

Sustainable Development of Reclamation in Russia on the Basis of Increasing the Technical Level and Improving the Ecological State of the Reclamation Complex

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Keywords: Reclamation System, Assessment of Technical and Operational Parameters, Technical Level, Ecological State, Recommendations, Technical Proposals, Operational Efficiency.

Abstract: Development of methodological recommendations for assessing the technical level, technical and operational parameters, and the ecological state of the reclamation fund, increasing the technical level (modernization) of reclamation systems and the ecological state of reclaimed lands, the efficiency of using interfarm and intrafarm reclamation systems. The article presents an analysis of the technical level and technical and operational parameters of reclamation systems, a qualitative assessment of the ecological state of reclaimed lands. Recommendations for improving the technological and environmental quality of the operation of reclamation systems and lands are developed. The relevance of scientific research is due to the need to improve the efficiency of the use of integral resources and reduce the energy intensity of the operation of reclamation systems, largely depending on the validity of decisions made on reconstruction, heavy overhaul and service checks, water use and water distribution in reclamation systems.

1 INTRODUCTION

Hydro land reclaiming systems are complex natural and technical objects, that function under conditions of uncertainty in the dynamic impact of a complex of external and internal factors, that change in space and time. The technical level and efficiency of the hydro land reclaiming system operation is a hierarchical set of structural, technical, economic, technological, ecological and operational indicators, that determine the production function of the system's compliance with its purpose. Low technical level and poor technical and operational parameters of hydro land reclaiming systems lead to the danger of emergencies, a decrease in safety and reliability indicators, which leads to low values of efficiency, causes significant losses of irrigation water, leading not only to a decrease in the efficiency of reclaimed lands, but also to environmental degradation of the natural environment (negative impact on the environment) (Reclamation complex, 2020; Report on the

implementation, 2018; Information portal of FSBSI, 2021).

It is necessary to develop and form a base of initial data for assessing the technical level of reclamation systems, agroecological and functional state, and use of the reclamation fund and, on this information and analytical basis, develop methodological recommendations for the development of the reclamation complex, taking into account the technical level, ecological state and actual use of the reclamation fund.

Carrying out of research work in this direction will allow to objectively assess the work and technical level of regional hydro land reclaiming systems and develop recommendations on the priority of the timing and cost of works during the reconstruction, modernization of systems, to ensure high-quality performance of capital and maintenance operational works, and agricultural producers to increase the yield of agricultural crops on reclaimed land.

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2 PURPOSE

Development of methodological recommendations for assessing the technical level, technical and operational parameters, and the ecological state of the reclamation fund, increasing the technical level (modernization) of reclamation systems and the ecological state of reclaimed lands, the efficiency of using interfarm and intrafarm reclamation systems.

The main tasks, solved in the course of research:

- to conduct a scientific and technical analysis of scientific and technical and production materials on the technical and ecological state of the reclamation fund and on the operation of reclamation systems;
- to develop a methodology for assessing and criteria for reliable stable operation of hydro land reclaiming systems during the life cycle;
- to justify and develop recommendations for improving the technical and ecological state of the reclamation fund and the standard operating mode of reclamation systems.

3 RESEARCH METHODOLOGY

When undertaking scientific information-analytical and statistical research, standard methodological approaches were used, scientific-methodical and regulatory-technical documents were studied, methods of analysis of the technical level and technical and operational parameters of reclamation facilities and the ecological state of reclaimed lands were used (Information portal of FSBSI, 2021; The consolidated report, 2019; Temporary provision, 2012).

The methods for assessing the technical level and efficiency of hydro land reclaiming systems operation establishes the nomenclature of indicators, used to assess the technical level and technical state of hydro land reclaiming systems and hydraulic structures, as well as the procedure for conducting and formalizing the assessment results (GOST R 58376-2019).

