

Concept of mining landscape rehabilitation

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Abstract. The article explores the concept of mining landscape rehabilitation during the period after the development of mineral deposits. It is a system of actions that allows reinserting mining landscape facilities in the national economy and to generate normal living conditions for the affected population. The paper analyzes the ecological state of the territory heavily impacted by a mining network facility and proves the necessity of rehabilitation. Positive implementation experience and high ecological and economical efficiency were demonstrated through the example of a facility in the Sverdlovsk region. Ecological and economic efficiency lies in the fact that after working out, for example, a career and its reclamation, there comes a so-called post-reclamation period. In the post-reclamation period, the recultivated object should not have a negative impact on the components of the environment, and also have environmental efficiency (that is, have a positive impact on the components of the environment), as well as bring economic profit to the object owner.

1. Conduct

During the development of mineral deposits (hereinafter referred to as 'MD'), in other words extraction and processing of natural resources (hereinafter referred to as 'NR') there emerges a distinctive man-made landscape, a mining landscape (referred to below as 'ML'). Such landscape is characterized by man-made landforms that appear during NR extraction: hollows (quarries, open cuts, pits, etc.), mounds (spoil heaps, gob piles, etc.) and zones of changed terrain, that is to say ground falls and landslides in hollows and mounds, cave-ins and collapsing above underground mining facilities, soil pollution by harmful substances (atmospheric emission and dumpings to surface and subterranean waters) and land degradation which takes form of land drainage by depression curve around the mining openings as well as floodings by forming underspoil waters. What is more, at the stage of NR primary processing various hydraulic engineering structures are constructed: hydraulic waste disposals, sludge and tailing dumps, sludge heaps, sedimentation ponds, etc. This process is accompanied by the construction of man-made facilities of the ML, that is to say of production buildings and facilities, in particular transport and engineering infrastructure [1].

At the MD exploitation phase a certain part of these facilities can be disposed of or reclaimed; after the end of the development according to the laws in force the majority of production buildings and facilities are disposed of or reclaimed [2] except for those that can be of use to the national economy; for example under the current legislation they can be qualified as secondary mineral resources or man-made mineral deposits (hereinafter referred to as 'MMMD') [3].

During the exploitation of MD it is a mineral developer himself who monitors possible negative impact of a mining network (referred to below as 'MN') on the environment [4]. After the end of the



exploitation period under the current legislation the remaining surface and underground ML facilities become the property of the State or local authorities, if the mineral developer refused the ownership [5].

2. Relevance and scientific significance of the issue

Indeed after the end of MD exploitation period there are quite a lot of unsold (unused) ML facilities left, such as quarries, spoil heaps, mining liquid waste depositaries, half-ruined or ruined production buildings and facilities, infrastructure, etc. It can be explained by a number of reasons; firstly, up till the second half of the XXth century there was no environmental legislation in place; secondly, considerable expense is needed to reclaim the facilities; or, thirdly, the reclaiming process is very difficult. There are other reasons as well. As a result there are many changed lands in mining areas [6].

For instance in the more than 300 years of mining in the Urals mining region (referred below as the UMR) many mining enterprises have been launched, run and closed. The total of more than 1670 mining companies have gone out of business in the UMR. The existing MNs in the UMR and the accumulated past environmental damage on the grounds of closed mining companies have as a result 8.5 bln tons of man-made mineral waste, derelict lands and heaps take more than 2 000 km² [7], that is 0.1% of the UMR; in 2013 only in KMAD-Yugra the total area of oil-polluted land was 5130 hectares in 18300 areas [8].

The analysis of man-made environmental impact generated by mining companies shows that it has multifaceted and multimedia effect. Figure 1 demonstrates zoning patterns of Nizniy Tagil industry hub in Sverdlovskaya oblast based on Zc cumulative total, which show many mining and iron and steel plants that have negative impact on the environment. It results in higher concentration of heavy metals (V, Mn, Co, Ti, Cu, Zn, Fe, etc.) in all the components of the environment against the recommended level. In making the zoning map the 5-year data from geochemical survey of snow blanket, soils, edible flora around the slagheaps of Nizniy Tagil Iron and Steel Plant was used [9-14].

