

**Research Article**

UDC 581.524.34

**Biological Recultivation in the North and Its Feature****(on the example of Yakutia)****S. I. Mironova, V. V. Ivanov,****L. D. Gavrilyeva and Z. A. Kudinova**Northeast Federal University of M. K. Ammosov.  
Yakutsk, Belinsky St. 58.**ABSTRACT**

The article presents the results of many years of research on the biological recultivation of disturbed lands in Yakutia. The severe natural and climatic conditions, the absence of a fertile soil layer to fill the man-made surface, the limited methods of reclamation, the lack of nurseries of re-cultivating plants - all this makes it difficult to carry out remediation measures and slows down the restoration of disturbed lands. The authors carried out experimental and experimental works on the biological recultivation of the dumps of the diamond quarry "Aikhal" in the west of Yakutia with the selection of more effective methods of biological reclamation without pouring out the fertile layer, which received a patent for the invention (Ru 2462845 - 2010, Ru 2497608 - 2012). In the conditions of the North where the deficit of fertile rocks is deficient, it is recommended to use last year's grass and industry waste.

**Keywords:** cryolithozone, vulnerability of ecosystems, deposits of diamonds, gold, coal, reclamation, technogenic lands, soils, reclamation potential, biota, use of last year's grass, use of industrial wastes, seed sowing, self-growth, cryogenic processes.

**1. INTRODUCTION.**

Yakutia occupies 18% of the territory of Russia and is a source of mining industry for raw materials. Over 40% of the territory is beyond Arctic Circle [1]. At open-pit mining of minerals to the place of natural landscapes technogenic forms of relief - pits over 500 m in depth, dumps of dead rocks up to 100 m high and the huge areas of tailings dams on beds of the rivers or small rivers appear. The fulfilled sites of fields turn not only into lands of little use, but also worsen sanitary and hygienic living conditions of the person. To some extent to liquidate consequences of industrial developments influence on natural complexes, these technogenic landscapes are subject to transformation or recultivation.

It is known that in the north technogenic transformation of natural ecosystems is easily vulnerable and less steady against technogenic influences, therefore remediation works solve an environmental problem.

Recultivation in the territory of Yakutia is

carried out by the mining enterprises, in particular technical and biological recultivation is at the beginning stage. The institute of applied ecology of the North plays the leading role in carrying out biological recultivation on diamond, gold and coal fields in recent years.

**2. Features of recultivation in the North.**

Researchers established that recultivation has specific features in the north. At restoration of the ecosystems of the North broken at subsurface use the specific mode of environmental management has to be provided. In Yakutia remediation works are carried out in severe climatic conditions and at universal distribution of the multi-year frozen grounds complicating the overgrowing of vegetation.

Severe sharply continental climate – is the main factor limiting development of biota. Deep frost penetration and a long frozen condition of mineral grounds do not promote development of biota in the rock mass [2]. Biocentric relation between components of an ecosystem not only

become closer, but also the vital space is narrowed to an organogenic layer, small on power, in which biological turnover of organic substance practically becomes isolated. Organic-accumulative layer is poorly connected with mineral waste because root system of plants (80-90% of the lump of the roots getting 50 cm deep) is concentrated in an organogenic layer. It is the main reason for easy vulnerability of northern ecosystems to technogenic influences. And therefore recultivation of technogenic territories is necessary for prevention of the erosive phenomena and the related additional expansions of the broken areas.

Environment complicates and limits a possible set of recultivation methods, especially biological [3]. In many regions of Russia a widespread method of biological recultivation is the meadowing method. In Yakutia at application of this method much attention has to be paid to local seeds and landing materials since seeds from other regions are not suitable for Yakutia at all, they do not maintain severe conditions and die off in the first or second year of crops. Also saplings from other regions of Russia with more temperate and humid climate, longer vegetative season of plant development cannot grow. Efficiency of biological recultivation and absence of nurseries of recultivative plants which would provide with seeds and saplings at recultivation detains.

### 3. Recultivation on dumps of diamonds with partial dumping of fertile grounds.

For the purpose of suitable ways and methods search for biological recultivation of dumps of dead rocks in diamond pits we carried out test

and experimental works in the territory of Mirninsky and Aykhalsky GOK which differ in climatic conditions. The pit of Aykhal is on border of Arctic Circle where northern light forests, and a *Mira* pit - the territory of an average taiga prevail. It is possible to find a potential and fertile layer from the loose field "Water Separate Galechnik" for dumping of a technogenic surface in a zone of influence of Mirninsky GOK, and - they are not in the territory of Aykhal pit. Therefore the main objectives of our experiments were:

- to investigate the remediation potential of dumps - a condition of a technogenic surface, soil and extent of their overgrowth;
- to carry out test works on identification of suitable ways of biological recultivation with partial dumping or without dumping of a fertile layer;

Dumps of dead rocks in diamond pits are very abrupt (to 60 °) and high (to 40-100 m) technogenic relief, hilly with plateau tops, created around the cities and settlements. Radical grounds are presented by mesozoic and Paleozoic aleurolites and sandstones with pro-layers of conglomerates with impurity of clays and loams with the considerable content of pyrites. The surface of dumps is strongly condensed with bulldozers which makes it absolutely impenetrable for roots of plants.