The nomenclature of parameters for assessing the technical level of hydro land reclaiming systems and hydraulic structures includes the following indicators: the engineering-technical level and the technical and operational state of the facility, the wear percentage (depreciation); the volume of water intake, (irrigation) or water disposal (drainage); the presence of a dispatch control system; equipment with control and metering devices; availability of design estimates, operational documentation,

technical passport, safety declaration; availability of qualified service personnel; availability of special equipment, machinery and equipment for operation; the yield of agricultural crops in the subcommand (suspended) reclaimed areas; the cost of carrying out maintenance operational works; the number of hydraulic engineering posts; the information on reconstruction and heavy overhaul and measures, taken at the facility, to ensure operational reliability.

According to the technical level and technical and operational state, reclamation facilities are divided into four classes (Table 1):

- first - facilities with a good level of technical state: facilities are equipped with a full set of all technical means, have the necessary reliability of all elements and ensure the performance of the functions assigned to them within the specified accuracy limits, the reconstruction of such facilities is not required;
- second - facilities with a satisfactory level of technical state, that is, the issue of the need to carry out works to maintain the technical level or to carry out reconstruction in the amount of up to 25% is considered on an individual basis to modernize and increase the technical level;
- third - facilities with an insufficient level of technical state: they need to consider the feasibility of reconstruction in the amount of up to 50% of the book value of fixed assets, depending on the plans for the development of agricultural production on the reclaimed lands, it is necessary to make a decision on the reconstruction or conservation of these facilities until the period of demand;
- fourth - facilities with an unsatisfactory level of technical state: such facilities require complex reconstruction in the amount of more than 50% of the book value of fixed assets, or it is necessary to make a decision on the conservation of these facilities or pension off (Olgarenko, 2015).

The results of the assessment are used to analyze the indicators of the technical and operational state of the existing hydro land reclaiming systems and hydraulic structures, make a decision on the feasibility of reconstruction, technical re-equipment, or heavy overhaul of hydro land reclaiming systems and hydraulic structures.

Table 1: Indicators for assessing the technical level and technical and operational parameters of the reclamation facility (irrigation system, drainage system, canal, separately located hydraulic structure).

The main standard indicators for assessing the technical and operational state	Technical and operational state class				
	1	2	3	4	5
	I	II	III	IV	
System name, location, cadastral numbers of plots					
1. Technical condition, wear percentage (depreciation)	Up to 50%	50-75%	75-90%	More than 90%	
2. The volume of water intake, (irrigation) or water disposal (drainage), the percentage of the design indicator of the reclamation facility	More than 75%	50-75%	25-50%	Less than 25%	
3. Availability of a dispatch control system - yes/no	If any, then I-II		If not, then III-IV		
4. Equipping with control and metering devices, in % of the design indicator of the reclamation facility, if there is no data on design indicators - yes/no	More than 75%	50-75%	25-50%	Less than 25%	
	If any, then I-II		If not, then III-IV		
5. The number of hydraulic engineering posts, in % of the design indicator of the reclamation facility, if there is no data on design indicators - yes/no	More than 75%	50-75%	25-50%	Less than 25%	
	If any, then I-II		If not, then III-IV		
6. Availability of design estimates, operational documentation, technical passport, safety declaration.	Available in full	Partially available, then II-III		Not available	
1	2	3	4	5	
7. Service personnel, (people), including: Engineering and technical personnel (1 person per 1,000 hectares), Workers (2 persons per 1,000 hectares)	More than 75%	50-75%	25-50%	Less than 25%	
8. Availability of equipment, (pcs.) Including: (mark by default) - construction; - specialized reclamation equipment; - vehicles.				+	
				+	
			+		
9. Yield on the serviced reclaimed areas of the main types of agricultural crops (t/ha) - check for compliance with the design yield - rice - vegetable - feed - technical - cereal	More than 75%	50-75%	25-50%	Less than 25%	
10. The cost of carrying out maintenance operational works as a percentage of the book value	8-10 %	5-8%	3-5%	Less than 3%	
11. Information about reconstruction and heavy overhaul, in accordance with the date of the last performance	Up to 5 years	5-10 years	10-25 years	Over 25 years	
12. Information about the measures taken at the facility to ensure operational reliability, as well as the prevention and elimination of emergencies. Annual measures taken and cost.	If any, then I-II		If not, then III-IV		