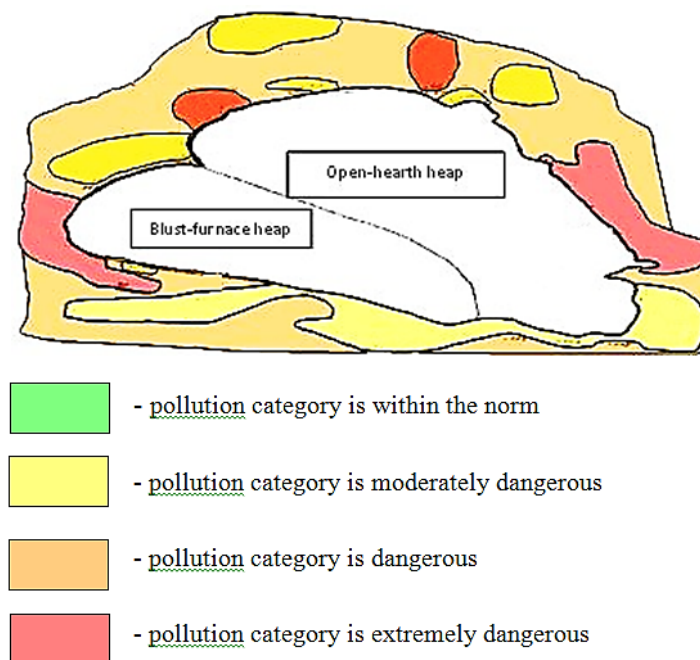


Figure 1. Territory zoning by pollution cumulative total.

The analysis of Figure 1 indicates that almost all the territory falls within the "dangerous" pollution category. Such pollution cumulative total results in higher sickness rates, higher numbers of sickly children, children with chronic diseases and physiologic failure of cardiovascular system.

So, the problem of rehabilitation of changed, degraded and polluted lands as a result of mining activities takes on a regional dimension.

3. Theoretical part

Historic and genealogy method, literary sources analysis and the authors' own observations demonstrate that MLs have different functional and development periods and therefore their final state is different too: it can practically blend into natural landscape or it can be highly negative, close to an environmental disaster. On the other hand, while examining the content of ML facilities remaining after developing MD a differentiated approach must be adopted. First, geological and economic evaluation of mining waste might show the existence of useful components, which will allow to qualify them as secondary MMMD. Second, environment studies of flooded (inundated) quarries might show their zero negative impact on the environment [15] and that therefore they can be used for recreational purposes. Third, established level of self-restoration of ML facilities determines their successful environment reinsertion. If that is not possible, measures must be taken to ensure reclaiming, elimination or conservation of ML facilities.

4. Problem statement

Taking into account the aforesaid, the authors suggest implementing rehabilitation measures generally in post-development period as a system (combination) of measures (Figure 2) that should make facilities of functioning landscapes as adapted as possible to new conditions on the ground; that is to their new social and economic functions or to their initially intended purpose, namely their primary social and economic function of extraction and processing of NR.

