EXAMINATION AND CURRENT STATE OF VEGETATION OF TECHNOLOGICALLY DISTURBED LANDS OF SSGPO

For the biological stage of reclamation of disturbed lands, the study of plant communities, the identification of dominant species and potential phytomeliorants of the local flora that are resistant to a complex of unique environmental conditions of technogenic formations are of paramount importance. The study of the comparative characteristics of natural and artificial vegetation overgrown with man-made man-made vegetation in the relationship of exploration of the subsoil by the open method, regime of disturbed land allotment, landscape, soil conditions and vegetation cover is a very important task.

The purpose of our research is to study the processes of natural overgrowing of dumps, the analysis of the results of previously carried out works on reclamation.

The study of the composition and structure of vegetation industrial dumps and adjacent areas was carried out using traditional methods of field geobotanical research.

We have analyzed the previous studies on the composition and structure of the vegetation of the Sokolov-Sarbay mining and processing production association (SSGPO), according to literary sources, local flora has been identified. By means of own research, an assessment of the current state of vegetation has been carried out, potential phytomeliorants have been identified for the subsequent biological stage of reclamation of disturbed lands located in similar natural and climatic zones of the republic.

The vegetation of a flat plateau-shaped dump mainly consists of formed by self-overgrown communities. Communities of steppe cereals and motley grass dominate. On the periphery of the dump, meadow cereals and motley grasses dominate along dug trenches. It consists mainly of herbaceous pe- rennials, but the role of annuals and one−two-year-olds is also quite large. The phytocenoses are dominated by steppe species, from the ecological groups of plants – xerophytes. The participation of weed plants is small. At the end of 60 years after the formation of the dump, we can conclude that the natural zonal vegetation is almost restored – zonal steppe grass and forbs dominate in the vegetation cover, with the exception of artificially formed negative relief elements, where mosaic patterns are observed due to changes in the environmental conditions of the habitat.

Key words: vegetation, phytomeliorants, dominants, disturbed lands, dumps.
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Изученность и современное состояние растительности техногенно нарушенных земель ССГПО

Для проведения биологического этапа рекультивации нарушенных земель первостепенное значение приобретает изучение растительных сообществ, выявление доминантных видов и потенциальных фитомелиорантов местной флоры, устойчивых к комплексу своеобразных экологических условий техногенных образований. Изучение сравнительной характеристики естественного и искусственного зарастания растительностью техногенных отвалов во взаимосвязи с режимом нарушения площадей земельного отвода, ландшафтом, состоянием почвы и растительного покрова представляет весьма важную задачу.

Целью наших исследований является изучение процессов искусственного зарастания отвалов, анализ результатов проведенных работ по рекультивации.

Изучение состава и структуры растительности промышленных отвалов и прилегающих территорий проводилось с использованием традиционных методов полевых геоботанических исследований.

Нами сделан анализ ранее проведенных работ по изучению состава и структуры растительности территории Соколово-Сарбайского горно-обогатительного производственного объединения (ССГПО), по литературным источникам выявлен состав местной флоры. Путем проведения полевых исследований проведена оценка современного состояния растительности, выявлены потенциальные фитомелиоранты для последующего проведения биологического этапа рекультивации нарушенных земель, расположенных в подобных природно-климатических зонах республики.

Растительность плоского платообразного отвала в основном состоит из сформировавшихся путем самозарастания сообществ. Доминируют сообщества степных злаков и разнотравья. По периферии отвала по прорытым канавам доминируют луговые злаки и разнотравье. В ее состав входят преимущество травянистые многолетники, но также довольно велика роль однолетников и одно- двухлетников. В составе фитоценозов преобладают степные виды, из экологических групп растений – ксерофиты. Участие сорных растений невелико. По истечению
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60 лет после образования отвала можно заключить, что естественная зональная растительность почти восстановлена – в растительном покрове преобладают зональные степные злаки и разнотравье, исключение составляют искусственно образованные отрицательные элементы рельефа, где наблюдается мозаичность ввиду изменения экологических условий местообитания.

Ключевые слова: растительность, фитомелиоранты, доминанты, нарушенные земли, отвалы.

Introduction

By Enterprises engaged in the extraction of coal, ferrous metals, and phosphorites located in Kostanay, Karagandy, Aktobe, East Kazakhstan, Pavlodar, Zhambyl, West Kazakhstan and Atyrau regions, have been accumulated significant dumps of mining and processing industry waste. Soil pollution at coal mining sites is patchy, which is explained by an imbalance of plant nutrients, the degree of anthropogenic pressure at the time of extraction, applied by agricultural technologies, the lack of continuous monitoring, and irregular reclamation work.

