Adaptation of Soil Ecosystems: An Inventory of SDG Linkages to Achieve the Goals of the UN Decade for Ecosystem Restoration

Natalya Ryazanova[1*], *Vladimir* Naumov[2], *Natalia* Kamennykh[2]

[1]Moscow State Institute of International Relations (MGIMO University), Department of Integrated International Ecological Problems and Wildlife Management, 119454, 76 Vernadskogo prospect, Moscow, Russia
[2]Moscow Timiryazev Agricultural Academy, Department of soil science, Geology and landscape studies, 127550, 49 Timiryazevskaya st., Moscow, Russia

Abstract. The aim of the work is to carry out a comparative analysis and links between the loads on soil ecosystems and the social, economic and environmental needs and capacities of the state. The current vectors of the ecological discourse of assessment of degradation and the current state of soil ecosystems and the possible limits of their adaptation to the growing impacts were considered. The system of links between the ecological component and socio-economic needs of development of the regions of the state was created. The study was conducted on the basis of modern data of inventory, analysis and synthesis of available information on the state of soil ecosystems, limiting factors of their use and prospects for sustainable land use. The work was carried out in the following areas: adaptation to soil degradation; impact of land degradation on the economy; current trends in agriculture; biological and economic productivity of soil ecosystems; creation of ESG approach to state planning of soil resources exploitation. Sustainable land management was considered as a science-based procedure to meet food security and the needs of a growing global population while maintaining high quality ecosystems. The approach used allowed to establish a set of indicators and criteria for their evaluation for further scientific research of the need and possibility of restoring the health of soil ecosystems in order to improve state planning of land use.

1 Introduction

The scientific approach to the management of any type of resources is built from a reliable base of inventory of the quantity and condition of the resource, its availability, determining the need to introduce new areas or exclude those already in operation and that have lost their quality. Decision-making methods can be statistical, legislative, practice-oriented, science-based. Modern approach to planning of sustainable exploitation of soils requires clear definition of actions in the following clusters: 1) ecological - preservation and increase of soil fertility taking into account regional climatic changes; 2) economic -

* Corresponding author: natamgimo@gmail.com

exploitation of resource should be necessary, but sufficient, adequate contribution of exploitation of soil resources should make both local and state budget, if necessary, this contribution can be demanded also on global level, but without increasing the load of land exploitation to maintain good quality of ecosystem; 3) social - employment of local population and its fixation on territories for production It is necessary to develop scientifically grounded criteria for each cluster and to propose indicators for their evaluation in order to create perspective plans and maps of rational land use in regions and to create progress ratings for each cluster for each region by public authorities. It is important to involve subject matter experts in the creation of such ratings and not to allow environmental sense to be lost in the process of implementing a utilitarian state objective - ecosystems can become diseased, depleted and not always "work" in the expected parameters. For example, biological degradation due to a decrease in soil organic matter content, diffuse pollution and reduction of biodiversity [1]; accelerated erosion, loss of fertility and imbalance of elements, acidification and salinization [2]; type of degradation in most cases is the root cause of the development of erosion processes. [3]

2 Methods and materials

Environmental cluster. The fight against physical soil degradation occurs in the following directions: soil compaction under the influence of excessive pressure of heavy agricultural machinery is rather difficult to solve by drainage or dewatering (if necessary) [4]; bringing the rate of erosion into balance with the rate of soil formation is possible with rationalization of crop rotations and new types of soil tillage [2]; a complex interaction of processes leading to the loss of soil fertility [4], loss of organic matter [5] and loss of topsoil, which provides with Trampling by people or livestock leads to compaction and degradation of soils requires legislative restrictive measures, often with the development of a system of fines [6]. Drainage of clayey and peaty soils combined with loss of organic leads to depletion and even destruction of soil ecosystems with very high economic costs and destruction of the social environment, the population leaves such places unable to provide jobs and maintain social status (by the information from Official website of the FAO). Special problems develop in the regions of wetlands and coastal ecosystems located downhill, erosion processes develop there and pollution accumulates, which requires works on dispersal of accumulations, sediment reclamation and introduction of new portions of soil, where they are needed for agriculture [5]. This type of degradation is in most cases the root cause of the development of erosion processes, the destruction of regional economies and the degradation of social relations [3, 7].

