Ecological risks of a steppe nature management: detection, classification and ways to overcome them (on the example of the Orenburg region)

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Abstract. The aim of the study is to reveal and classify ecological risks for steppe nature management as well as to suggest the ways to overcome them. The following methods were used: historical, cartographical, logic and field landscape researches, Earth Sensing data, the author's method of an expert ecological-economical assessment of steppe etalons and secondary steppes. The main ecological risks making influence on the condition of steppe land and biological resources are detected and classified for an agrarian and industrially developed steppe region. The conception of an “antiecological” framework is developed. The system of the most substantial risks is highlighted, recommendations to minimize these risks are offered.

1 Introduction

The industrially developed Orenburgskaya oblast (124 000 km²) is located in the central part of the Eurasia's steppe zone; on the south it surrounds the Ural Mountains. A crossing of the Ural mountainous-plain country and the steppe zone conditioned a wide range and wealth of natural resources, including land, that had promoted an active agrarian and industrial development of the area beginning the middle part of XVIII century. The territory has been developing agriculturally simultaneously with the industrialization in 1930-1970-s. By the end of XX century there was formed a current economical differentiation: the north-west part of the oblast is characterized by the most valuable land resources and developed oil-producing industry; the central part of the oblast is characterized by land resources of the average quality and developing gas and oil producing; the east part of the oblast which had suffered during the Virgin Land Campaign, is characterized by a minimal bioclimatic potential of ploughed lands and a developed infrastructure of mining industry. On the whole, the steppe zone of Trans-Volga, the South Ural and Trans-Ural regions represents itself a mixture of agrarian and technogenic landscapes where one can see grain elevators, bodies and pipes of the largest industrial centers and open cast mines' complexes.

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At the same time the main part of the area is occupied with quasi-natural landscapes with steppe hilly- and low-mountainous pastures.

In spite of the industrial and agrarian recession in 1990-s, values of the agricultural development are restored on the whole: croppage was stabilized on the level of 3-3.5 million ton in year, the figures of sunflower sowing are increasing annually and has already exceeded the level that had been in the USSR. In accordance with this, a consumption level of population, including rural people are increasing; a country rest becomes more available that implies a growth of annual industrial and domestic waste in agro-landscapes. Capital investments in mineral resources extraction, including open-cut mining, have been increased for last years – a number of open-cast mines and dumps is increasing too.

In the course of the design of a landscape-ecological base for the steady development within the Russian steppes with explanation of nature-similar technologies, we, considering the experience by Russian and foreign researchers [1, 2, 3, 4], detected and classified ecological risks of steppe nature management and developed ways to overcome them.

2 Materials and methods

We used historical and cartographic methods, field research methods and Earth Remote sensing, author’s methods of an ecological-economic assessment of steppe model lands and secondary steppes, a framework approach, logical methods.

3 Results

We consider ecological risks in an industrially developed steppe region as some factors threatening with hard reversible negative changes of steppe landscapes, their lands and biological resources. A system of negative anthropogenic influences, including those which could change natural processes, is formed on the territory of the region. This system is developing in consequence of the industrial and agrarian production and leading to degradation of steppe landscapes: an environmental disruption which is not fatal and might be prevent by means of a purposeful investment.

We offer a classification of ecological risks marking out two main groups.

Risks having a natural character: negative weather phenomena and unfavorable climate change effecting on the steppe management. It is an elevation of droughts during late springs and winters with little snow intensifying a risk of dry farming; an eolian processes activation (including dust storms in winters which had occurred in 2017-2018-s).

The following structure of anthropogenic risks is ascertained (Table 1).

Table 1. The structure of anthropogenic risks.

