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BASIC METHODOLOGY AND MODERN TECHNOLOGICAL SOLUTIONS FOR RECLAMATION OF DISTURBED LANDS AND SOILS

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Restoration of disturbed terrains is a complex problem, determined by a number of factors: geo-climatic, mining and technical conditions, mechanical and agrochemical properties of soil and geological materials to be seized. The main objective of the article is to propose a methodology for the study of disturbed lands and soils and to present the existing methods of technical and biological recultivation of these lands.

***Keywords*:** recultivation, disturbed lands, soils

МЕТОДИЧНА ОСНОВА И СЪВРЕМЕННИ ТЕХНОЛОГИЧНИ РЕШЕНИЯ ЗА РЕКУЛТИВАЦИЯ НА НАРУШЕНИ ЗЕМИ И ПОЧВИ

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Резюме: Основната цел в представената публикация е да предложи методология за изследване на нарушените земи и почви и да представи съществуващите методи за техническа и биологична рекултивация на тези земи. Възстановяването на нарушените терени е комплексен проблем, определящ се от редица фактори: географско-климатични, минно-технически условия, механични и агрохимични свойства на почвените и геологични материали, които се изземват. Основната задача при възстановяване на земите, нарушени от миннодобивните или други дейности, включва повишаване на почвеното плодородие и създаване на екологично балансирана екосистема. Рекултивацията е един от най-радикалните методи за възстановяване и подобряване на нарушените терени и възвръщането им в пълноценния (обработваем) поземлен фонд.

***Ключови думи*:** рекултивация, нарушени земи, почви

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INTRODUCTION

The intensive mining of mineral resources affects negatively environmental components and radically alters natural landscape. In the course of mining activities the soil cover is destroyed, the hydrological network is altered and new relief forms are formed, which disturbs the ecological balance of the mining territories. The processing of black, colored and inert materials, the construction of linear and engineering equipment, urban aglomerations, etc. causes large-scale environmental disturbances (Banov, et al., 2010; Butrym et al., 2016). These activities lead to constant decrease of the effective land fund, which is basic means of production in agriculture and forestry.

The disturbed terrains such as heaps from mines, quarries for sand and gravel, gullies, uncorrected river beds, waste dumps, etc., are not fit for agricultural use. They have partially or completely lost their economic function and they virtually appear to be a source of negative environmental impact when they contain toxic substances and specific microbiota (Committee on Soil as a Resource in Relation to Surface Mining for Coal, 1981; Thurman and Sencindiyer, 1986; Marinkina,-1999; Sencindiver and Ammons, 2000; Bendfeldt et al., 2001; Seybold et al., 2004; Androkhanov and Kurachev, 2009; Esshaimi et al., 2012).

As we have mentioned, some of the basic factors, causing anthropogenic alterations in environmental components are the mining and processing industries. On preliminary assessment about 90 000 ha of the territory of the country are affected by mining activities, quarries and construction.

International experience analysis shows that the reclamation of the disturbed terrains is a complex problem, determined by a number of factors: geographic-climatic, mining and technical conditions, mechanical and agrochemical properties of the soil and geological materials, which are extracted, the system of deposit exploitation, etc. /Marinkina and Banov, 2001; Tsolova and Banov, 2004; Zheleva and Bozhinova, 2009; Zheleva-Bogdanova, 2010; Ivanov and Banov, 2008; Misheva et al., 2007; Tsolova et al., 2010; Kaufmann et al., 2009; Smaliychuk et al., 2016; Zheng-fu, 2005/. Therefore this requires technological solutions for recovery of the fertility of the disturbed terrains to be in compliance with the specifics of every site and co-ordinated efforts of specialists from different scientific and applied science organisations and institutes to be used.

The main task in reclamation of lands, disturbed by mining and other industries includes an increase of soil fertility and creation of an environmentally balanced ecosystem. Reclamation is one of the most radical methods for recovery and improvement of the disturbed terrains and their return into the complete arable land fund.

