Ecological and Economic Assessment of Anthropogenic Impact on Deer Pastures

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Abstract. Due to the great industrial pressure, the northern territories suffer from heavy pollution. This leads to the deterioration of all biological resources in this region, the breakage of natural food chains, including the deer food resources which are crucial for the traditional nature management practices of the indigenous peoples of the North. Unsatisfactory conditions at deer pastures and the improper use of the pasture lands lead to the reduction of deer foraging lands due to their transformation into industrial facilities (mostly). This calls for an assessment of environmental damages done to the territories. It is also crucial to perform an economic assessment of actions aimed at the reduction of anthropogenic load in the polluted areas.

1. Introduction

The active development of the North led to some difficult-to-solve environmental and economic problems. Industrial enterprises make an adverse impact on natural habitats, including in the northern territories. The specific features of the northern territories include the extreme climate and the high anthropogenic impact. Due to those, the vegetation cover in the region is very vulnerable and hard to recover. The Khanty-Mansi Autonomous Okrug – Yugra (KMAO - Yugra) is one of the largest regions specializing in oil and gas prospecting and commercial logging. The largest proportion of the disturbed lands are those used by oil and gas industries (over 70%).

As a result of industrial and economic activities, first of all, the pollution due to the exploitation of fossil fuels, animal habitats deteriorate, their land area reduces, breeding conditions change, as well as feeding areas and migration routes, and populations shrink [1]. The appearance of multiple roads, pipelines, utility lines are some of the reasons to increase the discomfort of the deer, the elk, and valuable fur animals [2]. Deer pastures located near gas pipelines and settlements become unusable. The gas pipelines and other constructions built often break the pasture forage routes of the deer. Thus, the deterioration of the environment is the main reason for deer pasture productivity reduction in large areas.

2. Research methods

The subject matter of our research is the deer pastures of the Kazym Deer Company, in KMAO – Yugra. Currently, the conditions in a significant proportion of deer pastures are unsatisfactory. The irrational use of pasture lands leads to the disposal of farming lands, the changes in deer habitats, the reduction of animal counts, and the deterioration of forage quality and productivity. The transformation of deer pastures into industrial facilities leads to a significant reduction of their area.
and the increasing load on the remaining pastures. The emissions of pollutants produced by industrial enterprises make deer pastures impractical for deer feeding. Apart from that, gas pipelines, motorized transport, and fires also destroy the foraging lands [3, 4]. With such high anthropogenic load, the lichen forages cannot recover. This is especially true about the reindeer moss, which is the main source of food for the deer. It takes the reindeer moss 4 - 15 years to recover in wildlife, and up to 30 years under industrial pollution, while some lands are taken over by other moss and higher plant species and cannot be recovered.

The soil cover of the territory has not been properly studied up to this day. Taiga gley soils and podzol soils can be found in the region. Soils of all types are subject to clayization of various degrees. In the clay loam region, gley podzol and gley cryomorphic soils are common. The stark differences between the soils developing in the same climate are the result of the water conditions that are defined by the degree of the soil inland drainage and water stagnation. The low-drainage areas in the district are dominated by swamp-podzolic soils. Under the constant excessive moisture, swamp soil types are formed, and on the flood plains, alluvial soils are to be found. Depending on the intensity of the gleization and the combination with podzolic processes, podzolic illuvial gley soils and taiga surface gley soil are formed. The soil formation in the territory is slow due to the harsh temperature conditions in the air and the permafrost soils with low groundwater circulation. The putrefaction of organic remains and microbiological processes are suppressed by low temperature and excessive moisture even during the summer. Rapid waterlogging affects the soil cover directing its development to hydromorphism. All these factors reduce the biological activity of the soil cover, and therefore soil humification is slow. The plain terrain factors into the clear zoning in the soil distribution. In no-drainage and low-drainage areas between rivers, the flow of water is obstructed, as well as in lower areas and enclosed drainless basins. Peat bog and bog soils are formed there. Ridge patterns and hummocky peat moors are typical of these areas. On the flood plains, flash floods accumulate layers of silt, thus forming gley clay loams that are very rich in organic compounds. The riverside hills and elevated portions of flood plains are characterized by sandy, sandy clay, and sod-podzol soils with gleization due to the permafrost horizons. The areas with the most water consist of thoroughly washed sands. Sands that work as good filters and defreeze quickly facilitate soil drainage and continuous downward water flow, which creates the conditions for podzolization. A key feature of podzolization is the destruction of primary and secondary minerals in the upper part of the profile and the transportation of the destruction products to the lower horizons and groundwaters. The podzolic layer is characterized by the acidic reaction and the low content of organic substances.

