Economic entities of coal mining industry and wildlife resources: problem statement

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Abstract. The present study introduces the problem of interaction between coal mining enterprises and wild fauna. The research issues of the interaction of man and the biosphere are important for the entire world community. Game management is a significant part of environmental measures. The present study featured the specifics of Kemerovo region aka Kuzbass – a coal mining region with vast hunting grounds. Coal mining is a factor of man-induced impact on the habitats of elks and other large game animals. The author assessed the population dynamics of game species taking into account such factors as forest coverage and coal production on the hunting areas of Kuzbass. The research revealed the effect of coal mining, deforestation, and destruction of migration routes on the population of game species. A further comprehensive study of the issue can improve the accuracy of the data obtained. The analysis of the state of the local hunting grounds helps to identify patterns in the local landscape alterations.

1. Introduction

The issue of man-induced effect on the biosphere is as important for domestic and foreign science as the problem of sustainable development of natural resources [1]. The present article introduces and describes various factors of man-induces effect on hunting grounds. Anthropogenic landscape alteration is one of the most relevant concerns. In is represented by intensive deforestation, mining for coal, gold, natural gas, and oil, extensive forest fires, climate change, etc.

The ecological problems of man-induced impact on the environment are widely covered in scientific literature [2, 3, 4, 5]. Surface mining destroys landscapes, kills local flora, and radically changes the natural habitat of fauna [6]. These man-induced transformations affect such issues as animal population distribution [7], loss of biodiversity, animal and plant extinction [8, 9], etc. As part of ecosystem restoration, environmental scientists take into account landscape heterogeneity when assessing the migratory behavior of animals [10, 11]. A timely account of various factors of environmental risks, including coal mining, contributes to their effective assessment and can predict the population dynamics of large game species.

The search for effective methods of control and monitoring of large wild animals under anthropogenic pressure remains a matter of global relevance [12]. Wild fauna monitoring is part of the environmental control system and includes observation, assessment, and forecasting of the state of the natural environment.

Traditional accounting methods are widespread in the world practice [13, 14, 15, 16, 17], including Russia in general and Kuzbass in particular. Various studies describe their benefits and drawbacks. The traditional method of winter route count still remains very popular. However, advanced monitoring methods are becoming a new global trend. This trend is facilitated by the growing...
popularity of new monitoring technologies [18, 19], including unmanned aerial vehicles (UAV), or drones. Nowadays, they are used in various spheres of human life. The method of drone-based areal count has numerous advantages: it delivers accurate data on the migration routes in various natural landscapes [20] (Keeping et al., 2018); it is affordable; it possesses excellent qualitative characteristics, e.g. speed, safety, economy, accuracy, etc. [21]. Unfortunately, the results obtained from different flight sections are difficult to put together [22]. Other problems include mostly technical issues, such as inadequate UAV software [23].

The present research owes its relevance to a complex of environmental, managerial, and cultural reasons. Wild fauna census is more than just observing the population of a particular species. Wildlife monitoring makes it possible to take into account various natural and man-induced factors that affect the state of local environment. By controlling the animal population level, authorities can establish patterns of the ongoing changes and ensure the competent use of natural resources.

The global experience in wildlife monitoring in coal mining areas involves various traditional and modern accounting methods, e.g. observation, collection and analysis of demographic data, interviews with nature reserve personnel, GPS collars, and much more. Buuveibaatar et al. [24] noted a decrease in the habitat of nomadic ungulates in coal mining areas. By describing migration processes, the authors developed recommendations for mitigating the consequences of coal mining development in the region.

Benjamin et al. [25] showed how coal mining affects both human health and environment. The data for the study were collected using geo-information methods, questionnaires, interviews, and field observation.

Niningsih et al. [26] studied orangutan habitats in coal-mining zones. The research revealed that the local mining produces a direct impact on the orangutans and their migration patterns.

Ranjan et al. [27] described various effects of coal mining on local community and environment, including vegetation and topsoil. The authors believe that mining has major negative impacts on ecosystems, e.g. land degradation, deforestation, air pollution, and destruction of animal migration routes. Therefore, a better understanding of environmental transformations induced by surface mining helps to take better measures to protect the local ecosystem [27, 28].

Tolvanen et al. [29] reviewed 127 publications on the changes that mining indices on the Arctic region and concluded that the environmental impact of mining operations is negative and often long-term.