Most generally the reclamation of disturbed and destroyed lands represents a system of engineering, ecological, meliorative, agro-technical, forrestry managerial and other activities, aimed at reclamation of the disturbed terrains and at landscape improvement in order to create sites of different purposes such as agricultural, forrestry, sanitary, recreational and other ones. (Regulation № 26/2002).

The main purpose of this publication is offering methodology for terrain and analytical research of disturbed lands and soils and presenting the existing methods for technical and biological reclamation of these lands. This systemized information allows the development of technologies for technical and biological reclamation of a

high industrial, financial and ecological effect. The methodology offered for conducting preliminary research has proved that it generates ideas for creation of efficient technological solutions for reclamation of disturbed lands and is recommended by the authors for conduction of reclamation activities in the country.

TERRAIN AND ANALYTICAL RESEARCH

FIELD AND LABORATORY ANALYSIS OF SOIL DIFFERENCES

The field research of the soil cover in the region of disturbance must be done in Scale M 1:10 000 for large areas and flat terrains, and in Scale M 1:5 000 or Scale 1:2 000 in smaller areas and rugged relief. The research aims at determination of the soil type, the of the humus horizon and the opportunities for its collection, landfilling and usage. The study shall be done before starting the mining activities.

Soil differences are characterized according to the Bulgarian system for classification and diagnostics of soils - power of the humus horizon, color, mechanical composition, density, structure, availability of soil horizons, etc. It is necessary to make a conclusion for the aptitude of the humus material for biological reclamation according to the obtained analytical data. The humus horizon must be collected selectively, according to the depth of its building and in compliance with the soil categories – I-st, II-nd и III-rd on type and subtype levels; it must be deposited and subsequently spread in the same way because different soils possess individual fertility.

In order to complete field mapping of soils it is necessary to have a topographical base of the undisturbed area in the relevant scale. The genetic classification of soils accepted in Bulgaria makes it possible to classify them for the purposes of reclamation using the most characterictic indicators, having direct relation to the degree of aptitude for collection and usage of the humus horizon, as follows:

- power of the humus horizon;
- mechanical composition (content of physical clay);
- humus content;
- pH in water;
- carbonate content;
- stone availability;
- salinity;
- heavy metal content.

After completion of the field and analytical determination of soil differences on the territory of the site, classification of the soils according to degrees of aptitude for collection and depositing of the humus horizon is made. The classification scheme is divided into three levels - suitable soils, slightly suitable soils and unsuitable soils.

Suitable soils

In this group are classified soils, which are characterized by depth of the humus horizon above 20 cm - soils of horizon power of mostly 40-60 cm and humus content above 1,0%. The content of physical clay may vary from 20 to 75 %, and the reaction of the medium (pH in water) – from 5,5 to 7,5. Examples of soils which fall into this group are typical, slightly leached and carbonate clayey-sandy Chernozems; leached

and heavily leached sandy-clayey Chernozems; non-eroded and lightly eroded heavy Chernozems; Calcic Luvisols; Glayic Vertisols, non-eroded and slightly eroded, etc.

Slightly Suitable Soils

This group combines soils with a humus horizon below 20 cm, humus content above 1%, variable mechanical composition – 60-75% physical clay and pH in water from from 4,0 to 7,5. The following soils can be mentioned as an example of this group: averagely and heavily sandy-clayey Luvisols; Vetric Luvisols – averagely and heavily sandy-clayey; heavily leached to slightly podzolized Cinnamon Luvisols – non-eroded and slightly eroded; sandy and sandy-clayey Fluvisols.

Unsuitable Soils

These are the soils, from which humus horizon must not be taken. In this group of soils there is strong manifestation of erosion processes, development of the soil profile on a closely located hard rock, salinisated and marshy soils, as well as very acidic soils.