According to the forest zoning, the territory belongs in the northern and midland-taiga with a touch of the Siberian cedar and the larch. The forest stands formed mostly by pine trees grow on elevated areas among numerous marshes. Larches grow in smaller allotments and their overall area is quite small. Cedar forests grow in thin bands along river valleys and intermingle with other coniferous species and larches. Spruce forests form mixed stands of the spruce, cedar, and birch and they grow in the riverside areas and inter-ridge lows. A large proportion of the land is occupied by floodplain swamps and watershed moors. The floodplain swamps are located along river valleys and watersheds. They feature shrubby forms of the dwarf birch, willow, and the moss layer formed up to 95% by sphagnum and haircup mosses. Flat hummock swamps are formed everywhere, and shrubby budlike swamps are formed in bands along the forest edges. Peat and sedge bogs are located in the eastern part of the farm. The natural conditions and the climate in this territory are favorable for deer keeping and breeding [5]. However, we must note some factors that have an adverse impact on deer farming. The abundance of mosquitoes complicates the full acquisition of forage in the summer. The mass emergence of gnats starts in late June and lasts for about two months preventing the full acquisition of foraging resources. A large proportion of the bogs used as summer pastures is difficult to traverse or just impassable. The migration of the stock throughout the year is impossible due to a large number of rivers with steep clifffy banks.

Currently, it is necessary to have a more detailed study of the reindeer moss state, the degree of their disturbance as a result of pasturing, and to analyze the number of deer per area unit, as well as
forecast the damages from anthropogenic pollution. Since the territory in question is a remote one, arranging expeditions for further, more detailed research is complicated, it is necessary to develop a comprehensive study of the area involving many specialists to preserve the unique landscape and traditional land management practices of the indigenous peoples of the North. Deer farming is one of the traditional practices of northern peoples [6]. The national traditions that developed in this territory, as well as the culture, language, and national mentality are always connected to deer farming.

3. Results and discussion

The plot belonging to the Kazym Company is located in the eastern and central parts of Beloyarskiy district up to the rivers Amnya and Topryuygan, excluding settlements and kinship territories. The deer pastures of the Kazym Company include the lands of Sorumskiy Species Reserve with the total land area of 159.3 thousand ha. (and the protective area of 163.0 thousand ha). Out of those, 37.0 thousand ha belong to a kinship territory and Numto natural park with the total area of over 540.00 thousand ha (overall perimeter of 529 km). The south-eastern border of the pastures runs along the winter tractor route and 62.18 ha out of its area are loaded with the drilling sites of Berezovskaya GRES power plant.

The financial security of the Kazym Deer Company is not only based on its commercial activities but also on governmental support - see Table 1 [9].

Table 1. Volume of governmental subsidies for 2018.

| Types of support                              | Volumes, in thousands of rubles |
|----------------------------------------------|---------------------------------|
| State support (subsidies),                   | 11,714.0                        |
| Including those from:                        |                                 |
| - regional budget                            | 11,214.0                        |
| - local budget                               | 500.0                           |
| Subsidies, total:                            | 11,214.0                        |
| - deer farming support                       | 9306.0                          |
| - animal farming support                     | 1627.0                          |
| - other                                      | 281.0                           |

The data shown above signify that both native locals and state authorities are interested in the efficient work of the company. According to the annual reports, deer farming support amounts to 83% of all subsidies.

