Coal mining as a factor of environmental risks in the development of the hunting sector in Industrial Regions

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Abstract. The matter of efficient utilization of natural resources has reached a fundamentally new level of significance in modern science and practice. The present research featured the effect of coal mining on the integrity of hunting grounds and the population of game species. The paper introduces the problem of methodological errors in wild fauna counting, which can lead to unreliable population data. Coal mining and coal utilization cause major environmental problems by producing serious and often irreversible impact on the terrestrial compartment. The study focused on the environmental risks to hunting grounds and their exposure to man-induced factors associated with industrial activities. The author performed a detailed analysis of the population and use of game species in the Kemerovo region (Kuzbass). The research featured two public hunting grounds of Mezhdurechensk urban district No.1 and Belovo municipal district No.1. The research demonstrated some dynamics in the local forest coverage and game population in the spatio-temporal aspect for a five-year period. The comparative analysis of the hunting resources in various economic zones of the Kemerovo region revealed no natural population decrease related to the increasing industrial presence.

1. Introduction

The current economic conditions make the entire world community focus on the problems of sustainable use of natural resources and the restoration of the mineral resource base and strategic mineral reserves [1]. One of the most urgent matters associated with subsoil use is the prevention and elimination of the consequences of the negative industrial impact on natural landscapes.

Industrial regions experience a rapid development of extractive industries, which is accompanied by the expansion and improvement of both rail and road transport infrastructure as part of the coal mine life cycle.

Coal plays an important role in the global energy balance. The share of coal in the structure of the world fuel and energy consumption is 29%. It ranks second after oil, which accounts for 33%. Coal consumption is especially high in Pacific Asia: China is responsible for 3.8 billion tons, or 49% of total coal consumption, while India uses 0.95 billion tons (12%). The list of major coal consumers also includes the United States with 0.8 billion tons (10%) and the European Union with 0.73 billion tons (≥9%) [2].

Russia possesses 19% of global coal reserves, which makes it number two in the world. In addition, Russia ranks fifth in the global annual coal production (5%) and accounts for about 12% of world steam coal trade [3]. Most of the Russian coal is currently produced in the Kuznetsk Coal Basin, Eastern Siberia, and the Far East. In the first half of 2020, the Kemerovo Region extracted 107.7 million tons of coal. This figure is significantly lower than in the first six months of 2019 and 2018, when the region produced 121.1 and 123.8 million tons of coal, respectively [4].
Coal mining and utilization affect both terrestrial and aquatic ecosystems [5, 6]. Surface mining can radically change the natural environment [7, 8] as it destroys natural landscape [9] and causes soil compaction [10]. These changes can affect the distribution of wild species [11] and decrease their diversity [12]. Coal mining changes the quality of air as it produces coal dust, fine coal particles, and other air pollutants [13]. The main sources of air pollution in coal mining include drilling, blasting, loading and unloading of coal and overburden, heavy vehicle traffic, dragline operations, coal crushing in feeders, fires, open pits, wind erosion, exhaust fumes from heavy machinery, etc. [14, 15].

Migration patterns and routs of some wildlife species, including elks, can change under the man-induced impact [16, 17, 18]. This situation destroys the single natural complex formed by living organisms and their habitat.

Buuveibaatar et al. [19] studied the decreasing habitat of nomadic ungulates in coal mining areas. The research results provided a better understanding of migration processes. The scientists also proposed some useful recommendations that can mitigate the consequences of coal-mining development and related infrastructure in the region.

Maina et al. [20] studied the effect of coal mining process on human health and environment. The authors obtained their data by using geographic information methods, oral interviews, and field observation. Niningsih et al. [21] researched orangutan habitats in coal-mining areas and proved that the industry produced a direct impact on the animals and their migration patterns.

Colin et al. [22] identified the risks that mining and deforestation pose to wildlife. They formulated scenarios of how mining degrades and/or destroys the local environment.

Wanghe et al. [23] registered a similar correlation between mountain landscapes, populations of red pandas, their habitats, and protected areas. The authors used official data from mining regions and applied spatial analysis. The pandas appeared to avoid mining sites and preferred more comfortable habitats.

Asr et al. [24] described mining industry in terms of sustainable development. They defined the positive and negative impacts of this industry on three key principles of sustainable development, i.e. society, economy, and environment.

Johnson et al. [25] determined the effect of anthropogenic and natural disturbances on the migration of the Rangifer tarandus caribou by using GPS collars as a counting method. Beale and Boyce [26] assessed the effect of coal mining on various ungulates, including moose, by using direct observation methods and resource selection functions (RSF).