Examples of these soils are, as follows: Brunisols, Haplic Solonets, Gleyic Solonets, salinated, heavily eroded carbonate and typical Chernozems, Glayic and Cinnamon Luvisols.

Humus horizon from soils, covered with forests, which have power of the humus horizon below 10 cm is not collected.

When the humus material cannot be used immediately, it is stored and is protected from water and wind erosion. If the depots are conserved for a longer period of time (over 3 years) their surface is not grassed. The humus layer conservation in depots cannot last for a period of time longer than 15 years, the height of the humus depots being up to 10m.

CLIMATIC CHARACTERISTICS OF THE TERRITORY OF THE SITE

During the biological stage of reclamation grass cover is created according to the envisaged land use of anthropogenic soils – agricultural, forestry, recreational, etc. Therefore it is necessary to make a description of the most important for the plants climatic characteristics in the site under research: average monthly and annual temperature of the air, average and last dates of the latest spring and first autumn frost, average duration of the frost-free time, average monthly and annual precipitation amount, etc. This research guarantees the right selection of the plant species suitable for reclamation.

DETAILED ENGINEERING-GEOLOGICAL AND HYDROGEOLOGICAL RESEARCH

1. Clarification of the geological section and research of the physico-mechanical and resilience-deformational properties of the sediments, building the soils;
2. Establishing the level of the water-bearing horizon, the type and character of the subterranean waters;
3. Assessment of engineering-geological conditions;
4. Identifying the necessity of building a lower isolating screen

RESEARCH OF BIODIVERSITY

The research of biodiversity facilitates the selection of adaptable for the local conditions species and fast restoration of the ecological balance in the mining areas.

The biological diversity or biodiversity is a term, determining the multiplicity of life on the Earth and the different models that it has formed. Bulgaria is one of the richest in biological species country in Europe.

CHARACTERISTICS OF THE STRATIGRAPHIC PROFILE OF THE FIELD FOR THE PURPOSES OF RECLAMATION, CLASSIFICATION OF THE GEOLOGICAL MATERIALS BY DEGREE OF APTITUTE FOR RECLAMATION OF DISTURBED SOILS

The assessment of the reclamation aptitude of various in composition and properties geological materials, found in the mining of minerals is among the current essential problems in the field of of disturbed land reclamation. In a most general aspect this assessment displays the prospects for selective extraction and alignment of geological materials with a view to accelerated environmental restoration. The selective approach to the building of reclaimed lands is an opportunity for improvement of their characteristics and properties and for a decrease of the reclamation costs. In the meantime the danger of filling materials of toxic and unfavourable properties in the surface part of the heaps is avoided. As this approach is still rarely applied into practice, the reclaimed lands are characterized by a highly heterogeneous composition, which hampers the development and implementation of measures for increasing their productivity (Marinkina, 1999).

The research of different geological materials has the task of identifying the most suitable by physical and chemical properties substrates, which may be used in reclamation.

The investigated geological materials are assessed in regard to their suitability for biological reclamation based on a group of indicators. According to Marinkina, Banov (2000) these indicators must correspond to the following most general requirements:

– being universal and widely applicable;
– being distinquishable and comparatively easy to identify;
– being highly informative and representing certain criteria.

A classification of geological materials according to their suitability for biological reclamation, including 5 groups has been elaborated (Table №1):

- First group – suitable by physical and chemical properties – they are used in agriculture and forestry after the application of agrotechnics and fertilization;
- Second group – slightly suitable by physical properties – as well as the materials from the first group they are used after the import of substrates of light mechanical composition;
- Third group – slightly suitable by chemical properties – as well as the materials from the first group they are used after amelioration (washing of salts, gypsum amendment, etc.);
- Fourth group – unsuitable by physical properties – coarse, hardly weathering rock pieces, inappropriate for biological reclamation;

• Fifth group – unsuitable by chemical properties – geological materials of toxic properties, inappropriate for biological reclamation.