Based on the results of data analysis and comparison with standard indicators, an expert opinion is prepared, including conclusions and recommendations for the final assessment of the technical and operational state of the reclamation facility and its safety level, compliance with the structure and staff, qualification support, safety control, as well as technical proposals for increasing technical level and improving technical and operational parameters, of reclamation facility with

an indication of the types, volumes, and cost of construction and installation work and equipment.

The assessment of the ecological state of the soils of the reclaimed lands is carried out on the basis of standard assessment methods and a methodology, developed with the participation of the authors. A three-level system of qualitative assessment is adopted as the main parameters: good, satisfactory and unsatisfactory state of the land fund (Methodological recommendations, 1982; Nikitin et al., 2010).

The main indicators, characterizing the ecological situation on reclaimed lands, include: the level of groundwater, salinity and alkalinity of soils; the state of the surface of reclaimed lands, or a complex of all negative ecological processes, that appear simultaneously. Assessment categories reflect the degree of their suitability for agricultural production and the direction of measures to improve the land reclamation state (Nikitin et al., 2010; Technique of operational, 2015).

The algorithm for assessing the ecological state of reclaimed lands includes the following procedures: selection and justification of parameters, characterizing the ecological situation and standard values; assessment of the current ecological state of the soil of reclaimed lands; retrospective analysis of changes in the ecological situation by individual parameters; projected development of processes and predictive assessments of the territory; assignment of reclamation measures to improve the ecological state of reclaimed lands.

According to the results of the assessment of the ecological situation of the reclaimed lands, a list of reclamation systems and lands is drawn up: functioning in the normative mode, the assessment of the situation is good; requiring a set of measures to prevent or eliminate negative processes during the operation of reclamation systems or their reconstruction (the situation is assessed as satisfactory); requiring implementation of a complex of reclamation measures to improve the ecological state of soils at the stage of reconstruction, the assessment of the situation is unsatisfactory.

4 RESEARCH RESULTS

By 2020, the reclamation fund of the Russian Federation amounted to 9.45 million hectares, including with the following structure:

- with 4.67 million hectares of irrigated land, 3.86 million hectares were actually used in agricultural production, and irrigation was carried out due to the supply of water by state reclamation systems on an area of 1.69 million hectares and due to the initiative actions of agricultural producers, on expert assessment, about 0.75 million hectares were watered;
- with 4.69 million hectares of drained land, 3.16 million hectares were used in agricultural circulation, and in fact, the regulation of the water regime and drainage loss is ensured through state reclamation systems on an area of

about 916.86 thousand hectares (Ugryumova et al., 2018; Olgarenko and Ugryumova, 2019).

Not used in agricultural production, total reclaimed land - 2,320.60 thousand hectares, including:

Irrigated lands - 791.0 thousand hectares, of which 116.6 thousand hectares were not used due to salinization and waterlogging. Of the total area of irrigated land, 2,963.35 thousand hectares were not watered, including 1,912.92 thousand hectares due to the irrigation network failure.

Drained lands - 1,528.17 thousand hectares, of which: due to the drainage network failure - 625.8 thousand hectares, due to poor agroecological state (close occurrence of GWL, poor water-physical and agrochemical parameters of soils) - 894.8 hectares.

2,146.42 thousand hectares of irrigated lands are in federal ownership, 478.8 thousand hectares are owned by the constituent entities of the Russian Federation, municipal units, legal entities, and individuals own 1,216.55 thousand hectares of irrigated lands, there are 357.35 thousand hectares ownerless and under registration irrigated lands.