The first experiment put on a pit dump No. 6 "Mira" near the observation deck (fig. 1) which has height of 60 m and a slope angle 50°. Grounds of a dump in accordance with GOST 17.5.1.03-86 belong to of little use and are not suitable for biological recultivation.



Fig. 1. A dump No. 6 before experiment (2001) and after (2010)

Before experiments we studied the remediation potential of dumps, i.e. assessment of a condition of a technogenic surface, soil and extent of overgrowing by vegetation. On a dump dumping 2/5 surfaces of a dump by overburden grounds from the Water Separate Galechnik field was made. Crops of herb seeds and landing of saplings from surrounding forest allotments were the main actions of biological recultivation. Seeds of plants were collected on overburden dumps near the pit. A basis of seeds were herbs of bay willow, Gaup't's alkali grass, foxtail barley, frost blite, wild vetch, shamrock, purple milk vetch, white sweet clover, sorrel, waywide plantain, wild rye etc. Saplings of bushes (dogrose, raspberry, birch shrubby) were planted on a dump surface.

The first shoots began to appear in a year on the poured-out sites, and then on kimberlitic grounds. In 2006 not trodden part of a surface and a slope of a dump No. 6 represented an artificial green corner in the middle of "a lunar landscape". Now vegetation of a dump is steadily populated. Experiments on recultivation of dumps showed that survival of saplings depends on their age and look. The more senior is age of wood and shrubby types, the lower is the survival chance and vice versa. Quicker saplings of raspberry, birch shrubby and the willows growing around a pit get accustomed.

Difficult saplings of wood types get accustomed (larches, pines, alder). From experiment it is possible to conclude that at partial dumping of ore dumps potentially fertile layer of overburden grounds it is possible to achieve within 5-8 years of a steady vegetable cover.

#### 4. Recultivation of dumps without dumping the fertile soil.

For recultivation of dumps in Aykhal pit the task to find ways and methods of biological recultivation without dumping the a fertile layer or replacement with its other materials was set. The main objectives were:

- The choice of a dump for carrying out experiments on biological recultivation;
- Choice of options of experiment on biological recultivation of dumps;
- Selection of plant seeds suitable for dumps in Aykhal pit;

Dumps of dead rocks in Aykhal pit as well as dumps of all diamond pits represent high (up to 40-60 m), a terrace plateau hilly relief with abrupt slopes (fig. 2). Dumps are located around the pit and are close to the settlement of Aykhal. Reaction of the environment in soil of dumps weak and strong alkali, soil is poor in biogenous elements. Soil of dumps is related to group of little use on physical properties and the chemical composition.



**Fig. 2.** - Dumps in Aykhal pit

Vegetation of dumps is at an initial stage of succession development [4]. Fresher high dumps and their slopes, as well as industrial platforms where partial alignment of a surface (a technical stage of recultivation) is carried out are deprived

of vegetation and led to strong consolidation of soil which interferes with fixing of seeds and growth of plants. Not leveled sites of old dumps began to grow to 10-30% of a protective covering with domination of a chamomile,

horsetail, single plants of starwort, bladder seline, foxtail barley, bay willow, Gaup't's alkali grass appear. In places there are sprouts of a larch and willows up to 15 cm high.

The surface of a test dump is leveled for 50%, the second part consists of a large cloddy grounds.

Use of nontraditional materials instead of dumping of fertile grounds was the main objective of experiments.

We made the following experiments for biological recultivation:

- application of last year's grass as a protective layer for fixing and the shelter of seeds from wind, cold, as well as detention of moisture on



**Fig. 3.** Experimental grounds in August, 2012.

It is established that it is the most effective to use to the old grass in combination with crops of one-perennial plants during the first season seeds of annual plants, and in the next years of long-term herbs ascend.

#### **Method of ABB rainfall application**

Use of rainfall of sewage as organic fertilizers is regulated by GOST P 17.4.3.07–2001 "Requirements to rainfall of sewage at use as organic fertilizers" and Health regulations and norms the SanPiN 2.1.7.573–96 "Hygienic requirements to use of sewage and their rainfall for irrigation and fertilizer".

Rainfall of sewage – is the firm fraction consisting of the organic and mineral substances emitted in the course of sewage treatment with an upholding method (a crude deposit) and a complex of the microorganisms participating in process of biological sewage treatment and brought out of technological process (excess active silt) (GOST P. 17.4.3.07-2001).