Economic cluster. The costs of restoring or maintaining soil fertility can be very high and require necessary but sufficient measures to implement such projects. For example, the joint FAO/IAEA Division assists member states in developing and implementing radiation technologies to improve soil fertility practices to intensify crop production and conserve natural resources (by the information from Official site of the International Atomic Energy Agency). However, forward-looking plans for the treatment of land for various needs should be adopted at the state level. Integrated management of soil fertility is aimed at maximizing the effectiveness of agronomic use of ecosystems, but with the preservation and improvement of their productivity. This can be achieved by sowing leguminous crops and the rational use of chemical fertilizers. Cover crops, which add organic matter to the soil, resulting in improved soil structure and contributing to a healthy, fertile soil, are also actively used; by using green fertilizer or growing legumes to fix nitrogen from the air through the process of biological nitrogen fixation; by using microdoses of fertilizer to replace losses through plant uptake and other processes; and by minimizing losses through leaching below the root-forming zone of crops by improving water and out Nitrogen-15 and

Phosphorus-32 isotopes are used to track the movement of labeled nitrogen and phosphorus fertilizers in soil, crops and water, providing quantitative data on the use efficiency, movement, residual action and transformation of these fertilizers. This information is valuable for developing improved fertilizer application strategies. The nitrogen-15 isotopic method is used to quantify the amount of nitrogen fixed from the atmosphere by biological nitrogen fixation by legumes [8, 9]. Carbon-13 isotopic signature helps to quantify the incorporation of crop residues to stabilize and improve soil fertility. This method also allows us to evaluate the effect of conservation measures, such as plant residue incorporation, on soil moisture and soil quality. This information allows us to determine the origin and relative contribution of different crop species to soil organic matter, but is an inexpensive method (by the information from Official site of the International Atomic Energy Agency).

Social cluster. The main thesis in terms of sustainable development is to feed and keep people healthy. In less developed countries, both governments and regional authorities sometimes have to choose between these needs. By reducing the quality of land use (synthetic fertilizers, unsustainable irrigation, etc.) they can reduce the quality of food so much that people's health suffers. The KPI of managers is important here, if the main thing is to eliminate the head, the decision will be made in favor of increasing the amount of food grown at all costs. But how to find a balance between the need to survive people and ecosystems. For the majority of the local population it is not at all obvious the cause-effect relationship between the long-term preservation of high parameters of soil fertility and the health of soil ecosystems and their own ability to survive in their territory. Under such conditions, simple education of the population does not work. New approaches to territorial management are needed, which may include both resettlement of part of the population to more suitable regions, partial reorientation to other types of food, and possibly the hope for humanitarian aid.

Fragment of the creation of a research paper on correlating the importance of soil ecosystem conservation with the global sustainable development agenda. Working within the logic of sustainability suggests a tradition of highlighting three clusters: environmental, economic, and social in working with a set of global Sustainable Development Goals. The national agenda must rely on the same logic and develop its own evaluation criteria and their indicators, relevant to both the state as a whole and its individual regions. Below is just a fragment of how we can work in this direction.

Table 1. ESG transformation of sustainable soil management for the UN Decade of Ecosystem Restoration (the example of the Ecological cluster)

SDG	Criteria	Indicators
SDG 6	Preserving the high quality of fresh water	-database on the state of water sources in agricultural regions; -Accounting the state of water sources in peasant and private farms; mapping of lateral flow from non-centralized pollution sources; And other indicators.
	Equal access to clean water	-Data base of water sources for agricultural use; -Data base of water sources for drinking and household use in rural areas; -Formation of reserve and ways of emergency water supply to rural population (delivery); And other indicators.
	Reducing the number of people suffering from a shortage of fresh water	

	Transboundary cooperation in watersheds	-Aatlas of border and catchment areas; -maps of territorial use of soils in the border areas; And other indicators.
	Conservation and restoration of ecosystems and aquifers	-A plan for the conservation and restoration of soil ecosystems in mountainous, urban and other areas; -register of technologies certified for restoration and maintenance of soil ecosystems. And other indicators.
	Outreach programs on sanitation, surface runoff collection, desalination, etc.	-development of professional development programs by local or state universities; - Education programs for the local population (including children and adolescents); -specialized courses for schoolchildren. And other indicators.
	The Role of Local Communities in the Preservation of Aquatic Ecosystems	-Creation of an advisory body to make decisions on the types and forms of nature management in the regions; -creation of public councils under state and municipal bodies of state power. And other indicators.
SDG 13	Technologies of land adaptation to climate change	-Register of certified techniques for improving the sustainability of soils in different natural zones; -a database of observed changes in the condition of soils; And other indicators.
	Planning and response	-Plan for current maintenance of soil conditions; -Plan of actions during the occurrence of natural hazards; -Financial plan in case of natural disasters. And other indicators
	Outreach programs	-development of professional development programs by local or state universities; - Education programs for the local population (including children and adolescents); -specialized courses for schoolchildren. And other indicators.
SDG 15	Rational use of soil resources of different natural zones	-List of acceptable types of soil use in the region; -strategic plan of scenarios of alternative types of nature management and soil protection. And other indicators.
	Forest technical soil protection	-Register of certified methods for forest soil protection; -Methodological instructions to specialized organizations. And other indicators.
	Program to Combat Desertification	-Program of combating desertification; -prospective plan to combat desertification; -Financial plan for emergencies. And other indicators.