Nielsen et al. [30] examined how surface mining affects the wild fauna habitats and proved that it destroys forests, which are a sine qua non condition of wild animal life [30]. Knopff et al. [31] studied the effect of mining industry on biodiversity in areas of actively developing coal mining.

Colin et al. [32] showed various risks created by mining industry and deforestation. They proved that mining degrades and / or destroys wildlife habitats. Wanghe et al. [33] revealed a correlation between the state of mountain surfaces, panda populations, their habitats, and protected areas. The scientists used an applied spatial analysis to study official data on mining areas. Pandas appeared to prefer more comfortable habitats outside mining sites.

Poole et al. [34] also presented some effects of coal mining on the animal world [34]. The authors proposed to use GPS collars and performed an analysis of resource selection functions to study routes and habitat choice of mountain sheep.

Müller et al. [35] applied both traditional and advanced animal monitoring methods to study how red deer choose their habitats in a former brown-coal-mining area in Denmark. They registered animal faeces and used camera traps. The authors proved that the mining changed the natural environment dramatically. Asr et al. [36] considered mining industry in the aspect of sustainable development. They studied the positive and negative impacts of this industry on three key principles of sustainable development: society, economy, and environment.

There has been some related research that featured the territory of the Kemerovo region, for instance, on the anthropogenic load and the ecological potential of Kuzbass [37]. The author attempted
to evaluate the damage to land resources based on the standard methodology for assessing the need for investment in the sphere of environmental protection.

Kovalev et al. [38] acknowledged coal mining as a key sector of Russian and Kuzbass economy. The authors described Kuzbass as a coal-mining region with a complex of unsolved environmental problems. Kosinskiy et al. [39] developed a new methodology for assessing the impact of mining industry on local environment and economy.

Thus, the man-induced impact on wildlife habitat is a popular subject of various scientific approaches and studies. Awareness of the balance between the animal population size and the current environmental conditions serves as a starting point for hunting management. It makes it possible to perform an accurate economic assessment of hunting grounds and the damage that coal mining induces to the animal world.

The current research objective was to assess the population dynamics of several large game species taking into account the factors of forest coverage and coal mining in the hunting grounds of the Kemerovo Region (Kuzbass).

2. Results and discussion

The study was based on data that make it possible to reveal some patterns of increase and / or decline in the number of animals on the territory of the Kuzbass hunting grounds. The data on the forest coverage were obtained during expeditions to the hunting grounds of the Kemerovo region. The Kemerovo Region Department of Wildlife Protection provided the necessary information on the landscape characteristics and coal-mining licenses [40].

The research featured two municipalities, namely Novokuznetsk and Prokopyevsk municipal districts. According to preliminary data, they are responsible for the largest number of coal mining licenses. The tables below illustrate the geographical position of the municipalities, their natural conditions, hunting grounds, and hunting resources. Particular attention is paid to the factors of forest coverage and coal mining. Table 1 shows the number of coal-mining licenses.

**Table 1.** Hunting grounds and the number of coal-mining licenses in the Novokuznetsk municipal district.

| Municipality          | Catchment hunting grounds          | Area of the hunting grounds, ha | Number of coal-mining licenses, pcs | Area (including overlapping territories), ha |
|-----------------------|------------------------------------|---------------------------------|-------------------------------------|---------------------------------------------|
| Kondomsko-Kuzedeevsky ranger district | 87.999                            | 0                               | 0                                   | 0                                           |
| Nikolaevsky ranger district          | 39.832                            | 2                               | 0                                   | 0                                           |
| Nikolsko-Krasulinsky ranger district  | 27.707                            | 15                              | 4150                                |                                              |
| Hunting establishment "Verkhone-Tersinskoe" | 44.417                        | 2                               | 2081                                |                                              |
| Hunting establishment "Kundel"       | 34.252                            | 1                               | 155                                 |                                              |
| Hunting establishment "Mrasskoe"     | 86.484                            | 1                               | 51                                  |                                              |
| Hunting establishment "Myskovskoe"   | 49.607                            | 6                               | 3419                                |                                              |
| Sarbalinsky ranger                 | 37.251                            | 14                              | 7730                                |                                              |
Table 1 shows that the Novokuznetsk municipal district contains 11 catchment hunting grounds. As a rule, catchment, or assigned hunting grounds are officially exploited by legal entities or individual entrepreneurs.

The Kondomsko-Kuzedeevsky ranger district is the only hunting ground in the entire territory that is free from coal-mining licenses. Its area occupies 87,999 hectares. The area of the Sidorovsky ranger district is 87.186 hectares and has the largest number of coal mining licenses – 14. Its area, including overlapping territories, is 19.309 hectares.