Most of the areas of disturbed lands of Kazakhstan are in the category of lands of industry, transport, communications, for the needs of space activities, defense, national security and other non-agricultural purposes.

In regional terms, the largest amount of disturbed land is in three regions, in Mangystau – 78.6 thousand hectares and worked out in 3.6 thousand hectares, in Karagandy – 45.3 thousand hectares and 10.6 thousand hectares, respectively, and Kostanay – 37.8 thousand hectares and 13.7 thousand hectares respectively.

In total, there are 346 enterprises and organizations in the republic that have disturbed lands on their territory. Only in 2017, 1.8 thousand hectares were disturbed in the republic, 0.6 thousand hectares of disturbed land were reclaimed and 1.2 thousand hectares of disturbed lands were recultivated. The largest area of disturbed land was reclaimed in Aktobe region 1.0 thousand hectares.

With the issues of reclamation of lands disturbed by industry in different climatic zones the scientists began to deal from the second half of the last century. Conducted the study of the agrochemical and water properties of man-made illusions of dumps, the natural overgrowing of uneven dumps, the creation of experimental plots, on which tested woody and herbaceous plants, has been developed agrotechnical measures to care for them [1-14].

The issues of natural and artificial restoration of vegetation in the conditions of open-cast mining were investigated in a complex at various levels of landscapes [11-14]. The study of the comparative characteristics of the natural and artificial vegetation of man-made dump vegetation in the relationship of open-pit mining, the regime of violation of land allotment, landscape, soil conditions and vegetation cover is a very important task.

When carrying out the tasks of the project “Optimization of reclamation works in the open development of mineral deposits” by scientists of the Kazakh National Technical University named after K.I. Satpayev revealed that as the concentration of heavy metals in the soil increases, the contribution of melanin-containing micromycetes to the total microbial biomass increases and the proportion of light-colored hyphomycetes decreases. It has been established that under the influence of heavy metals in the structure of the fungal communities of the background zone, dominant positions (up to 85%) are occupied by dark-colored anamorphic fungi from the genera Alternaria, Cladosporium [15].

By us, in the framework of the project “Improving the management of technical and biological stages of reclamation of disturbed lands in open mining”, analyzed vegetation and conducted field research in the Sokolov-Sarbay mining and processing production association (SSGPO).

SSGPO is located in the northern part of the Turgai Trough, on the territory of the Turgai Plain. A characteristic feature of the relief of the Turgai Plain is a multitude of large and small lake basins, steppe saucers and depressions with aspen-birch pegs, less often elongated, very significant in size, but shallow depressions, which are traces of ancient troughs. Large, partially drying up lakes are confined to these depressions. Uvals alternating with lake depressions have very gentle slopes and flat outlines.

Dumps differ from the adjacent areas by the nature of the relief, the properties of the component soil, the moisture regime, and the content of mineral substances available to the plants. Substrate moistening at the dumps occurs mainly due to precipitation, and the moisture distribution is caused by the mechanical and mineralogical composition of the composing soils [16, 17].

The relief and exposure of dumps lead to a redistribution of moisture in the dumps, thereby affecting the process of overgrowing. Particularly
adverse conditions develop on the slopes of the southern exposure. If the humidity of tertiary soils (flasks) on the northern slopes is 40%, then on the slopes of the southern exposures it decreases to 10%, the northern slopes of the dumps have a more powerful snow cover (up to 54 cm on average, and in some places more than 120 cm). The slopes of the southern exposure as a result of exposure to winds of the southern and south-western direction in winter period are almost bare and in January the snow layer at the foot is only 19-20 cm.

At present SSGPO does not have funds for carrying out recultivation in large volumes. Therefore, it is of interest to study as the processes of natural overgrowing of waste dumps, as well as the analysis of the results of previously carried out remediation works.

Materials and Methods

The object of research is the vegetation of disturbed lands of the SSGPO territory located in Kostanay region.

The study of the composition and structure of vegetation of industrial dumps and adjacent territories was carried out using traditional methods of field geobotanical research [18-20], including: geobotanical description of the main plant communities; landscape and environmental profiling.

Vegetation cover consists of phytocenoses. In the composition and structure of the phytocenosis, internal patterns of plant interactions with each other and with the habitat are manifested. For each plant community is established a full floristic composition, determined the phases of the phenological development of certain species, morphometric parameters (height, habitus), life forms (trees, grass, bushes, etc.).