On the basis of fundamental and experimental data Marinkina, Banov (2000) estimate that several indicators must be necessarily used for the assessment of the suitability of different geological materials, isolated from the stratigraphic profile of the exploited field.

1. Reaction of the medium (pH) – it can be determined as a universal criterion for envisaging the limiting or favourable properties and processes.

2. Sorbtion capacity and exchanged cations. These indicators are highly informative in several directions:

– determining the buffer capability of geological materials for acidification – by the value of the degree of base saturation;

– determining of the level of harmful acidity;

– assessment of the toxicity of the exchanged Al – by its value.

3. Determination of the mobile and soluble Mn concentrations, as well as determination of other sensitive to geochemical changes elements: Fe, S, Zn, Cd, Co, Ni, etc. according to the general chemical or mineral composition. For most of the mentioned elements the lack of established criteria for assessment of their toxic content suggests the determination of the total amounts and the use of TLV (Threshold Limit Value).

Table 1

Classification of the Geological Materials for Biological Reclamation (Treykyashky, Hristov, 1982)

Group of suitability for biological reclamation	**Indicators**					
	pH in H_2O	**Total salt amount %**	**$CaCO_3$ %**	**Total sulphur amount %**	**Physical clay %**	**Rockiness %**
First	6,0 – 8,0	Up to 0,3	Up to 20	Up to 0,3	20 – 75	0 - 10
Second	6,0 – 8,0	Up to 0,3	Up to 10	Up to 0,3	below 10 above 75	0 – 10 10 – 20
Third	6,0 – 8,0	0,3 – 0,8	до 40	0,3 – 0,5	10 - 75	0 – 10
Fourth	No determination	No determination	No determination	No determination	No determination	No determination
Fifth	2,0 – 9,0	Above 0,8	Up to 40	Above 0,5	Different mechanical composition	No determination

RECLAMATION OF DISTURBED TERRAINS

PRINCIPAL SCHEMES OF RECLAMATION

Reclamation of the disturbed lands in the Republic of Bulgaria, according to Regulation № 26 is conducted as follows:

– spread of a humus layer with a power of 30-35 cm (after sinking) on technical lands, built from appropriat according to their physic-chemical properties geological or waste materials;

– direct assimilation of terrains, reclaimed with geological or waste materials;

– addition of suitable improvers to the geological materials on the surface of the terrain such as ashes from the ashponds, lignite powder, zeolites, sand, artificial or natural fertilizers, etc. in order to create conditions for normal development of plant species.

The first method of use of humus material is more perspective because the restoration of soil fertility is faster and to a greater degree it leads to a better sustainability of yields. The physical, chemical and biological properties of reclaimed lands are substantially improved by the use of this method. The humus contents regulate the aeration of the substrates in a positive direction by giving them looseness and porocity. That facilitates to a great degree the land cultivation and provides normal nutrition and development of plants.

In individual cases it is possible to exchange the humus layer for a substrate of organic and non-organic components, which has environmentally friendly analytical characteristics and natural bioproductive capabilites. The method is applied mainly in cases of agricultural reclamation. In these cases it is necessary to make an assessment of the materials, based on more indicators: morphological characteristics; mechanical and micro-aggregate composition; content of organic substance (humus), carbonates and general and assimilable forms of nitrogen, phosphorus and potassium; reaction of the media – pH in water; sorbtion capacity and exchange cations; microelement content; water-retaining ability.

In the absence of sufficient contents of humus **the second and the third methods of reclamation** are applied.