However, a coal-mining license for a particular territory does not necessarily mean that the area is being mined. As a rule, it means that this opportunity can be realized in the long term. Therefore, the risk of environmental damage still remains.

Table 2 shows the ratio of the forest coverage level and the population size of large ungulates in the Novokuznetsk municipal district in 2015-2019.

Table 2. Forest coverage vs. large ungulate population in the Novokuznetsk Municipal District in 2015 – 2019

| Novokuznetsk Municipal District | Population of large ungulates, animals | Forest coverage level of the total area of the catchment hunting grounds, ha |
|--------------------------------|---------------------------------------|--------------------------------------------------|
| 2015                           | 410                                   | 719.897                                           |
| 2016                           | 1016                                  | 719.357                                           |
| 2017                           | 1066                                  | 718.087                                           |
| 2018                           | 1297                                  | 717.019                                           |
| 2019                           | 1171                                  | 716.354                                           |

The data obtained revealed a curious contradiction: the population of large animals keeps increasing from year to year, while the level of forest coverage is gradually falling. Unfortunately, the information we possess is not sufficient to explain this phenomenon. The issue requires a more detailed study.

Table 3 shows the population dynamics of various species of large ungulates in the Novokuznetsk region in 2015-2019.

Table 3. Population dynamics of large ungulates in the Novokuznetsk region in 2015 – 2019

| Population size, animals | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------|------|------|------|------|------|
| Wild boar                | 0    | 0    | 36   | 94   | 54   |
| Siberian roe deer        | 9    | 0    | 0    | 0    | 59   |
| Elk                      | 382  | 994  | 965  | 1    | 929  |
| Red deer                 | 19   | 22   | 65   | 115  | 129  |

Source: Department of Wildlife Protection of the Kemerovo Region
The data show that the population of game animals keeps increasing from year to year. For instance, the elk population increased by 143% between 2015 and 2019. The irregular increase in the animal population and forest coverage can be explained by the on-going process of habitat change. The same methods of data description and analysis produced similar results for the Prokopyevsk municipal district. Table 4 shows the number of coal-mining licenses in this area.

Table 4. Hunting grounds and the number of coal-mining licenses in the Prokopyevsk municipal district

| Municipality        | Catchment hunting grounds | Area of the hunting grounds, ha | Number of coal-mining licenses, pcs | Area (including overlapping territories), ha |
|---------------------|---------------------------|---------------------------------|-------------------------------------|---------------------------------------------|
| Prokopyevsk         |                           |                                 |                                     |                                             |
| Kutonovsky ranger district | 49.987                   | 10                              | 6.400                               |                                             |
| Mikhailovsky ranger district | 43.421                   | 0                               | 0                                   |                                             |
| Sergeevsky ranger district | 24.383                   | 4                               | 2.256                               |                                             |
| Taldinsky ranger district | 38.314                   | 35                              | 14.782                              |                                             |
| Ust-Naryksky ranger district | 26.201                   | 2                               | 1.876                               |                                             |
| Tereshsky ranger district | 24.913                   | 0                               | 0                                   |                                             |

Source: Department of Wildlife Protection of the Kemerovo Region

Table 4 shows that the Prokopyevsk municipality has six catchment hunting grounds, the Mikhailovsky and Tereshsky ranger districts being the only hunting grounds with no coal-mining licenses issued. The area of the Mikhailovsky ranger district is 43,421 hectares. The Tereshsky ranger district is 24,913 hectares. Taldinsky ranger district (38,314 hectares) boasts the largest number of coal mining licenses (35). Its area is 38,314 hectares (14,782 hectares with overlapping territories).

Table 5 demonstrates the ratio between the forest coverage level and the population size of large ungulates in the Prokopyevsk municipal district in 2015 – 2019.

Table 5. Forest coverage vs. large ungulate population in the Prokopyevsk Municipal District in 2015 – 2019

| Prokopyevsk Municipal District | Population of large ungulates, animals | Forest coverage level of the total area of the catchment hunting grounds, ha |
|-------------------------------|----------------------------------------|--------------------------------------------------|
| 2015                          | 1                                      | 175.720                                           |
These data are similar to those obtained from the Novokuznetsk Municipal District. There is also the same discrepancy between the population dynamics of large game animals and the level of forest coverage.

Table 6 shows the population dynamics for various species of large ungulates in the Prokopyevsky district in 2015 - 2019.