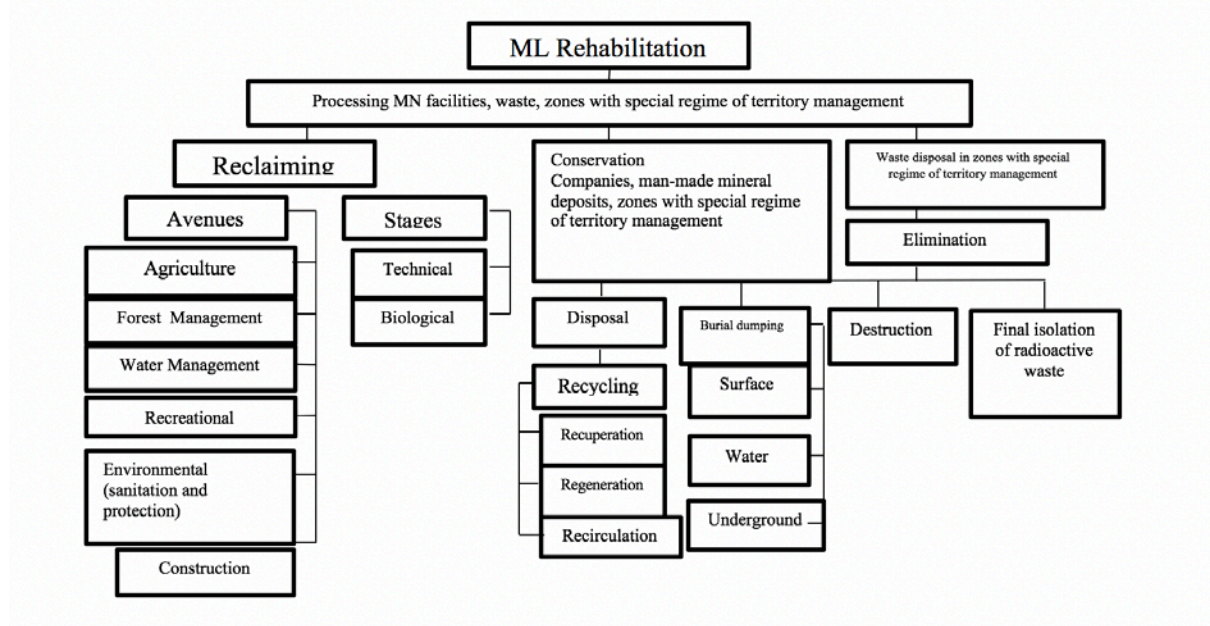


Figure 2. Set of measures aimed at rehabilitation of ML.

5. Implementation result

In this case rehabilitation of mining landscape is a set of measures aimed at its almost complete environmental recovery or at its best possible use in the national economy and at providing for normal life conditions for the affected population. For instance, Figure 3 shows acquired positive experience of implementing the proposed concept of mining landscape rehabilitation in Sverdlovskaya region

along with economic benefits: the quarry became a water facility with a recreational area and a hotel resort.



Figure 3. The flooded quarry with recreational improvements on its shores (the facility location: Ekaterinburg; The facility position: Chkalovsky district, m-district: Poultry farm) a) satellite image of the flooded quarry, b) air survey of the hotel resort "Ramada".

6. Conclusion

Thus the rehabilitation must be seen as a complex social and environmental problem that has a number of aspects, namely law, implementation, information, environment, management and, finally, social and economic factor. Law aspect takes into account the necessity of improving legal framework in the management of mineral resources and other resources, production waste, environmental protection, sustainable development of the affected territories, etc. In implementation it is necessary to identify the sequence of measures (steps) aimed at implementing the agreed upon norms and assigning responsibility for reclaiming MLs. Information factor deals with finding ML facilities, drawing up their inventory and evaluating the past accumulated at the locations of mining plants, environmental damage based on the ecological danger criteria for every identified ML facility [16,17]. Using (or taking into account) the results of the data analysis the authorized body (a state body or a local authority) makes a decision and chooses one or a number of measures: disposing, reclaiming, eliminating or conserving ML facilities individually, as a group or the ML network as a whole, or monitoring a mining territory while collecting predictive information on its future state. While choosing specific measures, social and economic consequences of ML facilities transformation must be taken into account. For instance, qualifying a ML facility as a real estate asset while entering it in the public register and establishing the right of ownership it can become an object of civil transactions [18]. In this case a ML facility can attract investments if there has been made a public register evaluation [19] as well as become an object of public-private and municipal-private business transactions [20]. A ML facility that has had a self-recovery period can be used for recreational or sanitary and protective purposes.

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