In order to improve the properties and fertility of lands, restored by direct reclamation there has been profound research of reclaimed and about to be reclamed areas on the territory of the whole country and outside this territory (Banov, Hristov, 1996; Banov, Markov, 1999; Gencheva, 1995; Garbuchev et al., 1975; Hristov et al., 1996; Banov et al., 1997; Banov, 1999; Banov et al., 1997; Banov, 1999; Dimitrova et al., 1998; Marinkina, 1999; Marinkina and Banov, 2000; Esshaimi, et al., 2012; Kołodziej, et al., 2016; Krümmelbein et al., 2010; Nii-Annang et al., 2011). A large number of geological, waste and soil materials have been investigated in regard to their suitability for technical and biological reclamation (Tsolova et al., 2005, 2005a, 2005b, 2005c; Marinova, Tsolova, 2005). The obtained results have been tested in vegetational and a field environment. A number of methodological instructions and technological developments have been indited in regard to particular sites or problems of national importance (Banov, Pavlov, 2014; Pavlov, Banov, 2014; Pavlov et al., 2015; Pavlov et al., 2015; Banov et al., 2015; Pavlov et al., 2015).

Reclamation is performed in two successive stages – technological and biological. In the technical stage (technical reclamation) there is cleaning and preparation of the terrain, extraction and transportation of land masses according to their function; leveling and formation of the terrain in its final shape; addition of improvers; extraction, transportation and spreading of the humus layer; construction of temporary and permanent roads; construction of anti-erosion and hydromeliorative equipment; formation of water areas.

Biological reclamation of the technically reclaimed terrains is done by growing certain crops, application of strictly measured fertilizer quantities, usage of specific agrotechnics, etc. according to the function of the terrain.

The conducted research and practical reclamation activites in a number of countries, including Bulgaria show that the reclaimed lands are characterized by low natural fertility. An additional unfavourable condition is the availability of increased content of heavy metals and other synthetic non-organic and organic substances, sometimes exceeding the Threshold Limit Values (TLV), determined in Regulation № 3/2008.

FACTORS, LIMITING RECLAMATION

The established large varieties in regard to morphological, physical and physico-chemical characteristics of materials, composing the profile of the reclaimed terrains, requires the development of specific (depending on the specific conditions) technological solutions for restoration of the fertility of these sites. In this regard the present guide aims at describing and analyzing modern (avant-garde) methods of reclamation of disturbed lands and soils.

The conducted long-term laboratory, vegetation and field research prove that the reclamation activities are accompanied by a number of difficulties and problems of technical, practical and financial nature, scilicet:

1. The use of the humus layer in the technical building of reclaimed terrains leads to relatively fast restoration of the soil fertility, but it is related to analytical procedures for determining the quality of the layer.

2. The biological stage of reclamation is durable and it usually includes the growing of of different crops, which require the performance of strictly determined systems of fertilization, plant protection and agrotechnics.

3. The two stages of reclamation (technical and biological) require the consumption of large capital investments.

4. The technically built reclaimed areas are characterized by different unfavourable properties – heavy mechanical composition, low natural fertility, heavy metal content above the Threshold Limit Values, toxic levels of the reaction of the medium (pH), etc.

5. Observation shows substantial mismatch in timing for conducting biological reclamation, determined in Regulation № 26 for reclamation of disturbed terrains, improvement of lands of low productivity, extraction and use of the humus layer and the real deadlines of restoration of the soil fertility of the disturbed terrains. According to the requirements of regulation documents the maintainance of biologically reclaimed terrains lasts for 5 years while the actually taken time in some cases reaches 12-16 years, especially with non-humus reclaimed lands.

6. There are no methods for fertility assessment of the reclaimed soils, which makes the process of returning the lands to to their real owners harder.

7. The technically built heaps need additional technological and biological activities for restoration of their agro-soil potential during the first years of mining.

The solution of these problems becomes possible through development and application of new, efficient and rational technological measures for restoration of the fertility of anthropogenic soils. That is imposed by the fact that the available contents of humus materials are exhausted, but at the same time a large amount of waste materials of a different origin are accumulated. For these and other reasons different organic sludge has recently found an exclusively large application in reclamation of lands, disturbed by the mining of mineral resources (Seaker and Sopper, 1988; Marinkina, 2002; Banov et al, 2016; Marinova et al., 2005). The high content of basic nutritional macro- and micro-elements in the sludge and mostly of carbon, accessible to plants, provides high amelioration effect, especially when there is disturbed balance of the organic substance.