Historically, rational land use actions have always been implemented in deer pastures. In 1981-1982, following the contract with the Tyumen branch of the Zapsibgiprozem Institute, the Angara prospecting expedition carried out land arrangement works for the deer farming enterprise in Beloyarskiy district of KMAO - Yugra. The internal land-use system of the farm was arranged following the existing land regulations. The Guidelines On the Arrangement of Deer Pasture Lands served as the main guidance document when developing projects for internal land-use systems for deer farms. Some types of works were carried out according to the guidelines suggested by the Angara prospecting expedition concerning the project and prospecting works in the far North.

Before the development of the internal land-use project, a number of inspection works were carried out to study the conditions of deer pastures, the current in-farm arrangements, feedstocks, and availability in different pasturing seasons, the actual deer pasture usage, the key economic indicators characterizing the economic activity and the further development prospects of the farm. The data collected during the inspections became the basis of the in-house land usage project for deer pastures. When preparing the project, the experts used the geobotanical maps drawn by the specialists of the Angara prospecting expedition on the land maps of 1:100 000 scale printed by the Main Office of Geodesy and Cartography of the USSR Cabinet. The deer pasture arrangement project developed was implemented only partially.
Further developments including various land transformations, environmental and economic problems, irrational use of pasture lands, rapid industrial development of territories led to significant changes in the existing traditional and project deer pasture arrangements. All of that led to the stagnation of deer farming development.

Currently, the proportion of deer farming in the economy is over 70% (Table 2).

Table 2. Deer Population Change Dynamics.

| Year | Deer Population (heads) | % of change (+/-) |
|------|--------------------------|-------------------|
| 1985 | 23,500                   | -                 |
| 1991 | 6567                     | -27.9             |
| 2018 | 8205                     | -34.9             |

Over 700,000 ha of pasture lands are allocated for gas pipeline construction, which leads to a significant reduction of pasture areas.

Taking into consideration that the company owns vast deer pastures with high deer-feeding capacity, it is necessary to concentrate efforts on the preservation of these territories and to conduct a thorough analysis of their conditions and develop comprehensive recovery actions.

The environmental and economic aspects of nature management began to emerge quite recently. The rates of economic development made the problems of limited natural resources more pressing, which led to the obligatory environmental requirements in the economy.

Charging fees for using natural resources has the following goals:
- increasing manufacturers’ interest in more efficient land usage;
- creating financial interest in the preservation and production of natural resources.
- creating additional means for natural resource recovery.

The balanced environmental and economic development is only possible when a uniform comprehensive program for the usage of natural resources is developed that would take into consideration the environmental protection, natural resource recovery and production requirements [7].

The extent of anthropogenic impacts has still not been assessed fully but we can say that the environmental losses nature incurs through all kinds of adverse influences significantly exceed the economic losses calculated at the time.

Currently, the main issue is the transition from the economic justification of decisions to a comprehensive environmental and economic assessment of natural economy territories.

It is necessary to support such interaction that would combine the high rates of extended reproduction and economic growths with the preservation of continuous quality improvement of the territories in use, as well as the development of both specific components and the entire natural environment [8].

It is necessary to preserve the biosphere as a unique reproductive system that creates favorable conditions for people's lives and work. In the traditional sector of the economy, the preservation and development of deer farming are vital because it is a national trade of the northern peoples and one of the key conditions for the preservation of these ethnic groups.

The environmental and economic assessment of the damages done to the deer pastures of the Kazym farm was carried out following the valid decree of the Council of Ministers of the RSFSR on the Standards for Loss Recovery to Agricultural Businesses when Deer Pastures are Appropriated, Destroyed or Damaged dated 15.03.1989 No. 86 [10] and the decree of the Government of the Russian Federation of 15.06.1994 No. 908-r [11].

