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STRATEGIC DIRECTIONS OF DEVELOPMENT OF HARD WASTES HANDLING SPHERE IN THE REGION

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Optimization of development model in hard waste management sphere in the region aimed at balancing economic and environmental criteria has been developed. Have also been determined development directions for handling hard waste in the context of realization of socio-economic and environmental strategies in Poltava region and recommendations regarding improvement in technical, financial and economic support.

Keywords: *hard wastes, sphere of waste management, region, balanced development.*

Statement of the problem. One of the conditions for sustainable territorial development is a socio-ecological-economic balance in the region, which presents such a state of regional systems that provides economic growth, social stability and ecological safety in the region. Violation of this balance leads to the emergence of losses having different characteristic features: ecological, economic and social. An essential element of socio-ecological-economic balance in the region is effective functioning of hard waste (HW) management sphere.

The problem of achieving sustainable development in the region expands the sphere of human impact on the environment and intensifies the use of natural resource base, which inevitably brings the problem of rational use of secondary resources to the fore. The region becomes a self-active economic agent, an active subject of competitive relations in national and global economy. In a deeper sense, as V. I. Vernadski noted in his studies, the solution of this problem requires creation of a new international order aimed at ensuring coordinated actions of the entire world community to avert environmental disaster, that is the transition to the noosphere development as intelligently managed co-development of a human being, society and nature, in which the satisfaction of vital needs of the population is made without prejudice for nature and future generations [1].

Today HW management sphere in the region does not have systemic features, most likely it is a set of related but non-effective elements. Exactly under these conditions the task of transformation of “a set of elements” into a system becomes important through the development of HW management system, covering all aspects of solid waste management: social, economic, technological, environmental and legal and their optimization. In this regard the region can and should become the backbone “vehicle” of the state policy in this area and provide a purposeful wide range decision of the problems related to waste handling.

The analysis of recent studies and publications discussing the problem. It is to be noted that effective waste management problem has been solved to some extent in developed countries, in the first place in Europe. Though for example, "garbage crisis" of 2007-2008 in Naples showed that Western experts having great experience and scientific knowledge in the field of hard waste management cannot assert that the problem is completely solved [2]. As for Ukraine, primarily the sphere of waste management is in a state that has been inherited from the planned economy of the former Soviet Union. In recent years a large number of works devoted to this problem has appeared in Ukraine, including the works by A. I. Bondar [3], V. Ye. Baranovsky, V. L. Pilyushenko [4], O. V. Moroz, A. O. Sventyh [5], V. S. Mishchenko, G. P. Vygovsky [6] and others. However, despite the significant scientific principles established by these and other scholars, their attention is focused mainly on the technical and technological aspects of the problem. At the same time there is lack of scientifically based methods and mechanisms of effective management in this field. Poorly substantiated here is also economic leverage. Besides the issues focused on getting the desired effect from the use of the potential waste management sphere, as a part of the total potential of the region's economy and as a result of cumulative actions of the participants of the wastes management sphere, have not yet received proper consideration up till now. That is, there is a need for comprehensive theoretical elaboration and practical improvement of HW managing based on the parameters and the criteria of the region sustainable development in terms of spreading globalization.

Task statement. It is necessary to work out the optimization model of waste solid management aimed at balancing of the two mutually contradictory criteria: economic damage for environmental pollution and total expenses for the functioning of HW handling sphere. The model will create the basis for determination of strategic development directions in the given sphere within realization of socio-economic and ecological strategy of regional development.

Methodology of researches. Scientific works of home and foreign scientists and normatively-legal acts became the methodological base of research in the sphere of HW. Methodically scientific economic methods became a research base, including such as a monographic, comparative analysis, cartographic and other methods.

Results of investigation. The idea of rational waste management is that all these aspects have to be considered in a complex. Taking into account the aforesaid the principles, criteria and indicators of effective management of the HW sphere have to consider two aspects of the question, the first are features directly the organization of the address with waste as process technological, and the second are features of a control system of HW sphere as algorithm of adoption of administrative decisions.

At a choice of the optimal technological system of HW handling it is possible to go out next principles: the system has to be most economically expedient; the system has to carry out the minimum adverse effect on surrounding environments and population health; the system has to have high technological rates and to be reliable. Coming from it task of HW management is aimed at balancing the two opposite criteria: economic damage from environmental pollution ($C_{екол}$) and the total

operation cost of the sphere ($C_{екон}$) when receiving the maximum economic profit on this sphere ($C_{техн}$).