The usage of sediment tackles a number of drawbacks, related to the reclamation of disturbed soils is achieved, namely:

a) The organic reserve of soils is increased for a certain period of time;

b) The organic substance content facilitates to a great degree the cultivation of the reclaimed terrains and provides an opportunity for normal development of the root system of plants;

c) The physical and physico-mechanical characteristics of reclaimed lands are improved;

d) The necessary capital investments for conduction of the reclamation activites are substantially decreased;

e) The process for returning the lands to their real owners is facilitated.

The conducted research shows that the restoration of the fertility of disturbed lands and soils and their return into the arable land fund is possible by using the sludge from wastewater treatment plants (WWTP), as follows:

– Mixture of the surface infertile layer of reclaimed terrains in an acceptable ratio to the sludge, with a view to the improvement of the structure and increase of the soil fertility;

– Creation of a self-contained surface layer of sludge.

The sludge could be used for technical reclamation of the disturbed terrains, which are situated close to wastewater treatment plants. They can be composted with other waste materials and used for the reclamation of disturbed and contaminated terrains. During the biological stage of reclamation it is recommended to meet both the requirements of the legislation and that of the grass and forest vegetation. According to the future guidelines for use of the reclaimed terrains norms of sludge of the order of 60-80-100 t/dka are recommended.The norm may vary and is individual for every particular case after the development of a project and a detailed assessment of the disturbed terrain.

The requirements related to the use of sludge in the reclamation of disturbed, contaminated or slightly productive terrains are connected with:

– determination of the reasons for disturbance of the terrain;

– lack of sufficient humus soil layer;

– physico-chemical characteristics of soils in the area, including the waste materials;

– future function of the reclaimed terrain;
– sludge characteristics;
– availability of land masses in the area and assessment of their properties and characteristics;
– distance to the wastewater treatment plant, etc.

INNOVATION METHODOLOGICAL APPROACHES TO THE DEVELOPMENT OF TECHNOLOGICAL OPTIONS FOR RESTORATION OF THE FERTILITY OF THE DISTURBED TERRAINS

In recent years increasing attention is paid to the search of new, efficient and rational technological solutions for restoration of the fertility of anthropogenic lands and soils (Banov et al., 2010; Chibrik et al., 2016; Dzhura et al., 2008; Gavrilescu et al., 2009; Kaufmann et al., 2009; Koptsik, 2014; Kovshov et al., 2015; Smaliychuk et al., 2016; Tarika and Zabaluev, 2004). As it has been pointed out this attention is necessitated by the lack of sufficient contents of humus materials and also by the tendency of subsequent use of the materials, accumulated in the depots, which at a certain stage of development of technologies are transformed into raw materials for obtaining precious metals and energy.

In compliance with the above stated a technology has been developed for the reclamation of terrains, which are used as depots for storage of waste products from Heat Power Plants and in particular ashponds, storing fly ash. (Banov et al., 2010; Vacca et al., 2004). It suggests different approaches to reclamation according to the suitability of geological and soil materials for formation of surface layers and the necessity of addition of improvers for maintenance and increase of the soil fertility.

The technology envisages technical and biological reclamation of the terrain by preparation of a reclamation substrate, which is poured onto the terrain, used as a waste depot, import of mineral fertilizers, cultivation of the terrain and its grassing with suitable plant species. Mixtures of geological and waste materials are used as reclamation substrate in various proportions, depending on the physico-chemical characteristics of the individual components. The characteristics of the product concerned allow the fly ash to be assigned to the limited number of materials, suitable for use in agriculture. On the other hand, an opportunity for its future use and utilization is provided. The advantages of the technology are in the fact that the complex of activities is carried out directly on the terrain. The technology is protected by application blank № 110092/26.03.2008 for Issuance of Patent of Invention entitled "Method for Reclamation of Terrains, Used as Depots for Storage of Waste Products".