Müller et al. [27] applied both traditional and modern animal monitoring methods to describe how red deer choose their habitats in a former brown coal mining area in Denmark. They used faeces count and camera traps. The research showed that the mining activities changed the natural environment dramatically.

The effect of coal mining on the nature is a relevant research topic in Russian science. There have been some related studies that featured the territory of Kuzbass. For instance, Kovalev et al. [28] analyzed the development of coal mining and proclaimed it a key sector in the domestic and local economy. The scientists described Kuzbass as a coal-mining region with a complex of unresolved environmental problems. Kosinskiy et al. [29] found that the intensive development of the Kuzbass coal-mining industry has negative environmental consequences for the local socio-economic indicators and the quality of life.

According to the Strategy of Socio-Economic Development of the Kemerovo Region for the period up to 2035, the area of disturbed lands in Kuzbass (0.75%) is 12.5 times higher than the national average (0.06%). In some districts, up to 20% of all local arable lands have been technologically disturbed. The area of land requiring reclamation reaches 79,000 hectares, of which more than 66,000 hectares were disturbed during the development of mineral deposits [30]. Large-scale industrial projects are bound to reduce the area of hunting grounds, thus decreasing the game population.

The research objective was to assess the impact of coal mining on the correlation between the population dynamics of large game species and the level of forest coverage in the hunting grounds of the Kemerovo Region aka Kuzbass.
2. Results and discussion
The present research was based on official data of monitoring the game population in Kuzbass for 2015-2019 in two municipalities: the Mezhdurechensk urban district and the Belovo municipal district. According to preliminary data, these districts are responsible for a significant number of coal-mining licenses. The Department of Wildlife Protection of the Kemerovo Region provided information on the population of game species, territorial features, and the number of coal-mining licenses [31]. The data on forest coverage were obtained during expeditions to the hunting grounds of Kuzbass. The research mostly concentrated on the factors of forest coverage and coal mining. Figure 1 visualizes the boundaries of the public hunting grounds of Mezhdurechensk urban district No. 1.

Figure 1. Visualization of the boundaries of public hunting grounds in Mezhdurechensk urban district No. 1

The public hunting grounds of Mezhdurechensk urban district No.1 cover the following territory. Its north-western border stretches from the north-western border of quarter 207 of the Usinsky tract (Mezhdurechensk district forestry), then follows the north-western border of quarters 207, 203, 191, 192, and 176, crossing quarter 141 in the south. From then on, it goes along the northern borders of quarters 161, 143, and 144 of the Usinsky tract (Mezhdurechensk district forestry). The south-eastern border stretches from the eastern border of quarters 144, 183, and 198 along the south-eastern border of quarters 197, 196, 194, 206, 213, and 211 of the Usinsky tract (Mezhdurechensk district forestry). The south-western border goes along the south-western border of quarters 211, 208, and 207 to the north-western part of quarter 207 of the Usinsky tract (Mezhdurechensk district forestry). The area is 36,990.24 hectares, not including the settlements located within its boundaries. Table 1 shows the characteristics of the hunting grounds and the number of coal-mining licenses issued for this territory.

Table 1. Hunting grounds and the number of coal-mining licenses in the Mezhdurechensk urban district

| Municipality       | Public hunting area | Area, ha | Coal-mining licenses, pcs | Area (including overlapping territories), ha |
|--------------------|---------------------|----------|--------------------------|---------------------------------------------|
| Mezhdurechensk     | 12                  | 4,386    | 6                        | 1,304                                       |

Source: Department of Wildlife Protection of the Kemerovo Region

The table shows that there are twelve public hunting grounds in the Mezhdurechensk urban district. Their total area is 4,386 hectares. The number of coal-mining licenses is 6. The area, including overlapping territories, is 1,304 hectares. A coal-mining license for a particular territory does not mean that the area is being mined. It means that this opportunity can be realized in the long term. Table 2
demonstrates the ratio of the forest coverage and the population of large ungulates in the Mezhdurechensk urban district in 2015-2019.

### Table 2. Population dynamics of ungulates in the Mezhdurechensk urban district (2015-2019).

| Population of large ungulates, animals | 2015 | 2016 | 2017 | 2018 | 2019 |
|---------------------------------------|------|------|------|------|------|
| Siberian roe deer                     | 21   | 101  | 284  | 349  | 333  |
| Elk                                   | 24   | 272  | 366  | 343  | 334  |
| Red deer                              | 6    | 114  | 190  | 196  | 200  |

*Source: Department of Wildlife Protection of the Kemerovo Region*

The data analysis showed that the game population is increasing from year to year. The absence of connection between the increasing large game population and the decreasing forest coverage can be explained by the ongoing changes in the habitat. Figure 2 shows the population dynamics of the game species and the level of forest coverage in the Mezhdurechensk urban district.