We chose industrial wastes - rainfall of sewage of the sewer treatment facilities (STF) which used as the organic fertilizer containing the elements necessary for development of plants in

a surface;

- application of biomats;
- use of a method of hydrocrops on slopes;
- application of ABB waste;

#### **Method of application old grass**

Old grass is a dry last year's grass on meadows. All not mowed plants or an aftermath after mowing are its part, i.e. these are meadow cereals, bean and wild grasses, as well as sedge plants are more rare plants. On the valley of river Sokhsolokh from where it was brought together the old grass, woodreed, sedge and foxtail meadow prevail.

In the fall of 2012 experiments showed positive results (fig. 3).

available forms.

The experiment was begun in June, 2011 on the skilled site No. 4 located on a surface of a pit dump. After preparation of a surface by fecal the car brought rainfall of sewage from the industrial platform of "Anniversary" and distributed evenly on the surface of the platform. The platform was stood within 2 days owing to what surplus of sewage flew down by a natural filtration. Rainfall mixed with techno genic soil, sand and sawdust with wood shavings and made crops of seeds.

In August, 2011 the first shoots with rather high degree of a protective covering of herbage (more than 30%) are described that showed considerable prospects of the chosen way for biological recultivation of dumps in the conditions of acute shortage of a fertile layer (fig. 4). In places the projective covering reached 50%. Together with oats single types bean (tributary) 2-3 cm high, a horsetail field, wormwood and frost blite appear.

In the fall of 2012 the specific structure reaches 11 views with prevalence of a wildrye, ice-holes, the tributary and lucerne, even small

sprouts of willow basket are visible, it confirms increase in intensity of settling with plants on experiment. The projective covering is more on



decreases (to 30%) where rainfall of ABB was late, and less (to 10%) on increases. Average height also differs and changes within 5-40 cm.



**Fig. 4.** Stages of works on experiments on use of ABB rainfall

In the fall of 2011 positive results on shoots of seeds on the skilled site are received. At first one-year views with domination of oats sowing become populated. The average projective covering of herbage made up to 30%, average height - to 20 cm.

### CONCLUSION.

Application of nontraditional methods of biological recultivation on dumps of diamond pits "Mira" and Aykhal showed the first positive results of use of a last year's grass and industrial wastes. Carrying out biological recultivation by the above-stated methods allows the mining enterprises to restore the broken lands without big costs of fertile layer dumping. Application of waste has double value since solves one more environmental problem with placement of industrial wastes.

### LITERATURE

1. Yakutia. - M.: Science, 1965. - 468 pages.
2. Recultivation of lands in the north. Syktyvkar: AN NTs URO Komi publishing house, 1997. - 34 pages.
3. Pereverzev V. N., Podlsnaya N. I. Biological recultivation of industrial dumps on Far North. - Apatity: Prod. Kola F Academy of Sciences of the USSR, 1986.-103 pages.
4. Mironova S. I. Technogenic suksessionny systems of vegetation in Yakutia. - Novosibirsk: Science. Sib. dep., 2000. - 151 pages.

### About authors

First name, last name: Mironova Svetlana Ivanovna  
Degree: Doctor of Biological Sciences, Full Professor

Organization: Research Institute of Applied Ecology of the North of the North-Eastern Federal University

Position: \_ Chief Researcher

Work address (with index): 677000 Yakutsk, Lenin Ave. 1

Telephone (with city code): 8(4112)34-47-23

Fax (with city code): 8(4112)49-67-27

E-mail: mironova47@mail.ru  
<mailto:mironova47@mail.ru>

First name, last name: Ivanov Vasilii Vasilievich  
Degree: Candidate of Engineering Sciences

Organization: Research Institute of Applied Ecology of the North of the North-Eastern Federal University

Position: \_ Chief Researcher

Work address (with index): 677000 Yakutsk, Lenin Ave. 1

Telephone (with city code): 8(4112)349-67-29

Fax (with city code): 8(4112) 49-67-27

E-mail: v.v.ivanov@mail.ru  
<mailto:v.v.ivanov@mail.ru>

First name, last name: Gavrilyeva Ludmila Dmitrievna

Degree: Candidate of Biological Sciences

Organization: Research Institute of Applied Ecology of the North of the North-Eastern Federal University

Position: \_Senior Research Officer

Work address (with index): 677000 Yakutsk, Lenin Ave. 1

Telephone (with city code): 8(4112)34-47-23  
Fax (with city code): 8(4112) 49-67-27  
E-mail: adoxa@mail.ru  
<mailto:adoxa@mail.ru>

First name, last name: Kudinova Ziya  
Artemovna

Degree:

Organization: Research Institute of Applied  
Ecology of the North of the North-Eastern  
Federal University

Position: \_ Research Assistant  
Work address (with index): 677000 Yakutsk,  
Lenin Ave. 1  
Telephone (with city code): 8(4112)34-47-23  
Fax (with city code): 8(4112) 49-67-27  
E-mail: kudi-nova@yandex.ru <mailto:kudi-  
nova@yandex.ru>