The economic damage from environmental pollution include:

$$C_{екол} = \sum_{n=1}^{N} Y_n \cdot R_n = \left(\sum_{n=1}^{N} 1 - exp\left\{\ln(0.84)\left[\frac{C}{ГДК \cdot K_e}\right]^b\right\}\right) \cdot (\gamma \sum_{i=1}^{n}\left[\sum_{j=1}^{J} \delta_j \cdot \sum_{i=1}^{I}(\sum_{k=1}^{K} V_k M_k e^{-ht}) \cdot C_i a_i\right] + \varphi \sum_{i=1}^{I} a_i b_i \, (l - E - \mu W) \cdot C_i + (BP + PP) \rightarrow min, \quad (1)$$

where Y_n- the economic loss for contamination of environment from HW sphere, hryvnias; R_n – the risk of health population from the HW sphere; n - amount of objects of environment (atmosphere, water environment, soils); C -middle concentration of substance that comes in the organism of man during his life; K_e – coefficient of danger, that is determined depending on the class of danger of substance; b – coefficient of izoefficiency; γ, φ – constants the numeral value of that is set taking into account inflation; δ_j –coefficient of relative contamination of atmospheric air; V_k – theoretical potential of formation of methane from the organic constituent of HW, м^3/year; M_k – mass of organic constituent generally speaking to the volume of wastes, ton/ton; h — constant of formation of methane from organic wastes; t — time from the moment of opening of ground, years; C_i – mass part of harmful substance in the general volume of biogas (filtrate); a_i – index of relative aggressiveness of harmful substance; b_i – index of relative ecological danger of upcast of harmful substances in reservoirs; l - general volume of water, м^3/year; E – volume of water evaporation, м^3/year; μ – absorptive ability of wastes; W – annual mass of wastes that retire, м^3/year; BP - the received less profit of region from the exception of earth under the objects of HW handling from economic turnover, hryvnias; PP - losses from contamination of earth as a result of functioning of this technology of HW handling, hryvnias.

The total operation cost of HW sphere (V) include:

$$C_{екон} = \sum_{t=1}^{T}\left[\frac{1}{(1+i)^t} \cdot (A_t \cdot X_t + B_t \cdot Y_t + C_t \cdot Z_t + E_t + F_t) \longrightarrow \min, \right. \quad (2)$$

where i – the discount rate; t – functioning periods of HW handling sphere per year; A – processing costs, excluding profit from the sale of resource fractions (hryvnias/ton); B – the cost of collecting and transportation of MSW (hryvnias/ton); C –the disposal cost of HW burial (hryvnias/ton); X –HW mass that goes to recycling (ton); Y – HW mass that is transported to the landfill (ton); Z – total HW amount that is removed, and the residue from recycling (ton); E, F – the cost of putting the processing plant (station), waste ground into operation (hryvnias).

Criterion of maximal economic earnings from this sphere ($C_{сум}$) taking into account:

$$C_{сум} = \sum_{t=0}^{T}[\,(\theta_t + U_t - З_{st})\left(1 - \gamma_{нт}\right)\left(1 - \delta_{учт}\right) - З_{мт} - Н_{Зt} - Н_{\varepsilon} - С_{екол} - E_{инт}К \pm \Delta З_{дрt}](1 + E)^{-t} \rightarrow max, \quad (3)$$

where $П$ – a profit, that remains at disposal of object that works in the field of HW handling, hryvnias; U – a profit from processing of valuable factions, hryvnias; θ – paying for the acceptance of wastes, hryvnias; $З_s$ – annual charges of production, that is attributed to the prime price, hryvnias; $\gamma_и$– a function that takes into account the system of government, regional and local dues; $\delta_{уч}$ – a function that takes into

account the terms of participation of founders and investors in distribution of profit; $З_м$ – material and other charges, that does not join in a prime price, hryvnias; $Н_З$ – cost of earth, that hatch from agricultural turnover, hryvnias; $Н_\varepsilon$ – total additional payments that include paying for a credit, paying for понадлімітне contamination of environment and others like that, hryvnias; $Е_{ин}$ – a coefficient of efficiency of capital investments in a variant that is examined; К – capital investments; $З_{дрt}$ – charges on corresponding productions and systems; E – norm of discount.

In the Poltava region the growth trend of HW formation since 2000 has been observed, its composition, physical and chemical characteristics being diversified. The annual HW formation per capita has also increased (from 0.25 ton per a person a year in 1998 to 0.42 ton per a person a year in 2012). This is a common trend in Ukraine. Thus, the volume of the formed HW in 2000 was 0.99 million m³, in 2005 it was 1.1 million m³, in 2012 it became 1.6 million m³ (1.6 times more than in 2000). A considerable part of HW (34.11%) is formed in Poltava and Kremenchug. Coverage of the Poltava region population by collecting and removing waste services is 60% on the average, for urban population it being 90% and for rural –25% [7].