![Figure 2. Population dynamics of game species and the level of forest coverage in the Mezhdurechensk urban district](image)

The data analysis revealed a contradiction: the population of large animals is increasing, while the level of forest coverage is gradually decreasing. Unfortunately, the information at our disposal was not sufficient to explain this phenomenon. Figure 3 visualizes the boundaries of public hunting grounds in Belovo municipal district No.1.
Figure 3. Visualization of the boundaries of public hunting grounds in Belovo municipal district No.1

The public hunting grounds of Belovo municipal district No. 1. cover the following territory. Its north-western border stretches from the shared border between the Leninsk-Kuznetsk, Guryevsk, and Belovo municipal districts to the north-east along the border of the Belovo municipal district until it reaches the intersection of the Belovo municipal district and highway P384. The south-eastern border follows highway P384 to the south until it crosses a minor field road at 54°21'17"N E86°27'56"E. From there, the border follows the field road south-westward to the Belovo-Karagaila highway and Ilyich village. From Ilyich village, it goes northward along the border of the Belovo municipal district to the Zarechnoye-Bekovo highway. It then follows the highway northward until it crosses the Guryevsk-Belovo highway. From that point, it turns west along the Guryevsk-Belovo highway to the border with the Belovo municipal district and then turns north-west to the shared border between the Leninsk-Kuznetsk, Guryevsk, and Belovo municipal districts. The area is 29.633.53 hectares, not including the settlements located within its boundaries.

Table 3 shows the number of coal-mining licenses in the Belovo municipal district in 2015-2019.

Table 3. Hunting grounds and the number of coal-mining licenses in the Belovo urban district

| Municipality | Public hunting area | Area, ha | Coal-mining licenses, pcs | Area (including overlapping territories), ha |
|--------------|---------------------|----------|----------------------------|---------------------------------------------|
| Belovo       |                     | 29.634   | 13                         | 2.360                                       |
|              |                     | 5.058    | 2                          | 43                                         |

Source: Department of Wildlife Protection of the Kemerovo Region

Table 3 shows that there are three publicly accessible hunting grounds in the Belovo municipal district, each of which has coal-mining licenses. The first hunting area is 29,634 hectares; it has 13 coal mining licenses. Its total area, including overlapping territories, is 2,360 hectares. The second hunting area is 5,058 hectares, with two coal-mining licenses issued. Its total area, including overlapping territories, is 43 hectares. Table 4 shows the population dynamics of the ungulates per capita in the Belovo municipal district in 2015-2019.

Table 4. Population dynamics of the ungulates per capita in the Belovo municipal district in 2015-2019

| Ungulates, animals | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------|------|------|------|------|------|
| Wild boar          | 0    | 17   | 0    | 0    | 0    |
| Siberian roe deer  | 0    | 58   | 128  | 99   | 64   |
The data analysis revealed that the game population is increasing from year to year. The fact that the population increase does not depend on the decreasing level of forest coverage can be explained by the ongoing changes in the animal habitat. Figure 4 shows the population dynamics of the game species and the level of forest coverage in the Belovo municipal district.

Figure 4 also shows the positive population dynamics of the game species in this period. This indicator appeared to be a common point for both areas. The data were similar to those obtained for the Mezhdurechensk municipal district. The analysis revealed a similar discrepancy between the population dynamics of large game animals and the animal population level in the area under consideration.

3. Conclusion
The study revealed that coal mining and utilization cause major environmental problems. They produce serious and often irreversible impact on natural landscapes. Therefore, the ecological risks to the local hunting grounds are connected with the man-induced factors associated with industrial activities.

The comparative analysis of the game population in various economic zones of the Kemerovo region showed a connection between the irregular increase and/or decrease in the animal population of the local hunting grounds and the negative consequences of coal mining, deforestation, and destruction of animal migration routes. The present assessment of the current state of the hunting grounds contributed for a better understanding of the landscape change patterns and their impact on the ecology of Kuzbass.

The two above-mentioned municipalities differed in the number of hunting grounds and coal-mining licenses. They demonstrated a common indicator in the contradiction between the increasing
population of large game animals and the gradually decreasing level of forest coverage. Unfortunately, the information available was not enough to explain this phenomenon. The unexpected ratio might have resulted from inaccurate data counting by traditional monitoring methods, calculation errors, etc. In the long term, the increasing large game population will need larger habitats. Therefore, the problem requires a more detailed study of this phenomenon.

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