1,117.96 thousand hectares of drained lands are in federal ownership, 755.47 thousand hectares are owned by the constituent entities of the Russian Federation, municipal units, legal entities, and individuals own 1,670.17 thousand hectares of irrigated lands, there are 1,877.69 thousand hectares ownerless and under registration drained lands.

In total, there are 2,868 reclamation facilities in the Russian Federation, of which 805 are irrigation systems, 1,052 are drainage systems, 285 are separately located hydraulic structures (Table 2). There are more than 34.3 thousand reclamation facilities in federal ownership, including: 232 water reservoirs; more than 2 thousand regulating and distribution waterworks facilities; 134 river stanches; 1.8 thousand supply and discharge pumping stations, 42.3 thousand km of main water supply and discharge canals; over 3 thousand km of protective stanches and protection embankments.

Of the reclamation fund of Russia, about 58.4% of hydro land reclaiming facilities are in federal ownership, and 34.7% are ownerless. The number of land plots under Federal property facilities is 12,200 units, of which 4,780 units have title documentation. The total area of land plots under reclamation facilities (water reservoirs, stanches, waterworks facilities, ponds, etc.) is 1,503.45 thousand hectares, of which the area of registered land plots is 352.7 thousand hectares.

Table 2: Technical and operational state of reclamation facilities by the Federal Districts of the Russian Federation as of 01/01/2020.

Name of the reclamation facility	Total	State class			
		I	II	III	IV
RF					
Irrigation interfarm systems	805	42	192	389	182
Drainage interfarm systems	1,052	56	213	574	209
Hydraulic structures on reclamation systems	721	34	143	437	107
Separately located hydraulic structures	285	–	–	–	–
Total reclamation facilities	2,868				
Central					
Irrigation interfarm systems	159	5	14	91	49
Drainage interfarm systems	450	27	83	231	109
Irrigation intrafarm systems	3	–	1	1	1
Drainage intrafarm systems	3	–	2	1	–
Hydraulic structures with facilities on the network	42	2	10	19	11
Separately located and other hydraulic structures and facilities	17	–	3	11	3
Northwestern					
Irrigation systems	2	–	2	–	–
Drainage systems	329	14	77	199	39
Hydraulic structures with facilities on the network	507	22	109	295	81
Separately located hydraulic structures	52	2	10	31	9
Volga					
Irrigation systems	174	14	53	76	31
Drainage systems	106	9	32	52	14
Hydraulic structures with facilities on the network	81	2	6	69	4
Separately located hydraulic structures	87	–	–	–	–
Southern					
Irrigation systems	119	5	51	43	19
Drainage systems	1	–	–	1	–
Separately located hydraulic structures	8	–	3	5	–
North Caucasian					
Irrigation systems	126	2	36	67	21
Drainage systems	7	–	1	5	1
Hydraulic structures with facilities on the network	62	7	11	37	7
Separately located hydraulic structures	41	–	–	–	–
Ural					
Irrigation systems	43	5	9	18	11
Drainage systems	39	–	6	19	14
Separately located hydraulic structures	25	–	–	–	–
Siberian					
Irrigation systems	68	3	12	32	21
Drainage systems	19	–	3	7	9
Separately located hydraulic structures	23	–	3	16	4
Far Eastern					
Irrigation systems	116	8	17	61	30
Drainage systems	101	6	11	56	28
Hydraulic structures with facilities on the network	28	1	7	17	3
Separately located hydraulic structures	32	–	–	–	–

On irrigated lands: 2.41 million hectares are in a good ecological state; 1.38 million hectares are in a standard (satisfactory) state; 0.9 million hectares are

in an unsatisfactory state. Of the irrigated lands in an unsatisfactory ecological state on an area of 0.9 million hectares (19.0% of the availability), 0.4

million hectares have a close occurrence of groundwater, 0.26 million hectares - soil salinization, and on 0.24 million hectares, there is the combined action of unfavorable ecological factors - unacceptable close occurrence of groundwater and soil salinization.