Comparing with 1998 the content of polymer waste, glass, paper and cardboard waste in HW has considerably increased. The reason for this is, in the first place, the increase of packing material and its diversity. At the same time the volume of utilization of HW valuable fractions does not exceed 3% on the average. So, in 2012 the amount of collected waste paper was 9697.97 m³, of polymers – 8829.03 m³, of glass – 2734.15 m³. In fact, the collection of resource valuable fractions in the area of HW collection is currently done in Myrgorod, the system is implemented in Kremenchug, Horol, Lubny. Therefore, most of the resource valuable materials that make HW are transported to the landfills and dumps and are sorted partially into separate groups. The amount of resource valuable components is not controlled. Sorting out waste is not centralized and is done by hand with the assistance of other physical persons – enterpreneurs on a contractual basis. An important problem in this sphere is the off-gauge waste that cause the formation of unauthorized dumps [8].

Handling the collected HW in the Poltava region includes mainly liquidation method now. According to the State Administration of Environmental Protection of the 1.01.2012 in the Poltava region there were 377 authorized landfills and HW dumps with a total area of 460.2 hectars, of which 90 have been certified and calculated. Today about 60% of landfills do not meet the standards of environmental safety and more than 18.5% are overloaded. The area of illegal dumps has also increased significantly. In 2008 the dumps were found with the total area of 18 hectars, in 2006 – 298 landfills with the area of 13.7 hectars, in 2011 – 411 dumps with the area of 60.2 hectars [89].

The carried out research in HW handling sphere allows to distinguish the major problems in the field of waste handling in the Poltava region. They are: particular constant increase in waste formation in the region, low utilization level of HW landfills and lack of correspondence of the majority of them to environmental health and safety standards, situations regarding waste handling in disorganized storage space is far from being satisfactory. On the whole the situation in the Poltava region in waste handling sphere is complex, it results in the loss of great amount of

secondary materials and the shortfall of revenue from their utilization, the need for a permanent allocation of considerable amount of financial resources for building new waste grounds. The maintenance of the existing landfills and dumps in most cases create ecologically hazardous conditions in the areas of landfill.

The studies of current trends and the problems of hard waste handling in the Poltava region testify to the necessity of working out the strategy of waste handling development sphere accounting the interests of all stakeholders of this process [9]. Thus it is especially important to take into account that systems HW handling, that is based on the decision of partial problems of enterprises and separate inhabited cities, in spite of their high expenses, as a rule, not effective. Building of local objects of utilization of HW in every city, settlement or on every enterprise conduces to dispersion of money, groundless increase of charges on the burial place of wastes and does not allow effectively to solve problem handling wastes in the scales of region. An exit from a situation that was folded are development and realization of the regional complex systems handling wastes, that are based on creation of modern charts of the sanitary cleaning of the inhabited cities, organization of net of regional and interregional objects of utilization of wastes, effective systems of collection and transporting of wastes with an exception and utilization of secondary raw material and factions of wastes, that have resource potential.

According by the optimization model of waste handling development has been offered for the Poltava region, it is aimed at balancing the two opposite criteria: economic damage from environmental pollution ($C_{екол}$) and the total operation cost of the sphere ($C_{екон}$) for the different scenarios of development of HW:

1) Existent situation is kept. In this case it is necessary to estimate a risk from the sanctioned and unauthorized existent grounds and take into account to wipe and profits in the field of given.

2) On the change of existent dumps is entered regional grounds (seven grounds are for providing of the complete moving away of HW taking into account maximal logistic of transport, two from that serve cities Poltava and Krementchuk power 200 thousand tons, and five by power 50 thousand tons.

3) Building of four processing plants (total power is 1,2 million $м^3$). A remain is taken out on the grounds of HW (additionally are seven grounds by power for 50 thousand tons)

4) Building of two plants which burn waste (Poltava, Krementchuk), additionally seven grounds by power for 50 thousand tons.

5) Building of two composting plans, additionally seven grounds by power for 50 thousand tons.

Comparing of existent situation to the possible scenarios of the technological retooling of HW sphere in the Poltava region is driven to table 1.