Description of vegetation is made on special forms, including the following sections:

a) Name of the community.

b) Relief: is noted a micro-relief, which may be of phytogenic, zoogenic origin.

c) Moistening conditions: atmospheric, groundwater, flowing, stagnant, the presence of runoff on the slopes.

d) Projective soil cover by plants is defined as the percentage of the area occupied by the projections of the aerial parts of all plants of the phytocenosis as a whole. It is expressed by the projective coverage in percent. The projective cover varies greatly in seasons and years, it is an indicator clearly reflecting changes in the environment.

e) Aspect – physiognomic characteristic of the community, reflecting the visually recorded features of the phytocenosis structure: the color of the main background species and the brightest colorful spots of flowering plants.

f) Species composition of the community: For each species are being noted the stratification, abundance, vital condition, placement, phenophase and true projective cover. A complete list of plants forming the phytocenosis is being compiled.

g) Stratification (vertical structure): determined by the height of the plants with the release of substages.

h) Phenophase: information on the phenological phases of plant development is important for characterizing the seasonal rhythm of the phytocenosis as a whole. The following main stages of seasonal development or phenological phases are distinguished: vegetation, budding, flowering, fruiting, vegetation after fruiting, dying out, and a state of rest.

i) Surface condition: is estimated clutter, ticking, burrows of earth shrew, stoniness, debris, etc.

j) The influence of anthropogenic factors.

The coordinates of the points of description of plant communities were determined by ground-based laser scanning.

Results and Discussion

Analysis of the results of experimental work on the reclamation of dumps showed that on a favorable substrate (quaternary loams, Neogene sands and sandy loams), the creation of phytocenoses cultures is possible by sowing herbaceous plants and planting trees and shrubs without additional agrotechnical measures. On an unfavorable substrate (flask and Chegan clay), the creation of plant phytocenoses is possible only if the surface of the substrate is covered with a soil fertile layer, and in some cases subject to the application of mineral fertilizers. It is noted that for the reclamation of dumps of iron ore quarries most environmentally plastic such phytomeliorants as: white birch (Betula pendula Roth), mixture of legumes: sainfoin (Onobrychis), clover (Trifolium), alfalfa (Medicago), melilot (Melilotus) and several others. Grass mixtures of cereals are also plastic: bonfire (Bromus), wheatgrass (Elytrigia), timothy (Phleum).

The current state of the vegetation of the project area was carried out in 2018. The quarry, the Southeast dump of the Sarbay field and the territories adjacent to them were visited.
Various species of trees and shrubs grow on the sides of the quarry: hanging birch (*Betula pendula* Roth), American maple (*Acer negundo* L.), Ash willow (*Salix cinerea* L.), Shrub Caragana (*Caragana frutex* (L.) K. Koch), double-twisted currant (*Ribes diacantha* Pall.), Wild rose prickly (*Rosa spinosissima* L.), filipendula (*Spiraea crenata* L.), Cotoneaster (*Cotoneaster melanocarpata* Lodd., G. Lodd. & W. Lodd.), Elaeagnus (*Elaeagnus*), Sea Buckthorn (*Hippophae*), some of which were planted earlier in the process of agrotechnical measures (Figure 1а – Quarry and adjacent territory).

The dominant type of vegetation cover is sod-cereal steppes on ordinary chernozem. Dominate turfy cereals – feather grass: reddish (*Stipa rubens* P. Smirn.) and Zalessky (*S. Zalesskyi Wilensky*), Welsh fescue (*Festuca valesiaca Gaudin*). *Agropyron fragile* (Roth) P. Candargy is a significant contributor to the grass, mixed with *Helictotrichon* (*Helictotrichon desertorum* (Less.) Nevski) and motley grass (Figure 1b – Quarry and adjacent territory).

On the territories adjacent to the quarry, mainly motley grass-sod-cereal with wormwood community are prevalent. Alfalfa yellow, yarrow, yarrow tansy, mouse pea, swinging paniculum, Tartar breastwoman, immortelle, astragalus and others take part in the composition of the grass stand. The basis of the herbage is turf cereals – reddish feather grass and fescue. On low relief elements, on more wetted habitats are developed the Austrian wormwood-motley grass-coarse stalk cereal with shrubs of community (Figure 2 – Plains lowland vegetation).

![a) General view of the quarry](image1.jpg)

![b) Dominant vegetation](image2.jpg)

**Figure 1** – Quarry and adjacent territory

The dominants of the herbage communities are coarse stalk cereals – southern reed (*Phragmites australis* (Cav.) Trin. Ex Steud.), wood small-reed (*Calamagrostis epigeios* (L.) Roth); motley grass consists of the above-mentioned steppe grasses. From polynyas, in addition to Austrian, in places there are also wormwood tarragon (*Artemisia dracunculus* L.). From grasses in the flora of the project area are represented economically valuable and other species.