	Organic farming development program	-List of agricultural and other crops for organic farming; -methodological recommendations for the implementation of organic farming. And other indicators.
	Chemical and genetic soil protection program	-Register of approved chemical reagents for use; -legislative framework legal regulation of genetic resources. And other indicators.
Directions within public administration		
Development and adoption of normative legal base for regulation in the field of sustainable use of soils and protection of soil ecosystems. Organization of work of supervisory bodies in the field of soil use according to the established purpose. Organization of work of specialized expert councils.		
Opportunities for business and the corporate sector		

Development of our own environmental strategies, including in the regions where the business operates.
Working on thematic governmental directions.[9]

Implementation of activities with employees and local residents aimed at the implementation of sustainable soil use.

Creating non-financial reporting in this area. Inclusion of information in ESG reporting in the field of sustainable use and protection of soils.

The development of criteria and indicators in the Economic and Social Clusters is going in similar directions. Sustainable but effective land use must be systematic and can include three main components:

● economic, based on a regulatory legal framework that ensures the implementation of market mechanisms to adequately distribute the income generated;

● ecological, conditioned by the impact of natural factors (soil fertility, natural environment, farming system) on agricultural production;

● social, aimed at raising awareness and responsibility for damaging the environment and encouraging producers to use land rationally.

The criteria for the sustainable use of agricultural land are obtaining a specific amount of production at the minimum cost of labor, production and natural resources, as well as the preservation of soil fertility (economic efficiency), the prevention of environmental degradation and improving the quality of productive land (environmental efficiency), as well as the degree of achieving the standard of living (social efficiency [10].

The directions of increasing the responsibility of the efficiency of agricultural land use are as follows:

● organizational and managerial - activation of the activities of management bodies, the impact on
public and individual consciousness to rationalize land use [11].

● socio-economic, consisting of measures for financing state and regional programs, income distribution, optimization of working conditions; ecological, characterized by the level of use of natural resources, reduction of resource intensity of production and improvement of its quality [11].

There is also a category of agricultural land that has a zero or negative rent value in the following cases:

● anthropogenic impact (uncontrolled, excessive use of fertilizers, pesticides, etc.) resulting in degradation of the soil cover;

● Establishment of payments for land in excess of the income it generates;
● Allocation of land unsuitable for profitable agricultural production (erosion-prone, hillsides, bushy, stony, swampy, saline, etc.).

3 Analysis

In the formation of transformation criteria, the Targets within the framework of the mentioned SDGs are taken as a basis, but they are transformed under the direction of work on the conservation and restoration of soil ecosystems. Indicators should be developed taking into account natural characteristics and needs of regional ecosystems, the need for economic development of regions and the real needs of local communities. Thus, the principle "Think globally, act locally" is observed.

Government agencies, businesses and local communities are not equally able to protect and restore ecosystems. Most countries of the world have not developed specific or narrowly focused regulations which can translate environmental management into sustainable natural resource use. In many countries this has taken more than a decade, as public authorities realize that the adoption of updated legislation must match both the economic feasibility of its implementation and the willingness of society to follow the new course. If such strategies, plans, programs appear at the state level, it will be possible to consider that the work on sustainable use of soils is carried out systematically and can achieve success.

4 Conclusions

Development of national and corporate plans, programs and methods of action to achieve sustainable management of soil ecosystems should be based on the global trend of ecosystem restoration, correspond to global development goals, adequately adapted to the national development goals of states and planned on a short, medium and long term basis and be quantitative. Ideally, National Strategies should be created within the environmental management sectors. The assistance of public authorities can be specified in state strategies, concepts, plans, programs, which are usually created for 30-50 years. However, given the high volatility of the current moment, such strategies can be developed for 2-5 years with constant adjustments.

A point-index evaluation system for each criterion can be adopted. This will allow creating quantitative assessment scales and determining the rating of regions and states in terms of achieving the criteria for each indicator and the aggregate rating for each SDG, determining what contribution has been made to the achievement of these SDGs by sustainable soil management.

References

1. A. Sorokin et al. in: *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development*, 541-576 (Springer, Cham, 2016)
2. C. Yin, W. Zhao, P. Pereira, Global Ecology and Conservation. **33**, 01974 (2022)
3. I. Leshan, I. Brekhova, Aktual'nye problemy gumanitarnyh i estestvennyh nauk.. **8-2**, 68-70 (2016)
4. E.A. Korneeva. Lesa. **12 (**10), 1317 (2021)
5. R. Lal. Sustainability, **7** (5), 5875-5895 (2015)
6. I. Savin et al. Byulleten' Pochvennogo instituta im. B.B. Dokuchaeva. **94**, 38-56 (2018)

7. A. Yakovlev, in: EGU General Assembly Conference Abstracts, EPSC2016-12512 (2016)
8. J. Lehmann, M. Kleber. Nature,. **528** (7580), 60-68 (2015)
9. Vologzhina S., Ryazanova N., Eroshenko V. E3S WoC, **169**, 05005 (2020)
10. E.F. Zavorotin et al., Fundamental'nye issledovaniya. **9** (2), 423-427 (2017)
11. E. N. Krylatykh, Agrarnyj vestnik Urala. **5**, 3-10 (2006)