Methodology for estimating the cadastral value of real estate objects when creating the Krapivinsky reservoir

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Abstract. The authorities of Kuzbass drew attention to the objects of the Krapivinsky hydroelectric complex in 2019 that is 30 years after the suspension of construction. It was decided to assess the environmental impact and choose one of the following options for completing the construction of the Krapivinskaya HPP on the Tom River: zero option (refusal of completion), refusal of completion with liquidation of unfinished construction objects, option of completion to the project parameters of 1976 and option based on the results of basic technical solutions development in 2021. The initiative to consider the possibility of completing for the Krapivinskaya HPP construction in the current socio-economic conditions prevailing in the region will not only become an important incentive to study the prospects for the development of the region, but will also determine the priorities for radically improving the state of natural surface waters and living conditions of the population. However, the design of a hydroelectric power plant is a process that requires a comprehensive assessment of objects that will be in the zone of its influence. Some of those objects are flooded real estate objects. In the course of the study, calculations for real estate objects (land plots and capital construction projects) that will be in the flood zone are presented at elevations of 175.0 m and 177.5 m above sea level in the Baltic Elevation System of 1977. This work presents the results of cadastral value assessment for the real estate that will be flooded.

Keywords: Krapivinsky reservoir · Krapivinskaya HPP · Kemerovo region – Kuzbass · Environmental impact assessment · Real estate objects (land plots, capital construction projects) · Green energy.

1. Introduction

The construction of large industrial facilities requires an environmental impact assessment (EIA) and the damage caused to the territory where they are located. The natural and social environment of the territory is subject to various kinds of assessment. It should be noted that there is no unified methodological framework that allows conducting an EIA and determining all types of economic damage from the construction of hydroelectric power plants and reservoirs, therefore, the choice of a

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suitable methodology is a debatable issue throughout the entire course of the project for the construction of the Krapivinskaya hydroelectric power plant on the Tom River in Kuzbass.

This hydroelectric unit was intended for seasonal regulation of the Tom River flow for the purpose of water resources integrated use according to the project of the Kazakh branch of the Gidroproekt Institute (1975-1976). The construction of the waterworks continued until 1989. At that time, the work was completed by almost 60%, there were 1.5-2 years left to launch generators. The suspension of the Krapivinskaya hydroelectric power plant construction occurred due to the negative conclusion of environmentalists in connection with the failure to fulfill one of the main conditions of construction – wastewater treatment above the dam (Kezina, 2021).

Measures to resume work on the completion of hydroelectric power plant construction have been taken since 1998. The cost of facilities construction completion using the main hydro-power and electrical equipment was determined taking into account updated information on water-power and energy-economic calculations after assessing the cost of the main hydropower equipment in 2019. It amounted to 45.07 billion rubles in prices of 2019 (including VAT, without the costs of preparing the reservoir territory). The estimated cost of Krapivinskaya HPP facilities liquidation amounted to 17.24 billion rubles at the same price level (Jurkevichet al., 2021). The results obtained allowed to make a decision on the expediency of carrying out further steps to implement the project of completing the construction of the Krapivinskaya hydroelectric power plant on the Tom River, including the resumption of the EIA procedure.

At the moment, the Center for Collective Use of Scientific Equipment from Kemerovo State University is developing a methodology for evaluating the effectiveness of the Krapivinskaya HPP construction. The staff of the Center carried out topographic and geodetic works in order to assess the cadastral value of real estate objects affected by the creation of the Krapivinsky reservoir on the Tom River using aerial photography and aerial laser scanning of the territory, performed in 2021.

2. Materials and Methods

A study based on the intersection was conducted to determine the real estate that will be in the flood zone. The data was processed in the Quantum GIS software, based on information about vector layers from the cadastral plans of territories (CPT), contained in the Unified State Register of Real Estate Objects (EGRN) and vector layers of projected flood zones at elevations of 175.0 m and 177.5 m (Federal Service for State Registration, Cadastre and Cartography, 2021).

The calculation of the total area and percentage of the flooded area was made for each land plot where borders were defined (Olfat et al. 2019). Further adjustment of the land plot cadastral value was carried out on the basis of flooded territory percentage in order to account only for its eliminating part (Public cadastral map of Russia, 2021). For each capital construction project, which was defined with the borders and which supposed to be in the flooding zone, the flooding area was recognized as equal to its entire area, since if the capital construction project went into the flooding zone, it was eliminated completely from economic activity (Galchenko et al., 2021).