Among them are fodder plants: tuberiferous rank (*Lathyrus tuberosus* L.), crescent-shaped alfalfa (*Medicago falcata* L.), lupine-shaped clover (*Trifolium lupinaster* L.), tufted vetch (*Vicia cracca* L.), comb grass (*Agropyron cristatum* (L.) Gaertn.), meadow foxtail (*Alopecurus pratensis*), *Bromus inermis* (*Bromopsis inermis* (Leyss.) Holub), ground reed grass (*Calamagrostis epigeios* (L.) Roth), creeping wheatgrass (*Elytrigia repens* (L.) Nevski), meadow fescue (*Festuca pratensis* Huds.) cloves, spurge, *Galatella*, Jacob’s ladder (Figure 3 – Some potential phytomeliorants from local flora).

The following medicinal plants are found: Ural licorice (*Glycyrrhiza uralensis* Fisch.), large plantain (*Plantago major* L.), Marshall Thyme (*Thymus marschallianus* Willd.), Ziziphora
There are poisonous plants that include: Cockerel (Xanthium strumarium L.), multi-flowered buttercup (Ranunculus polyanthemos L.), simple basil (Thalictrum simplex L.), black henbane (Hyoscyamus niger L.), bittersweet (Solanum dulcamara L.).

The study of the vegetation of the Southeast dump, which is the very first dump of the deposit (1957) and the territory adjacent to it, was carried out by a detailed route method. The description of vegetation was carried out according to the traditional method of geobotanical research. In the course of the study, the most typical communities in different stages of succession were distinguished. A total of 11 plant communities were identified and described.

The vegetation of the adjacent territory is distinguished by a high projective cover (90-100%), with a slight predominance of cereal over the motly grass and some participation of Austrian wormwood. In the composition of the herbage cereal-motley grass with wormwood communities dominate – hedgehog team (Dactylis glomerata L.), creeping couch grass (Agropyron repens (L.) P. Beauv.), Meadow fescue (Festuca pratensis Huds.), numerous species of motley grass are subdominant – Alfalfa (Medicago), Silverweed (Potentilla), true and tenacious bedstraw (Galium verum L., G. aparine L.), iris (Iris), heartwood (Cardaria), colza (Barbarea), yarrow (Achillea millefolium L.), Convovulus (Convovulus), hard carnation (Dianthus rigidus M. Bieb.), Roots of tubers (Lathyrus tuberosus L.), Crescent-shaped alfalfa (Medicago falcata L.), Lupine-shaped clover (Trifolium lupinaster L.), tufted vetch (Vicia cracca L.), and others.

Characterized by the development of shrubs in the lowlands and depressions. The development of thickets of sucker indicates salinity and semi-hydromorphism of soils in the vicinity of the lake formed by urban runoff (Figure 4 – Vegetation of the adjacent territory).

On slopes of the eastern and southeastern exposition of the dump were formed wheatgrass-motley grass-cereal and wheatgrass-bluegrass-motley grass communities. The vegetation of the communities is composed of wheatgrass (Agropyron pectinatum (M. Bieb.) P. Beauv.), Bluegrass (Poa bulbosa L.), steppe motley grass and cereals. In some places on more humid slopes, reed dominates in the composition of the stand, isolated shrubs are encountered (Figures 5 – Vegetation of dump; 6– Single bushes found on the dump).
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Figure 3 – Some potential phytomeliorants from local flora

a) Medicago falcata                                      b) Thymus marshallianus                              c) Agropyron cristatum

d) Artemisia dracunculus                                  e) Convolvulus arvensis                              f) Tanacetum vulgare

Figure 4 – Vegetation of the adjacent territory

Thickets of Elaeagnus                                     Cereal and motley-grass community
Dump slope communities

Figure 5 – Vegetation of dump

Upper lined part of the dump

Figure 6 – Single bushes found on the dump
The vegetation of a flat plateau-shaped dump mainly consists of formed by self-overgrown communities. Communities of steppe cereals and motley grass dominate. On the periphery of the dump, meadow cereals and motley grasses dominate along dug trenches. There are single bushes of poplar, sea buckthorn, silverberry and other steppe shrubs.

**Conclusion**

According to the results of our research and taking into account the literature data, the flora of dumps of the iron ore industry is represented by 208 species of vascular plants belonging to 33 families and 118 genera. It consists mainly of herbaceous perennials, but the role of annuals and one–two-year-olds is also quite large. The phytocenoses are dominated by steppe species, from the ecological groups of plants – xerophytes. The participation of weed plants is small.

At the end of 60 years after the formation of the dump, we can conclude that the natural zonal vegetation is almost restored – zonal steppe grass and forbs dominate in the vegetation cover, with the exception of artificially formed negative relief elements, where mosaic patterns are observed due to changes in the environmental conditions of the habitat.

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