On drained lands: 0.86 million hectares are in a good state; 2.14 million hectares are in a satisfactory

state; 1.78 million hectares are in an unsatisfactory state. Of the irrigated lands in an unsatisfactory ecological state on an area of 1.78 million hectares (37.0% of the availability), there is an unacceptably close (critical) occurrence of groundwater and inadmissible terms for surface drainage.

Table 3: Ecological state of the reclamation fund in Russia

Federal districts	Good, (%)	Normal, (%)	Bad, (%)
Irrigated lands			
Central Federal District	45	30	26
Northwestern Federal District	8	54	38
Volga Federal District	68	28	4
Siberian Federal District	63	29	9
North Caucasian Federal District	41	25	34
Southern Federal District	60	22	18
Ural Federal District	53	36	11
Far Eastern Federal District	46	21	33
Drained lands			
Central Federal District	16	38	45
Northwestern Federal District	11	53	36
Volga Federal District	21	55	24
Siberian Federal District	23	35	42
North Caucasian Federal District	41	41	18
Southern Federal District	45	39	16
Ural Federal District	5	58	36
Far Eastern Federal District	39	30	31

5 RESULTS AND DISCUSSION

An analysis is carried out and an assessment is given of the technical and operational state of reclamation facilities in the federal districts of the Russian Federation, which are under the operational management of the regional FSBI "Management "Meliovodkhoz". The bulk of reclamation facilities (73.6%), in terms of their technical and operational state, belong to the III and IV classes, of which 70.93% are irrigation systems, 74.4% are drainage systems and 75.45% are hydraulic structures with facilities on networks. In the regional context, the largest percentage of reclamation facilities in an unsatisfactory state falls on the Central Federal District, so for irrigation systems, about 90% of facilities classes III and IV, and more than 75% of facilities for drainage systems (Table 2).

The first class - facilities with a good level of technical state, which have the necessary reliability of all elements and ensure the performance of the functions assigned to them within the specified accuracy limits, wear does not exceed 50%.

The second class - facilities with a satisfactory level of technical and operational state (wear is no more than 50-75%). For each facility, on the basis of an expert assessment, the issue of the need to carry out works on technical re-equipment, heavy overhaul or reconstruction in the amount of up to 25% of the book value of fixed assets to increase the technical level is considered.

The third class - facilities with an insufficient level of technical and operational state, equipment wear is 75-90%. They require modernization and reconstruction in the amount of up to 50% of the book value of fixed assets. Depending on the plans for the development of agricultural production, it is necessary to make a decision on the reconstruction or conservation of these facilities until the period of demand.

The fourth class - facilities with an unsatisfactory level of technical and operational state, wear of elements is more than 90%. At such facilities, complex reconstruction is required in the amount of more than 50% of the book value of fixed assets, or it

is necessary to make a decision on the conservation or liquidation of facilities of this class.

For the effective operation of reclamation systems and separately located hydraulic structures, it is necessary to carry out the whole complex of technical, organizational and economic measures to ensure the maintenance of the reclamation network, structures and equipment, their periodic inspection, scheduled preventive maintenance, identification and elimination of emergencies, rational water distribution, regulation of the water regime of soils, management and control over the preparation of the reclamation network and structures for work during the growing season by water users.

However, the potential of reclaimed lands and state reclamation systems is significantly higher than the actual indicators. The main limiting factors for increasing the productivity of agricultural land are the insufficient development of complex reclamation, low technical level of reclamation systems, the development of land degradation processes, such as erosion, salinization, waterlogging, underflood, deficiency of organic matter and mineral nutrients, desertification (Kireicheva, 2017; Olgarenko et al., 2019).