Anthropogenic risks	
Groups	Subgroups
1. Structural agro-ecological risks	
Risks are caused by costs of the existed structure of agriculture lands	a) a high part of official arable lands in agro-landscape
	b) a lack of a legislation, regulating structure transformation in the steppe agrolandscapes, including a closedown of an anti-ecological structure of agricultural lands in the course of the land reform during the late Soviet period
	c) a complication to transfer agricultural lands from a cropland to pasture and haying lands

	d) a lack of the balance of agriculture and livestock farming as a producer of organic fertilizers
	e) a low actual crop capacity in condition of the minimal usage of mineral and organic fertilizers
	f) a lack of a motivation through agricultural commodity producers to preserve and restore steppe biodiversity and bio-recourses, including hunting fauna
	g) a loss of agricultural lands owing to an overgrowing of unused lands with low quality open woodlands, mainly elm, first of all on sandy-loam soil on south-east of the oblast. A formation of specific elm-steppe savanoidea or impenetrable tangle
	h) a development of agricultural holding companies registered out of the land use region
	i) a hardening of requirements to target use of agricultural lands, first of all arable lands that promotes to conserve extensiveness and soil consumption of agriculture [5, 6]
2. Risks connected with agrarian production	2.1. Plant growing
Risks are apperead due to the process of agricultural industry	a) an activate of fallow lands ploughing up, including low-productive areas
	b) a mass growth of sunflower's sowing, including on lands that are not potentially suitable for this crop, especially in the south and east districts
	c) a development of watermelon cultivation in Preduralie (the Pre-Ural region), which demands constantly to involve sandy-loam virgin and fallow lands mainly located on fluvial terraces, to increase a consumption of water resources for watering that effects fatally on the water content of small and middle rivers. A nitrate accumulation on the soil and land pollution with polyethylene films and domestic litter are connected with the development of watermelon cultivation too
	d) a formation of a spontaneous network of temporary field roads
	2.2. Livestock farming
	a) a lack of equipped drinking places and a unsystematic usage of small rivers for watering
	b) a destruction of riverside and water vegetation on unequipped drinking places leading to small rivers' degradation
	c) a degradation of natural meadowlands owing to overgrazing within outskirts of villages and ungrazing within distant lands which undergo regularly steppe fires
3. Risks connected with industrial activity	
Risks are apperead due to a building and operating of industrial enterprises	a) an emission of liquid and solid waste products and a pollution owing to development of poultry farming, swine breeding, oil extraction
	b) an intensive development of mining quarries
	c) a spontaneous development of small quarries with accessible

	mineral resources
	d) an expansion of oil and gas production into agrarian landscapes, on strictly protected natural areas and near-by building zones
	e) a loss of valuable agricultural lands due to a development of alternative energetic
4. Built-up risks	
Risks are apperead due to vital activity of settlements	a) a unauthorized stocking of black soil for plots of land
	b) an exemption of agricultural lands for suburban building
	c) solid domestic waste scattering by the wind from dumps to agricultural lands
	d) unauthorized dumps with solid domestic waste in quarries, ravines, on agricultural lands, in forests and woodland belts, in outskirts of villages
	e) steppe fires connected with a human activity and an accumulation of steppe felt
	f) a spontaneous construction and destruction of earth embankments
	g) an unauthorized usage of biological resources, first of all hunting species
	h) a negative influence of stray dogs and cats on reproduction of hunting resources

Risks sources are divided into point (small separate objects), linear (spreading objects joint with a transport or industrial infrastructure) and areal (large single objects or conglomerates). A character of the spatial distribution of the ecological risks' sources in the agrarian-industrial steppe region allows to put a question about a formation of the "antiecological" framework of the territory where areal objects might be considered as cores and linear objects – as corridors. A territorial planning should take into account an antagonistic interaction of the existing "antiecological" and the projecting ecological frameworks and a nature conservation network [7, 8].

4 Discussion

One of the most significant geo-ecological task concerning to the steppe nature management is a destruction of the "antiecological" framework, conservation of extra valuable land resources, first of all arable lands, prevention of their irreversible destruction. To optimize the steppe nature management a measurement was developed as an alternative of ecological risks. Also, a specific character of threats for steppes and their overcoming are urgent issue for industrially developed steppe regions of Kazakhstan [1].

The main threat for the Orenburg steppe landscapes joint with a loss of arable lands is oil and gas industry [1, 9]. An extraction process is characterized by numerous objects of the oil and gas producing infrastructure which literally pierce vertically and fragment the steppe agrolandscape across. A fragmentation and irreversibility of transformations so considerable that there is a reason to separate out a new type of an anthropogenic landscape – agro-oil and gas production-landscape. It is characterized by an oil and gas production network putting over agrolandscapes in the largest agricultural region of the state. Spreading of oil and gas production to east caused Orenburg turns out to be surrounded an agro-oil and gas production-landscape with its specific features, including flares with

burning of associated petroleum gas, systematic accidents with pipelines, an anthropogenic destruction of fertile soil and biota.