The damage calculations were made using the following formula:

\[ D = \sum D_p, \]

where \( D \) is the damage done to the deer pastures;
\( D_p \) is the damage done to the deer pastures during both summer and winter.
\[ D = D_w + D_s \]

where \( D_w \) is the damage done to the deer pastures during winter.

\( D_s \) is the damage done to the deer pastures during summer.

\[ \frac{D_w}{s} = \frac{S_0 \times N}{s} \]

where \( \frac{D_w}{s} \) is the standard of deer feeding capacity of the pasture for summer/winter;

\( S_0 \) is the area of the deer pasture outline.

\[ \frac{N}{s} = N \times R \]

where \( N \) is the standard of loss recovery for agricultural businesses when deer pastures are appropriated for non-agricultural purposes, destroyed or damaged, which corresponds with the deer feeding capacity;

\( R \) is the 500 multiplier used following the decree of the Russian government.

Using these formulae, the authors calculated the forecasted damage done to deer pasture because of the gas pipeline.

The overall land area occupied by the gas pipeline is 1220 ha, and the amount of the damage in monetary terms is 6,783,000 rubles. (Table 3). The gas pipeline mostly runs over winter pastures with high deer feeding capacities.

**Table 3.** The calculation of damages done to deer pastures because of the gas pipeline (in rubles).

| Outline | Area (S) | Deer feeding capacity | Standard | Damage calculation | Total |
|---------|----------|-----------------------|----------|--------------------|-------|
|         |          | winter | summer | winter | summer | winter | summer | |
| 14      | 92.5     | 22.8   | 0.2    | 16,000 | -      | 1,480,000 | - | 1,480,000 |
| 12      | 10.0     | 4.4    | 0.6    | 3200   | -      | 32,000   | -  | 32,000  |
| 11      | 80.0     | 13.0   | 1.0    | 10,400 | 400    | 832,000  | 32,000  | 864,000 |
| 38      | 20.0     | 1.4    | 1.3    | 800    | 400    | 16,000   | 800     | 24,000  |
| 66      | 25.0     | 5.4    | 1.0    | 40,000 | 400    | 100,000  | 10,000  | 110,000 |
| 35      | 117.5    | -      | 0.6    | -      | -      | -        | -       | -       |
| 33      | 17.5     | 10.8   | 1.0    | 800    | 400    | 140,000  | 700     | 147,000 |
| 62      | 27.5     | -      | 1.0    | -      | 400    | -        | 11,000  | 11,000  |
| 61      | 80.0     | 1.7    | 0.6    | 800    | -      | 64,000   | -       | 64,000  |
| 59      | 70.0     | 2.0    | 0.1    | 1,600  | -      | 112,000  | -       | 112,000 |
| 82      | 42.5     | 3.4    | 0.6    | 2,400  | -      | 102,000  | -       | 102,000 |
| 83      | 75.0     | 10.0   | 0.7    | 8,000  | -      | 600,000  | -       | 600,000 |
| 105     | 67.5     | 12.5   | 0.9    | 9,600  | -      | 648,000  | -       | 648,000 |
| 104     | 25.0     | 7.4    | 0.4    | 5,600  | -      | 140,000  | -       | 140,000 |
| 103     | 110.0    | 505    | -      | 4,000  | -      | 440,000  | -       | 440,000 |
| 102     | 42.5     | 2.1    | 3.2    | 1,600  | 1,200  | 68,000   | 51,000  | 119,000 |
| 101     | 97.5     | 5.3    | 0.5    | 4,000  | -      | 390,000  | -       | 390,000 |
| 100     | 42.5     | 4.8    | 2.0    | 3,200  | 800    | 136,000  | 34,000  | 170,000 |
| 119     | 50.0     | 7.4    | 0.1    | 5,600  | -      | 280,000  | -       | 280,000 |
| 99      | 37.5     | 6.8    | 0.8    | 4,800  | -      | 180,000  | -       | 180,000 |
| 117     | 42.5     | 27.9   | 0.2    | 16,000 | -      | 680,000  | -       | 680,000 |
| 118     | 47.5     | 5.2    | 4.0    | 10,000 | -      | 190,000  | -       | 190,000 |
| Total   | 1220.0   |        |        |        |        |          | 6,783,000 |       |