For sustainable development and complex modernization of the reclamation complex, an agreed solution of a number of priority tasks is required:

- development of a complex of engineering and technical and technological solutions for the restoration and modernization (reconstruction) of hydro land reclaiming systems and hydraulic structures, reclamation measures to improve the ecological state of reclaimed lands, with a justification of the scope and structure of work, resourcing, as well as the sequence of works to modernize the reclamation complex on irrigated lands and dykeland by stages of the Program implementation;
- improvement of the operation of reclamation systems, incl. introduction of new technologies and equipment for maintenance operational works on reclamation systems and canal cleaning, organization of rational water use, using GIS-technologies for water distribution, automation, and telemechanics, flood prevention measures;
- increasing the efficiency of water-economic complex management using computer technologies, information and analytical support, development of monitoring and planning systems for water use, ecological audit, management and control in the field of land reclamation and water management;

development of a system for the provision of information and consulting services and the contagion of advanced experience in modern technologies of construction, reconstruction and effective use of reclaimed lands;

- development of infrastructure, improvement of organizational and socio-economic mechanisms for the functioning of the reclamation and water-economic complex of the agro-industrial complex;
- reforming the organizational structure of the system of the operation of reclamation facilities with the creation of regional technological parks and specialized operational bases, that ensure high-quality carrying out of maintenance operational works; creation of experimental production testing grounds;
- development of the production base of the reclamation industry, the formation of planning and surveying centers, the scientific and laboratory base of federal state budgetary scientific institutions, subordinate to the Department of Reclamation;
- development and updating of regulatory and procedural and standard technical documents, ensuring the effective operation of the reclamation and water-economic complex of the agro-industrial complex;
- development of human resources in the field of reclamation industry, hydraulic engineering, water economy, and agricultural water supply: preservation and development of scientific potential, training of highly qualified scientific and pedagogical personnel, retraining of engineering and managerial personnel in universities and research institutes, taking into account the new economic situation and land planning of the territory.

The development program of the reclamation complex should include the concept of adaptive landscape agriculture, the development of ecologically reliable water circulation irrigation and water supply systems, drainage and wastewater treatment technologies; prevention of water and wind erosion, restoration and vegetative reclamation; biochemical technologies for restoring soil fertility, bioengineering systems for treatment of drainage and wastewaters, land and forest reclamation. Development of an industrial base for the reconstruction and restoration of reclamation systems of operation and maintenance providers, technical re-equipment, a system of machines for the construction and operation of reclamation systems.

6 CONCLUSIONS

In this work, an analysis is carried out and an assessment is given of the technical and operational state of reclamation facilities in the federal districts of the Russian Federation, which are under the operational management of the regional FSBI "Management "Meliovodkhoz". There are 2,868 objects in total, including: 807 - irrigation systems, 1,055 - drainage systems, 721 - hydraulic structures on the reclamation network, and 285 facilities - separately located hydraulic structures. The bulk of reclamation facilities (84%), in terms of their technical state, belong to the III and IV classes, incl. 70% of irrigation systems, 88% - drainage systems and separately located hydraulic structures, and 100% - canals. Such reclamation facilities do not work efficiently and require reconstruction or heavy overhaul.

Basic components for the development of reclamation potential and infrastructure: reclamation systems and reclaimed lands not used in agricultural production, as well as reclamation systems with unsatisfactory technical and operational characteristics and reclaimed lands, that are in an unsatisfactory ecological state and have a low level of soil fertility. To increase the level of productivity of reclaimed lands, it is necessary to significantly increase the technical level of reclamation facilities by completing a set of works on the reconstruction of reclamation systems and hydraulic structures, as well as to implement a set of reclamation measures to increase the level of fertility and improve the ecological situation on reclaimed lands. The main measures are technical, technological, organizational, managerial and others, aimed at increasing the sustainability of the development of the reclamation complex and the agro-industrial complex of Russia, including: measures for hydrotechnology, land, and forest reclamation, cultural and technical, and chemical reclamation.

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