The area of flooding for the cadastral plan of territories (CPT) where they were located was calculated for real estate objects with undefined borders. If the percentage of CPT flooding was more than 95%, such real estate objects located there were taken into account in the sample as flooded, otherwise, the real estate objects were considered as not going into the flooding zone (Kirichek and Grianyk, 2018). At the same time, the area of flooding for those real estate objects was calculated on the basis of the area indicated in the EGRN data. The adjustment of the area and cadastral value by the percentage of CPT flooding was carried out for land plots where the borders were defined. Capital construction projects with undefined borders were taken into account without adjustments for the percentage of flooding. The logical scheme of real estate objects selection is shown in Fig. 1.

The intersection of flood zones with open vector-format spatial data contained in the OpenStreetMap (OSM) information resource was also carried out during the determination of flooded capital construction projects (Sternik et al., 2021). Therefore, the information of this resource does not have an appropriate legal basis, however, it may contain data that is not available in official sources

(Galchenko et al., 2020). Comparison of the calculations obtained using the OSM information resource with the results based on the data of the official source – the EGRN – was carried out to obtain complete information (OpenStreetMap, 2021).

In addition, the calculation of CPT flooding area, where there were no registered real estate objects, was carried out (Komarov et al., 2019).

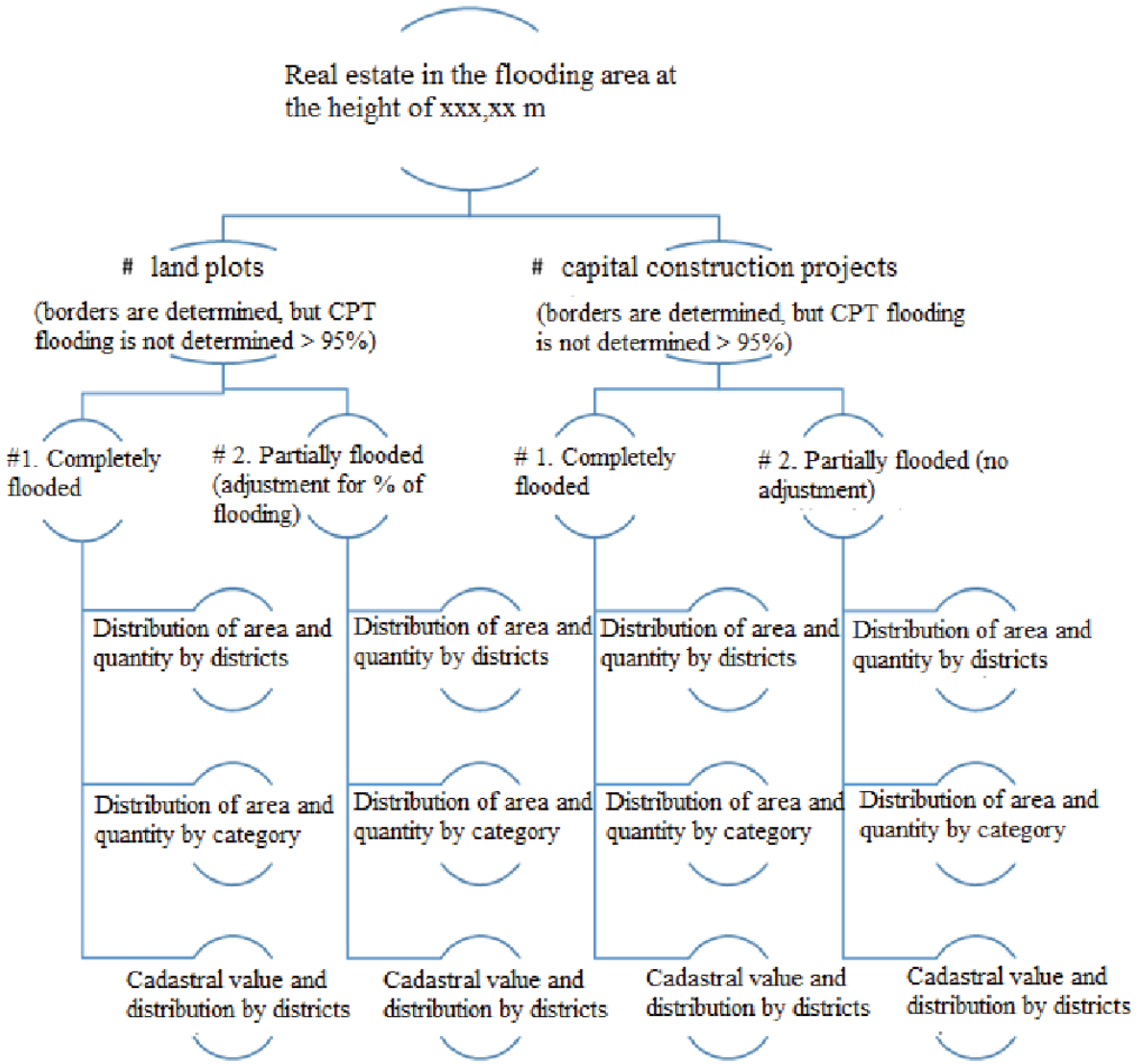

Fig. 1. Scheme of selection for real estate objects that will be in the flood zone for further analysis of their parameters. *Source:* Compiled by the authors.