An activation of a short-term exploitation of quarries without following recultivation might be noticed on the east of the region.

A solar power engineering development for which favorable zonal climate conditions are in the Orenburg region, is still realized on the most productive steppe lands. A value of “pure” energy and land consumption for its producing are still not correlated.

“A rubbish reform” has not improved yet the situation with domestic waste products in rural territories: it continues rubbish disposal on villages’ outskirts from which it is carried by the wind to agricultural lands.

Land resources are weakening, a crop rotation is being ignored, and fertilizers almost are not introduced in an agro-industrial complex. The program concerning to a conservation of underproductive arable lands have not been realized yet. In accordance with an expansion of sunflower’s sowing, soil degradation is intensifying; these crops have already reached 20% of the total tillage.

5 Conclusion

On our assessments the main ecological problems the industrially developed steppe Orenburg region are: the aftermath of oil and gas production, first of all in the west and the most agriculturally developed central parts of the oblast; an intensive opening of short-term quarries without recultivation; dumps of domestic and industrial waste products; soil consumption of agriculture.

At the same time means of ecological funds which go to solve the most urgent social problems, is reduced. According to our assessments, a development of the “antiecological” framework prevails over a formation of the ecological one.

To reduce and prevent ecological risks we offer:

- 1) to restore in full ecological funds and its specialization;
- 2) to raise an ecological responsibility of a oil and gas production complex by means of a severe limitation imposition, redistribution of a part of profit for solving ecological questions;
- 3) do not permit to strengthen the influence of an alternative energy on landscape-biological steppe diversity;
- 4) to make actual closedown programs concerning to underproductive arable lands and a development of adaptive livestock farming;
- 5) in the course of “the rubbish reform” to realize the project on an ecological liquidation of dumps in rural areas.

A practical realization of these recommendations can be workable in the frame of the regional component of the national project “Ecology”.

Estimating a special topicality of ecological problems within the industrially developed steppe agrarian regions, we suggest to admit the steppe zone potential as the region of advanced development, a driver of “green economics” and nature-similar technologies. The full realization of this potential might be implemented in the frame of the national project “The Steppe of Russia”.

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References

1. J. Kamp, M.A. Koshkin, T.M. Bragina et al., Biodivers. Conserv., **25**, 2521–2541 (2016) <https://doi.org/10.1007/s10531-016-1083-0>

2. A.N. Barmin, N.S. Shuvaev, E.A. Kolchin, *Arid Ecosyst*, **1**, 278–284 (2011) <https://doi.org/10.1134/S2079096111040032>
3. C. Levers, M. Schneider, A.V. Prishchepov, S. Estel, T. Kuemmerle, *Sci. Total Environ*, **644**, 95–111 (2018) <https://doi.org/10.1016/j.scitotenv.2018.06.326>
4. H. Yin, A.V. Prishchepov, T. Kuemmerle, B. Bleyhl, J. Buchner, V.C. Radeloff, *Remote Sens. Environ*, **210**, 12–24, (2018) <https://doi.org/10.1016/j.rse.2018.02.050>
5. A.V. Linkina, M.I. Lopyrev, E.V. Nedikova, *Vestnik of Voronezh state agrarian university*, **2 (49)**, 60–65 (2016) <https://doi.org/10.17238/issn2071-2243.2016.2.60>
6. V.P. Yakushev, V.V. Yakushev, *Vestnik of RAS*, **88 (9)**, 773–784 (2018) <https://doi.org/10.31857/S086958730001690-7>
7. V.I. Kiryushin, *Eurasian Soil Sc.*, **52**, 1137–1145 (2019) <https://doi.org/10.1134/S1064229319070068>
8. B.I. Kochurov, Y.A. Khaziakhmetova, I.V. Ivashkina, E.A. Sukmanova, *South of Russia: ecology, development*, **13(3)**, 71–82 (2018) <https://doi.org/10.18470/1992-1098-2018-3-71-82>
9. K.V. Myachina, A.G. Ryabuha, *IOP Conference Series: Earth and Environmental Science*, **381**, 012066 (2019) <https://doi.org/10.1088/1755-1315/381/1/012066>