Table 6. Population dynamics of large ungulates in the Prokopyevsk region in 2015-2019

| Population size, animals | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------|------|------|------|------|------|
| Siberian roe deer        | 0    | 8    | 8    | 3    | 10   |
| Elk                      | 1    | 40   | 81   | 90   | 121  |
| Red deer                 | 0    | 0    | 0    | 0    | 5    |

Source: Department of Wildlife Protection of the Kemerovo Region

Table 6 clearly shows that the population dynamics of large game species also increased in this area during the specified period. For example, the elk population increased by 120% between 2015 and 2019. This indicator proved to be a common point in the studied territories.

3. Conclusion

The territory of the Kemerovo region experiences a severe coal-mining load. The exploitation of coal resources raises a number of environmental problems. Coal mining companies continue to develop new coal deposits. The life cycle of a coal mine is a complex system that functions within the single infrastructure of organizational, economic, and financial management. For a coal mine to function effectively, the company has to build railways and highways, transport large mining equipment, etc. Researchers study the impact of coal mining on the local environment in order to assess the loss of biodiversity and calculate the ratio of economic and environmental aspects in the nature management.

The present analysis revealed that the irregular and uneven growth and / or decline in the animal population on the Kuzbass hunting grounds is associated with the negative impact of coal mining, deforestation, and destruction of migration routes. The results of assessing the current state of hunting grounds provided a better understanding of the patterns in the landscape alteration processes and their impact on Kuzbass ecology.

The two municipalities appeared to differ in the number catchment, or assigned hunting grounds and coal mining-licenses. The research revealed one common indicator: the contradiction between the population of large animals that increases from year to year and the gradually decreasing level of forest coverage. Unfortunately, the available information was not enough to explain this phenomenon. To a certain degree, the ratio may be explained by the inaccuracy of traditional animal count methods or a human error, etc. In the long term, the increasing animal populations are likely to need larger habitats. However, such problem statement means that a more detailed study of this phenomenon is required.

Unfortunately, animal counts are never one hundred percent accurate – for various reasons, including the fact that they take place in areas affected by extensive coal-mining. However, the censuses can reveal the trends and dynamics of the ongoing changes in population size and habitat. An effective control of large animals in coal mining areas requires a special monitoring methodology that
combines different accounting methods in order to obtain the most reliable information. We believe that the most promising and reliable way is to combine traditional winter route counts, interviews with experts that are familiar with a particular territory, and advanced monitoring by unmanned aerial vehicles.

Reference

[1] Ranjan A K, Sahoo, D and Gorai, A K 2020 Environ Dev Sustain [https://doi.org/10.1007/s10668-020-00784-0]

[2] Gang C, Zhao W, Zhao T, Zhang Y, Gao X and Wen Z 2018 Sci Total Environ. 645 827–836.

[3] Beygi Heidarlou H, Banj Shafiei A, Erfanian M, Tayyebi A and Alijanpour A, 2019 Land use policy. 81 76–90.

[4] Maina B, Confort C A and Aliyu, K Glob J 2016 Anim Breed Genet. Publisher: Global Journals Inc. (USA). Online ISSN: 2249-460x.

[5] Farvacque M, Lopez-Saez J, Corona C, Toe D, Bourrier F and Eckert N 2019 Glob Planet Change. 174 138–152.

[6] Wickham J, Wood P B, Nicholson M C, Jenkins W, Druckenbrod D, Suter GW, Strager M P, Mazzarella C, Galloway W and Amos J 2013. Bioscience 63 335–348.

[7] Weir J N, Mahoney S P, McLaren B and Ferguson S H 2009 Wildlife Biol 13 66–74.

[8] Larkin J L, Maehr D S, Krupa J J, Cox J J, Alexy K, Unger D E and Barton C 2008 Southeast Nat 7 401–412.

[9] Ardente N C, Ferreguetti A C, Gettinger D, Leal P, Mendes-Oliveira A C, Martins-Hatano F and Bergallo H G 2016. PLoS One 11(11) e0167266.

[10] Fraser L H, Harrower W L, Garris H W, Davidson S, Hebert P D N, Howie R, Moody A, Polster D, Schmitz O J, Sinclair A R E, Starzomski B M, Sullivan T P, Turkington R and Wilson D 2015. Restor Ecol 23 503–507

[11] Jones M E and Davidson N 2016 Restor Ecol 24 836–842

[12] Beale M M and Boyce, M S 2020 Restor. Ecol. 28(4) 828–840.

