon dioxide is measured, and receiving "carbon quotas" for this, which can later be sold/leased for real money in the financial market from the profits of carbon credits.

In the Russian Federation, a pilot project was launched by the Ministry of Science and Higher Education on carbonic polygons, where seven pilot geostrategic different regions (Kaliningrad, Sakhalin, Novosibirsk, Tyumen, Sverdlovsk regions, as well as the Chechen Republic and Krasnodar Territory) were selected in the first stream of the project). In the future, it is planned to create at least 80 carbon polygons throughout Russia since the opening of such facilities is very important for the formation of a low-emission economy in the country. However, for the introduction of carbon capture technologies, it is necessary to develop a Unified Methodology that would be recognized by the world community, as well as a National System for accounting for greenhouse gas emissions by ecosystems (forest, steppe, tundra, farmland, water areas, etc.). The Ministry of Education and Science emphasizes the importance and significance of developing its methodology for calculating carbon monoxide fluxes for implementing the Paris Agreement within the framework of the UN Framework Convention.

Meanwhile, it should be noted that there is a precedent for creating a generally accepted methodology for assessing carbon sequestration (carbonic polygons in Italy, figure 1.) and that Russian soil scientists and geographers took the central part in its preparation. The following (fFigure 1) are the International Community Baseline Models (ICBM) for soil carbon determination.

1. Carbon content in the soil layer (tCga)

$$SCD_{site} = \sum_{layer=1}^{layer=j} (SOC_{content} * BulkDensit_y * Depth * (1 - frag))_{layer}$$

2. Stocks of carbon in the soil layer of the site (kgC)

$$SOC_{refstock} = \left(\sum_{site=1}^{site=m} SCD / m \right) * A_{plot}$$

3. Change in stocks in the soil layer of the site (kgC)

$$\Delta SOC_{stock} = SOC_{refstock} - SOC_{curstock} - f_{org} - f_{lim}$$

Figure 1. Internationally Recommended Standard Practice for Estimating Carbon Stocks in Soils (Ivanov, 2019).

In the developed today effectively-implemented projects of landscape agriculture, improved competitive and demanded, agrotechnological differentiation is adjusted considering the heat and moisture supply of crops, the steepness and exposure of slopes, hydrogeological, micro-and mesoclimatic parameters, and other conditions. In other words, new agricultural technologies and farming systems have already been attributed to the latest ideas about global climate change and the development of related fundamental and applied sciences.

4. Conclusion

Based on the above, we can conclude that there are still no answers to many questions and that it is necessary to "develop" in the direction of carbon landfills and farms, especially in anticipation of a carbon tax on products exported from the country. However, the adopted decree of the President of the Russian Federation "On measures for the implementation of the state scientific and technical policy in the field of environmental development of the Russian Federation and climate change" dated 08.02.2021 should bring with it an impetus for (discussions and decisions) the issue of updating the global climate, ecological and economic development of our country.

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