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The Assessment of the Loss of Economic Benefits from Ecosystem Services and Biodiversity at the Stage of Design and Function of Coal Companies

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Abstract. At present time ecosystem services are of big importance in improving the quality of human life as well as the sustainable development of the economy of the country or a particular region. However, ecosystem services, which have been «inexhaustible» earlier, now are losing their potential, what leads to the decreasing of their functioning. World practice shows the actuality of studying this issue, because the important problem in the most highly urbanized industrial regions, which include the Kemerovo Region, is the accounting of economic value of ecosystem services in the development of industrial areas. During the research we have used logical and statistical analysis methods to account the value of ecosystem services in the coal mining region. The article presents the results of the losses of value of ecosystem services at the design stage of coal companies. The research of the possibility of ecosystem services restoration in areas with high anthropogenic loading (in the context of the Kemerovo Region) has shown the impossibility of a full recovery. However, the recultivation can restore soil fertility processes and their further economic use. Today the active environmental management has the strong impact on the environment and this leads to the using of the resource-saving type of output.

1. Introduction

Today, the preservation of the environment, biodiversity and natural resources for satisfaction of requirements of present and future generations is the strategic goal of public policy in the majority of countries. The preservation of the natural environment, which includes natural ecological systems and objects of flora and fauna, is considered as the priority of the policies of different countries; also the great attention is paid to the development of economic, organizational and methodological mechanisms for assessing and preventing damage to biological diversity and ecosystems. In Russia coal takes a major place among natural resources [1, 2, 3, 4, 5, 6, 7]. Thus, coal extraction grows and the number of the lands, which are allocated under mines and quarries, also increases, on the one hand, it provides additional budgetary and commercial benefits, and on the other — is followed by losses of ecosystem services as a result of land area reduction. However, the rational use and the restoration of the lands, which have been allocated under coal mining, will give the chance to preserve the



ecosystem services value. The damaged coal lands could be more cost-effective through their alternative use.

2. Materials and methods

In modern conditions if handled properly it is possible to set up benefits in coal-mining projects. The component parts of the main economic benefits are: project benefit without the value of ecosystem services; benefits from the ecosystem services, which have remained after realization the project; the benefits from the restoration and compensation of biodiversity losses, which have been put in the project [8, 9, 10]. The exact economic assessment of benefits from preservation of a biodiversity in coal-mining projects is possible only with use of a project, investment and permission documentation of the enterprises, standard and methodical and special literature and also with the opinion of leading experts in this area. The economic assessment of benefits can be made only for the entire period of the coal project, because they are the long-term projects (up to 50 years or more).

The impact of the coal-mining project on ecosystems and the environment has a complex character. Especially negative effect is seen on soil resources, the atmosphere and water objects. There is a minimum level of restoration of ecosystems, which is provided in projects of recultivation. These minimum methods of recultivation are carried out according to the schedule; however, they can be carried out not every year. Ecological costs in energy projects are considered, because they influence on the cost price, and the assessment of benefits is the new phenomenon for these projects.

In our opinion, it is important to consider a time factor and to estimate the possible level of restoration of the damaged ecosystems at assessment of benefits from preservation of a biodiversity in coal projects. Therefore in this work we have presented the assessment of possible level of restoration of ecosystem services in the territory of the Kemerovo Region in areas with the high level of a technogenesis.

The long-term history of the mining industry development in the Kemerovo Region has defined formation of the example for studying and restoration of technogenic landscapes and a soil cover. According to scientists with the long experience of researches in technogenesis consequences the complete recovery of an ecosystem is impossible due to completely different conditions of its formation at the present time [10, 11, 12, 13]. First of all it is impossible to create geological conditions of a source rock formation for soils and climatic conditions in which the ecosystem has been evolved. The implementation of primary vegetation is possible due to careful studying of it and creation of reproduction conditions. The scientific publications on the comparison of damaged lands fauna with normal conditions of ecosystem functioning show that the majority of animal types are capable to evolve on the restored lands, with the exception of irretrievably lost lands [14,15, 16]. It is a common practice to call a complex of actions for restoration of the broken territories as recultivation.

Also nowadays there are types of rocks with a proper soil fertility degree that is enough for plants growth and their development. That is why there is a possibility of the productive, ecological phytocenosis creation without restoration of a fertile layer of ground at the location of these rocks. At the present time one of the coal mining companies of Kemerovo Region «Juzhnyi Kuzbass» has already created suitable recultivants on coal opencasts. The plantings of pines, larches, which have been created on mine tips with overburden rocks, have shown significant power growth, II and III classes of sites quality of forest. Therefore, we have drawn a conclusion that sustainable growth of plants demands a sufficient stock of soil food elements in rocks that is used at recultivation itself.

In 2006, the researchers M.T. Logua and T.V. Ivanova have analyzed different types of rocks soil in mine tips in Kemerovo Region; also they have identified a range of grasses and grass mixtures [17]. This analysis has become the basis of highly productive fodder grounds creation that is done on pit heaps without drawing on them a fertile layer of soil. The vegetation of grass mixtures increases with annual cultivation, and the yield will be 150-380 C/ha in 2-6 years [18, 19]. However, the number of ratoons will increase annually, if the fertile layer is applied to the overburden. The efficiency of the ecological functional recovery is defined by the degree of approximation of the damaged lands bioproductivity to the types which were before it or a similar type of biogeocenoses. The criterion of

ecological functional recovery extent is total biological efficiency which is expressed as a percentage: low - up to 25%; satisfactory - 25-50%; sufficient - 50-75% [20, 21]. The high productivity (> 75%) is created only with a complete recovery of a soil cover, the uttermost happens quite rarely. The analysis of biological productivity of the damaged lands showed that the index of forest recultivation efficiency is about 40-60%, and in the most environment-friendly conditions forest cultures, aged about 25 years, had a biomass around 85%, that is similar to the landings in undisturbed soils areas. Higher productivity was calculated in forest cultures, when the composition of the soil-improving ameliorative shrubs was a part of it (buckthorn, silverberry).