*Table 1 – Comparing of existent situation to the possible scenarios of the technological retooling of HW handling sphere in the Poltava region**

Criterion	*1 scenario*	*2 scenario*	*3 scenario*	*4 scenario*	*4 scenario*
Ecological criterion					
Contamination of atmosphere					
Risk to the health of population	0,19	0,04	0,02	0,464	0,004
Economic damage from environmental pollution, million hryvnias/year	14,602	0,046	0,04	6,605	0,0135
Economically appraised risk, million hryvnias/year	2,753	0,0018	0,0008	3,692	0,0001
Contamination of water environment					
Risk to the health of population	0,3	0,276	0,02	0,57	0,02
Economic damage from environmental pollution, million hryvnias/year	9,26	0,084	0,0482	0,934	0,035
Economically appraised risk, million hryvnias/year	2,798	0,023	0,001	0,532	0,0007
Contamination of soils					
Risk to the health of population	0,26	0,26	0,02	0,59	0,02
Economic damage from environmental pollution, million hryvnias/year	15,207	2,655	0,945	3,885	0,905
Economically appraised risk, million hryvnias/year	4,029	0,69	0,019	2,29	0,018
General economic damage from environmental pollution, million hryvnias/year (Y)	39,069	2,785	1,03	11,424	0,95
General economically appraised risk, million hryvnias/year ($C_{екол}$)	9,58	0,72	0,02	6,52	0,019
Economic criterion					
General charges ($C_{екон}$), million hryvnias/year **.	12,5	207,9	288,5	485,2	220,8
The profit is from realization of secondary raw material, million hryvnias/year (U)	0,76	0,76	41,06	25,5	13,6
$H_з$, million hryvnias/year	118,5	66,12	37,16	40,8	42,8
$C_{сум,}$ million hryvnias/year	-12,92	- 5,86	9,88	- 28,13	2,81
Taken seat	4	3	1	5	2

* - it is expected by an author; ** - in quality of calculation term on determination of economic efficiency it is certain 10 years.

According to the defined development directions of HW handling sphere the urgent problem remains this: a wide application of financial and economic provision

measures. But the vector of using these measures should have innovational character for creating powerful production potential from secondary raw materials; ecological safety and social growth must be promoted. Otherwise the financial resources coming into the sphere of waste management will compensate losses from irrational management in this sphere and will support uncompetitive model of production organisation. Considering the demands to local development policy of HW handling sphere, introducing the system of priority measures of financial and economic supply of optimal functioning and development of the sphere as well as the Resolution of EU Council of 24.02.1997 "The Strategy of the European Union in Waste Management" it is necessary to strive for realization of tactic goals: minimization of HW formation and their highest possible utilization and there safe removal (Fig. 1).