3. Results and Discussion

The results of real estate objects study for the flooding area with brake down by territorial feature.

At a height of 175.0 m, flooding of land plots will affect the Belovsky, Krapivinsky and Novokuznetsky districts of the Kemerovo region, while the Novokuznetsk district will suffer the most in terms of the area of flooding (79865400.79 m^2). Nevertheless, when calculating the total cadastral value of land plots, more damage will be caused to the Krapivinsky district (55.21 million rubles), including when calculating the cadastral value of land plots that will go into the flood zone completely (11.39 million rubles), which makes them absolutely unsuitable for further use. When choosing this

flood elevation, it is necessary to take into account the interests of business and residents of the Krapivinsky district as the party to which the maximum economic damage will be caused.

At a height of 177.5 m, in addition to the above-mentioned areas, flooding of land plots will additionally affect the Prokopyevsky district of the Kemerovo region, but the damage to it will be insignificant. At the same time, the Novokuznetsk district will also suffer the most in terms of completely and partially flooded areas (92127275.7 m^2, +15.35%). Due to the flood elevation increase, this territory will lose valuable land plots that will go into the flooding zone not only partially (increase in the cadastral value to 29.89 million rubles, +32.03%), but completely, which is even more important (increase in the cadastral value to 15.52 million rubles, +75.15%). When choosing this flood elevation, it is necessary to take into account the interests of business and residents of the Novokuznetsky district as the party to which the maximum economic damage will be caused.

At heights of 175.0 m and 177.5 m the flooding of capital construction projects will affect only the Krapivinsky and Novokuznetsky districts of the Kemerovo region, but it should be noted that unlike land plots that are still usable being partially flooded, capital construction projects are completely eliminated from economic activity.

In both cases, the Novokuznetsk district has the biggest damage from capital construction projects flooding (the area of flooded capital construction projects at a hight of 175.0 m is 2106.96 m^2; at a height of 177.5 m is 2366.35 m^2 (+12.31%); the total cadastral value of such objects at a hight of 175.0 m is 19.28 million rubles; at a hight of 177.5 m is 22.32 million rubles (+15.75%)). At the same time, due to the elevation increase, this territory will lose capital construction projects that will be completely flooded (increase in the cadastral value to 11.79 million rubles, +34.7%).

The results of real estate objects study for the flooding area with brake down by categories of land and capital construction projects.

The land plots that will be in the flood zone are of the greatest interest depending on the category of land from the point of view of managerial decisions on the Krapivinskaya HPP construction completion on the Tom River.

A large proportion of flooded lands at elevations of 175.0 m and 177.5 m are forest lands (86.74% and 84.46%, respectively), the area of which is occupied by secondary forest and shrub vegetation that covered areas of logging and forest cleaning performed in the 80s of the twentieth century (Kovyazin et al., 2021). The lands of specially protected territories and objects with an area of 19907.4 m^2 are partially flooded with an increase in the flood elevation. Bungarapsko-Azhendarovsky and Saltymakovsky state nature reserves of regional significance located on the lands of the Krapivinsky and Belovsky districts of the Kemerovo region will also be in the flood zone. The purpose of the creation for these nature reserves is preservation of biological diversity in the Kemerovo region, including the protection and reproduction of wild animals classified as hunting objects, protection of their habitats, conservation and restoration of numerous rare and endangered species of fauna and flora (On provision of information for engineering and environmental surveys…, 2018). Therefore, the creation of the Krapivinsky reservoir on the Tom River will negatively affect the flora and fauna of the flooded and adjacent territories (Zhichkin et al., 2020).

The flooding area of agricultural land increases at the height of 177.5 m: from 13.05% to 15.3%. In order to avoid negative impact of the flooding to the region's food security it is necessary to pay attention to the qualitative composition of such lands (Sorokina et al., 2019).

As for the lands of settlements, according to 2017 data, just over 1,200 people live on their territory. Despite the small population, the social aspect is one of the most important, since it leads not only to a change of residence, but often to the need of change the occupation and the usual way of life for the displaced population, who, for the most part, are employed in budgetary institutions and enterprises of the forest complex (Jurkevich et al., 2021).