Throughout this research possible losses of ecosystem services value at the stage of design of the coal companies have been estimated. The coal field in the center of the Kemerovo Region has become the analyzing project. The mine age of the coal field is 44 years and its annual output is 2 million tons.

Table 1. Statistical calculations of possible loss of ecosystem services value at a design stage of the coal enterprises

Land allotment	Surface ,ha	Ecosystem services	Losses of economic value of ecosystem services , \$/ year
Total sort of lands	1389		1 014 007
		Carbon oxide absorption, CO/ha	9 862
Forest lands	293	The wood for construction, cub/ha	566
		Mushrooms, berries, t/ha	52 049
Field	282	Collecting grain crops, t/ha	6 231
Forage lands	290	Food (hay, meat), t/ha	6 406
		Providing with clear water, climate regulation, water streams regulation , soil fertility support	28 893
Backwater	66		

3. Conclusion

We have drawn a conclusion that the greatest value of ecosystem services such as regulating and food functions has been lost in the process of forest and backwater lands violation. Thus, after the implementation of the coal project and its recultivation, we can calculate the benefits obtained from ecosystem restoration. Also a big amount of researches of damaged lands restoration methods and the assessment of soil and environmental conditions allow ranking disturbed areas by cost structure and types of necessary restoration measures. Generally the efficiency of recovery processes reaches 60-85% in comparison with damaged lands. So after exhaustion of coal reserves on the territories of production, their recultivation has to be focused on their further use for cultivation and sustainable use of ecosystem services resources.

4. References

- [1] Bulte E, Hector A and Larigauderie A 2005 *EcoSERVICES: Assessing the impacts of biodiversity changes on ecosystem functioning and services* DIVERSITAS Report 3 40 p
- [2] Global Environment Outlook 4 2007 *Environment for development* (United Nations Environment Program – UNEP) 540 p
- [3] Krapivny I V, Omelyanenko, V A and Vernyudub N O 2015 *International innovation networks as new stage of innovation development. Economic Processes Management,1*. Retrieved from: http://epm.fem.sumdu.edu.ua/download/2015_1/2015_1_17.pdf

- [4] Porfiryev B 2013 *Green Economy: Realities, Perspectives and Growth Limits* Access mode: // <http://carnegie.ru/2013/04/04/ru-pub-51414>
- [5] Farinelli F, Bottini M, Akkoyunlu S and Aerni P 2011 *Green entrepreneurship: the missing link towards a greener economy*. Journal Atfd 8 (3/4) pp 42-48
- [6] Kholina V 2005 *Basics of environmental economics*. (St. Petersburg: «Piter») p 78
- [7] *Towards the circular economy. Economic and business rationale for an accelerated transition* 2013 Report 1 Ellen MacArthur Foundation. Rethink the future
- [8] Bobylev S N *Ekonomicheskaya ocenka bioraznoobraziya. Eko-byulleten' INEHKA. Elektronnyj resurs* Rezhim dostupa <http://ineca.ru/?dr=bulletin/arhiv/0075&pg=004>
- [9] Balvanera P, Pfisterer A, Buchman N, Jing-Shen He, Nakashizuka T, Raffaelli D and Schmid B 2006 *Quantifying the evidence for biodiversity effects on ecosystem functioning and services* // Ecology Letters. vol 9 pp 1146-1156
- [10] Luck G, Daily G and Ehrlich P 2003 *Population diversity and ecosystem services* // Trends in Ecology and Evolution vol 18 pp 331-336
- [11] Barannik L P 1988 *The biological principles of forest regulation* (Novosibirsk: Nauka. Sib) p 85
- [12] Tarchevskij V V 1970 *The natural vegetation of dumps in open coal mining in Kuzbass* (Sverdlovsk: UrGU) pp 65-77
- [13] Kandrashin E R 1979 *The soil formation in technogenic landscapes* (Novosibirsk: Nauka, Sib) pp 163-179
- [14] Manakov Y U and Dumps A 2006 *or it's time to make strategic decisions* (newspaper Kuzbass) 44 march 15
- [15] Kupriyanov A N, Manakov Y U and Sorokin A V 2006 *Reclamation of disturbed lands in Siberia* (Kemerovo: KREHOO «Irbis») vol 2 p 6
- [16] Bobylev S N, Vishnyakov V S, Komarova I I and etc. 2017 *Green Economy*. (Reloading. M.: SOPS) p 65
- [17] Logua M T and Ivanova T V 2006 *The role of agricultural reclamation in the restoration of disturbed lands* (Kemerovo: KREHOO «Irbis») 2 pp 29-30
- [18] Farming Data 2016 *Cultivating Insights for Agriculture in Asia* Retrieved from <https://iixfoundation.org/2016/12/20/farming-data-cultivating-insights-agriculture-asia/>
- [19] Hirschfeld A 2017 *New agriculture industrialization. Lb.ua*. Retrieved from https://ukr.lb.ua/economics/2017/02/20/359120_industrializatsiya_apk.html
- [20] *Globalisation and the environment* Access mode: <http://ifsw.org/policies/globalisation-and-the-environment/>
- [21] Androhanov V A, Kulyapina V D and Kurachev V MT 2004 *he soils of technogenic landscapes: genesis and evolution* (Novosibirsk: SO RAN) pp 50-51