Another technology for reclamation of disturbed and contaminated lands and soils aims at the use of a biological substrate with the following components, mixed in various volume proportions – geological materials, characterized by light to heavy sandy-clayey mechanical composition, inavailability of organic substance (humus), low content of nutritional elements for the plants, lack of toxic components and a compost with a commercial name Kompost B-4. For the creation of the biological substrate geological materials are mixed with Kompovet B-4 in proportions 2:1; 3:1; 4:1 и 5:1. The obtained biological substrate can be used as a substitute of the humus materials in the technical and biological reclamation of terrains, which have been used as mining heaps, mining sites, tailing ponds, etc. The advantages of the biologi-

cal substrate are related to the fact that it can be used indepependently from the physico-chemical characteristics of the materials, building the terrains; its quality characteristics are constant; the frequent lack of humus materials and organic fertilizers for technical and biological reclamation make it non-alternative in many cases. The technology is protected by Utility Model Registration Certificate № 947/30.11.2007 г. – "Biological Substrate".

The efficiency of the reclamation activities is substantially increased after a pleminary selection and assessment of the plants, suitable for phyto-reclamation (Marinkina, 1999). An especially suitable for biological reclamation and creation of meadow-pasture lands method is the one of introduction of grasses, which grow in similar areals under natural conditions and meet the following requirements: being drought-resistent, having a forage value, forming a deep root system, being suitable for storage in a good condition at low temperatures, growing fast without building powerful turf, providing protection for slowly growing species (Marinkina, Banov, 2001).

The negative impact of the anthropogenic activity on environment determines the necessity of continuation of the research for finding new, rational and mostl economically efficient methods for reclamation of the disturbed lands, which can easily be introduced into practice.

CONCLUSION

The reclamation of the disturbed terrains is a complicated problem, determined by a number of factors: geographic-climatic and mining-technical conditions, mechanical and agro-chemical properties of the soil and the geological materials, which are extracted, the system of development of the deposit, etc. That requires the technological solutions for restoration of the fertility of the disturbed terrains to be compliant with the specifics of the terrain and it also imposes the necessity of using the co-ordinated efforts of specialists from different scientific and applied science organizations and institutes.

The basic task in the reclamation of lands, disturbed by mining or other activities includes the restoration of the soil fertility by creating an ecologically balanced eco-system and return of the disturbed lands to active usage. The reclamation is one of the most radical methods for restoration and improvement of the disturbed terrains and their return into the absolutely useful (arable) land fund. It is accompanied by preliminary research, which covers all the environmental components with a basic accent on geological substrates, which will be used as soil formation materials. This research allows the development of specific technologies for technical and biological reclamation of high industrial, financial and environmental effect. The methodology for conducting the preliminary research, presented in this article, has proved the generation of ideas for creating efficient technological solutions for reclamation of disturbed lands and is recommended by the authors for the performance of reclamation activities in the country.

The conducted long-term laboratory, vegetation and field research has proved that the reclamation activities are accompanied by a number of difficulties and problems of technical, practical and financial character such as: large capital investments,

slower restoration of the non-humus reclaimed eco-systems in comparison with the envisaged in the regulation documents timing, necessity of a specific approach to the reclamation of problematic terrains, lack of methods for assessment of the fertility of anthropogenic soils, etc. The solution of these problems is only possible by developing and applying new, efficient and rational technological solutions for restoration of the fertility of anthropogenic soils. This is due to the fact that the available amounts of humus are exhausted and simultaneously large amounts of waste materials of a different origin are accumulated.

The negative impact of the anthropogenic activity on environment identifies the necessity of continuation of research for finding new, rational and mostly economically efficient methods, which can easily be introduced into practice for restoration of disturbed lands.

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