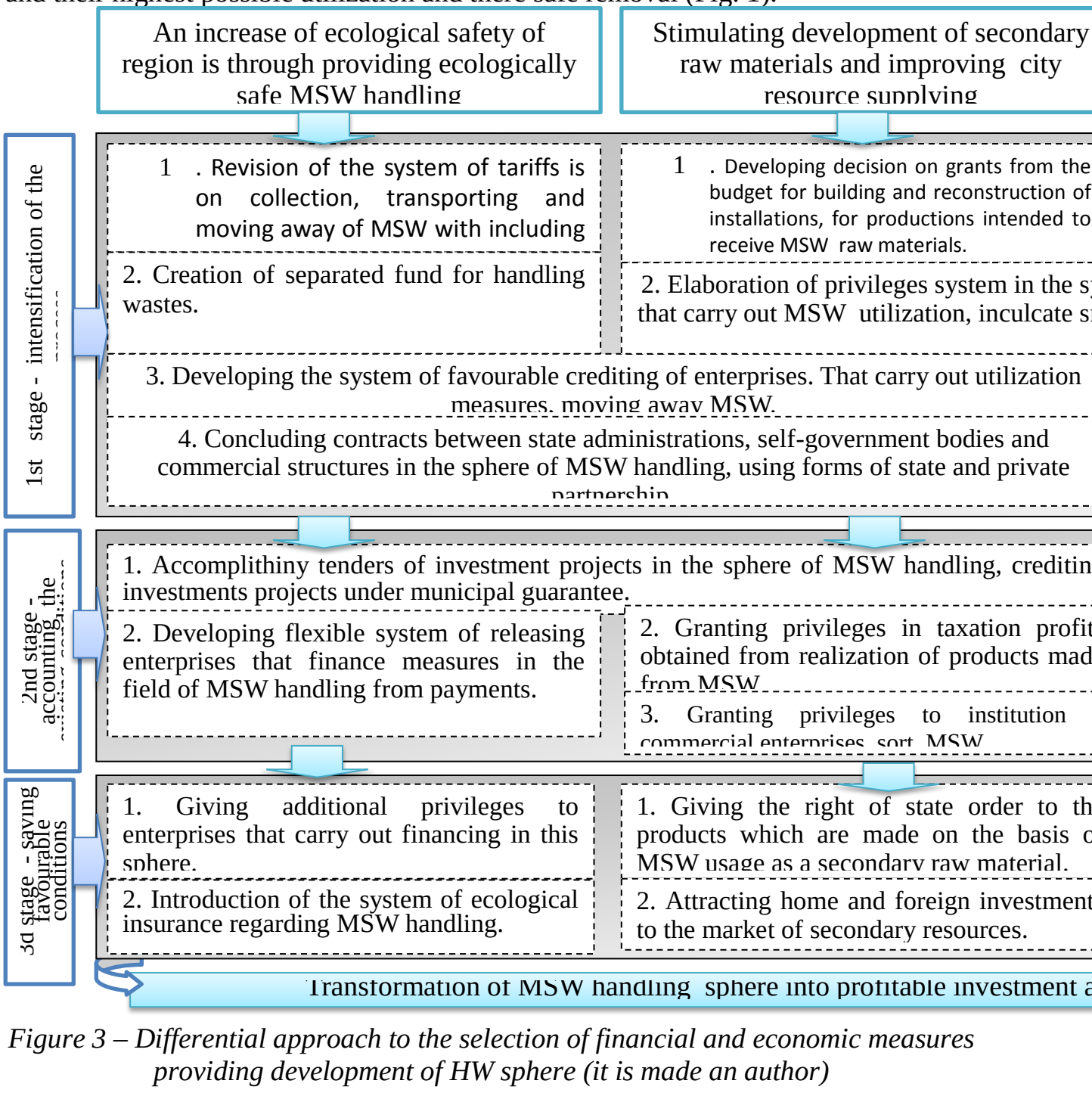

Figure 3 – Differential approach to the selection of financial and economic measures providing development of HW sphere (it is made an author)

The mentioned measures will have to be realized in 3 stages: stage I – immediate measures aimed at intensifying the process, the II stage – medium measures aimed at taking into account the existing conditions, the III stage – long-term measures aimed at preserving the favorable conditions in certain target areas.

Conclusions. Thus, it offers an author and scientifically reasonable methodology of optimization of development model in hard waste management sphere in the region aimed at balancing economic and environmental criteria has been developed. The feature of this model is that she to a full degree takes into account influence of ecological risks on economic indicators. On the basis of the worked out model the conducted optimization of ecological and economic criteria is for the existent system of handling hard wastes and alternative charts on the example of the Poltava area, that allowed to set that most risky and dangerous for the health of population, and also a most expense is building of plants which burn waste, id est a fourth scenario is unacceptable for an area. Existent situation, is though characterized the least charges is unacceptable, so as is characterized most ecological risks (9,58 million hrn.) The least risky and safe-health population and environment there is building four the processing stations or two plants on punching, here economic efficiency of processing of HW in comparing to the ground burial place considerably higher. Thus most acceptable from the ecological and economic point of view is the third variant at that a minimum economic risk is provided, and an annual economic effect makes a 9,88 million hrn. Taking into account requirements to forming of local politics of development of sphere of behavior from HW, the priority events of the *financial and economic* providing of development of this sphere are worked out, realization of that in combination with technical events allows translate HW sphere from low profitable in cost-effective and investment attractive industry.

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У статті розроблена оптимізаційна модель розвитку сфери поводження з твердими відходами регіону, яка спрямована на збалансування економічних і екологічних критеріїв та дає можливість при існуючій ситуації й наявних коштах підібрати комплекс оптимальних рішень. Визначені напрями розвитку сфери поводження з твердими відходами на прикладі Полтавського регіону та надані рекомендації щодо удосконалення її технічного та фінансово-економічного забезпечення.

Ключові слова: *тверді відходи, сфера поводження з відходами, регіон, збалансований розвиток.*

В статье разработана оптимизационная модель развития сферы обращения с твердыми отходами региона, которая направлена на сбалансирование экономических и экологических критериев, а также дает возможность при существующей ситуации и имеющихся средствах подобрать комплекс оптимальных решений. Определены направления развития сферы обращения с твердыми отходами на примере Полтавского региона и предоставленные рекомендации относительно усовершенствования ее технического и финансово-экономического обеспечения.

Ключевые слова: *твердые отходы, сфера обращения с отходами, регион, сбалансированное развитие.*

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