This deer pasture territory also includes burnt spots with the overall area of 3692 ha. The damages to the deer pastures incurred through fires amount to 27,953,000 rubles. (Table 4).
Table 4. The calculation of damages done to deer pastures because of the fires.

| Outline | Area (S) | Deer feeding capacity | Standard | Damage calculation | Total |
|---------|----------|-----------------------|----------|--------------------|-------|
|         |          | winter | summer | winter | summer | winter | summer |         |
| 19      | 1,367.0  | 8.2    | 4.8    | 6,400 | 1,600 | 8,748,800 | 2,187,200 | 10,936,000 |
| 48      | 713.0    | 5.6    | 4.0    | 4,000 | 2,852,000 | 2,852,000 |
| 123     | 557.0    | 26.6   | 16,000 | 8,912,000 |
| 137     | 294.0    | 7.9    | 1      | 5,600 | 400    | 1,646,400 | 117,600 | 1,764,000 |
| 131     | 390.0    | 5.7    | 4,000  | 1,560,000 |
| 143     | 371.0    | 6.3    | 1.8    | 4,800 | 400    | 1,780,800 | 148,400 | 1,929,200 |
| Total   | 3692     |        |        |        |        | 8,748,800 | 2,187,200 | 10,936,000 |

Taking into consideration the rates of industrial development of the territory, the authors calculated the possible damage to it.

The overall land area of deer pastures in this economic and geobotanical locality is 181,724 ha. If local deer pastures get destroyed, the damage will amount to 8,455,644 thousand rubles. (Table 5).

Table 5. The calculation of possible damages because of the anthropogenic impacts.

| Number of pastures | The overall area in ha | Damage in thousands of rubles. | The total amount, in thousands of rubles |
|--------------------|------------------------|---------------------------------|----------------------------------------|
|                    |                        | winter | summer | winter | summer |                      |
| 180                | 181,724.0             | 8.0732801 | 0.39001400 | 8.455644 |

This research has produced the following findings:
- The stock reduction trend continues due to the active industrial development of this territory. The current state of the Kazym Deer Company is unsatisfactory. Compared to the 1985 figures, the deer stock reduced by over 34%, i.e. 2.9 times.
- It is feasible to conduct territory zoning taking into consideration its current state, vulnerability, and foraging value.
- In pastures with high deer feeding capacities, it is necessary to draw large-scale geobotanical maps with extensive legends that would depict pasture and industrial transformation of the landscape and show the maximum pasture loads and usage modes. In seasonal deer pasture, it is recommended to use rotational grazing and respect the changeover schedules to avoid overgrazing.

4. Conclusion
With a view to the current situation, the following actions are deemed necessary:
- Define the prospects of using deer pastures and developing deer farming considering the further industrial development of the farm territories.
- Develop improved technologies for gas pipe construction.
- Arrange deer pastures taking into consideration the location of industrial facilities to prevent their influence on deer farming.
- Develop a recovery system for disturbed the lichen cover.
- Analyze the reaction of the lichen cover in deer pastures to the anthropogenic impacts.
- Consider territories’ feeding capacities when appropriating them for industrial facilities.
- Form a database to forecast pasture productivity with the current and suggested usage.

Thus, developing and implementing a comprehensive system will help form a basis for further decisions concerning the preservation, transformation, and degree of usage of deer pastures, justify the operational control system for their state and assess the damages and further development prospects for deer farming.
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