[13] Bobek B, Merta D and Furtek J 2016 For Ecol Manage 359 247–255.

[14] Davis A J, Leland B, Bodenchuk M, Vercauteren K C and Pepin K M 2017 Prev. Vet. Med. 14 33–37.

[15] Found R and Clair C C St 2016 Anim Behav. 115 35–46.

[16] Sieber A, Uvarov N V, Baskin L M, Radeloff V C, Bateman B L, Pankov A B and Kuemmerle T 2015 Biol. Conserv. 191 567–576.

[17] Valente A M, Binantel H, Villanua D, Acevedo P, 2018 Z. Saugetierkd. 91 23–29.

[18] Havens K J and Sharp E J 2016 Elsevier Inc., Academic Press. [https://doi.org/10.1016/C2014-0-03312-6].

[19] Buxton R T, Lendrum P E, Crooks K R and Wittemyer G 2018 Global Glob Ecol Conservative 16 e00493.

[20] Keeping D, Burger J H, Keitsile A O, Gielen M, Mudongo E, Wallgren M, Skarpe C and Foote A L 2018. Botswana. Biol. Conserv. 223 156–169.

[21] Xu B, Wang W, Falzon G, Guo L, Chen G, Tait A and Schneider D 2020 Comput Electron Agric. 171 105–300.

[22] Shao W, Kawakami R, Yoshiihishi R, You S, Kawase H and Naemura T 2020. Int. J. Remote Sens. 2020 41 31–52.

[23] Ezat M A, Fritsch C J, Downs C T 2018. Biol Conserv. 223 76–81.

[24] Bayarbaatar B, Mueller T, Strindberg S, Leimgruber P, Petra Kaczensky P and Fuller T K 2016. Biol Conserv 203 168-175.

[25] Benjamin M, Al-amin C C and Kachalla A 2016 Global Journal of Human-Social Science Research 16(3) Global Online ISSN: 2249-460x. Journals Inc. (USA).

[26] Niningsih L, Alikodra H S, Atmoko S S U and Mulyani Y A 2017 Indonesia Jurnal Manajemen Hutan Tropika 23(1) 37–49.
[27] Ranjan A K, Anand A, Vallisree S and Singh K R 2016 AIMS Geosciences 2(4) 273–285.
[28] Goparaju L, Prasad P R C and Ahmad F 2017 Present Environment and Sustainable Development 11 219–238.
[29] Tolvanen A, Eilu P, Juutinen A, Kangas K, Kivinen M, Markovaara-Koivisto M, Naskalie A, Salokannel V, Tuulentie S and Similä J 2019 Journal of Environmental Management 233 832-844
[30] Clayton K, Nielsen C K and Kelly, V L 2016 Journal of Contemporary Water Research & Education 157(1) 23-32
[31] Knopff K H, Franklin C W, Luini G L and Vasiga D J 2018 British Columbia Mine Reclamation Symposium University of British Columbia. (Vancouver : University of British Columbia Library). PDF File. 16 pp.
[32] Colin G 2018 Scanes Animals and Human Society (United States: Academic Press). pp. 451–482
[33] Wanghe K, Guo X, Hu F, Ahmad S, Jin X, Khan T U, Xiao Y and Luan X 2020 Biol Conserv 247 108600
[34] Poole K G, Serrouya R, Teske I E and Podrasky K 2016 Can J Zool 94(11) 733–745.
[35] Müller A, Dahm M, Böcher P K, Root-Bernstein M, Svenning J C 2017 PLoS One 12(5) e0177431.
[36] Asr E T, Kakaie, R, Ataei M, Mohammadi M R 2019 J Clean Prod 229 213–231.
[37] Sagdeeva L, Starikova L and Trapeznikova I 2019 E3S Web of Conf. vol 105 (Kemerovo: Gorbachev Kuzbass State Technical University) 2 04008
[38] Kovalev V, Khoreshok A and Litvin O 2016 Proceedings of the 8th Russian-Chinese Symposium “Coal in the 21st Century: Mining, Processing, Safety”. vol 92 editor Oleg V. Tailakov, Vice-Rector on Research and Strategic Development, KuzSTU. (Kemerovo: Atlantis Press). pp. 287–290.
[39] Kosinskiy P, Merkuriev V and Medvedev A 2019 E3S Web of Conf. vol 134 03009.
[40] Department of Wildlife Protection of the Kemerovo Region [Online]. http://depoozm.ru.