4. Conclusion

Flooding of 303 land plots and 74 capital construction projects with a total area of 153905028.34 m^2 and 3614.71 m^2, respectively, was determined at the height of 175.0 m. The

cadastral value of land plots adjusted for the percentage of flooding is 86.8 million rubles. The cadastral value of flooded capital construction projects is accepted without adjustment and amounts to 30.7 million rubles.

Flooding of 358 (+18.2%) land plots and 78 (+5.4%) capital construction projects with a total area of 169767699.86 m^2 (+10,3%) and 3874.11 m^2 (+7.2%) respectively, was determined at the height of 177.5 m. The cadastral value of land plots adjusted for the percentage of flooding is 101.9 million rubles (+17.4%). The cadastral value of flooded capital construction projects is accepted without adjustment and amounts to 33.7 million rubles (+9.8%).

The work results represent one of the main components in the comprehensive EIA of the Krapivinskaya HPP construction completion on the Tom River and can serve as a starting material for subsequent management decisions on the creation of the Krapivinsky reservoir.

Acknowledgments

The research was conducted on the premises of the Research Equipment Sharing Center of Kemerovo State University, agreement No. 075-15-2021-694 dated August 5, 2021, between the Ministry of Science and Higher Education of the Russian Federation (Minobrnauka) and Kemerovo State University (KemSU) (contract identifier RF----2296.61321X0032).

References

1. Federal'naya sluzhba gosudarstvennoi registratsii, kadastra i kartografii [Federal Service for State Registration, Cadastre and Cartography] (2021). Accessed on: October 25, 2022. [Online]. Available: https://rosreestr.gov.ru/
2. S.A. Galchenko, D.V. Antropov, S.I. Komarov, R.V. Zhdanova, R.A. Kirillov, IOP Conf. Ser. Earth Envir. Sci. **579(1)**, 012149. (2020). https://doi.org/10.1088/1755-1315/579/1/012149
3. S.A. Galchenko, R.V. Zdanova, N.P. Ruleva, M.A. Smirnova, IOP Conf. Ser. Earth Environ. Sci. **867(1)**, 012149 (2021). https://doi.org/10.1088/1755-1315/867/1/012149
4. B.N. Jurkevich, A.A. Zhevlakov, V.A. Lvovskij, Predvaritelnaya otsenka vozdeistviya na okruzhayushchuyu sredu zaversheniya stroitelstva Krapivinskoi GES na r. Tom [Preliminary Environmental Impact Assessment of the Completion of the Krapivinsky HPP on the Tom River] (Lengidroproekt, 2021). Accessed on: October 25, 2022. [Online]. Available: https://ako.ru/upload/medialibrary/bf2/Приложение%201_2198-8-1-OBOC.PDF
5. A. Kezina, Vlasti Kuzbassa rasskazali o riskakh i plyusakh stroitelstva Krapivinskoi GES [Kuzbass authorities spoke about the risks and advantages of the construction of the Krapivinsky HPP] (2021). Accessed on: October 25, 2022. [Online]. Available: https://goo.su/Lu7JaX
6. Yu.O. Kirichek, V.A. Grianyk, Bul. Transnistria State Aca. Civil Eng. Architec. **5**, 42-46. (2018). https://doi.org/10.30838/J.BPSACEA.2312.271118.42.364
7. S.I. Komarov, D.V. Antropov, A.A. Varlamov, S.A. Galchenko, R.V. Zhdanova, IOP Conf. Ser. Earth Environ. Sci. **350(1)**, 012060 (2019). https://doi.org/10.1088/1755-1315/350/1/012060
8. V.F. Kovyazin, A.A. Kitsenko, S.O.R. Shobairi, J. Mining Inst. **249**, 449-462 (2021). https://doi.org/10.31897/PML2021.3.14
9. Pismo ot 20 fevralya 2018 g. n 05-12-32/5143 o predostavlenii informatsii dlya inzhenerno-ekologicheskikh izyskanii [On provision of information for engineering and environmental surveys (Letter No. 05-12-32/5143)] (2018). Accessed on: October 25, 2022. [Online]. Available: https://rulaws.ru/acts/Pismo-Minprirody-Rossii-ot-20.02.2018-N-05-12-32_5143/
10. H. Olfat, A. Jani, D. Shojaei, A. Darvill, M. Briffa, A. Rajabifard, F. Badiee, Land Use Policy **83**, 84-94 (2019). https://doi.org/10.1016/j.landusepol.2019.01.037
11. OpenStreetMap (2021). Accessed on: October 25, 2022. [Online]. Available: https://www.openstreetmap.org/
12. Publichnaya kadastrovaya karta Rossii [Public cadastral map of Russia] (2021). Accessed on: October 25, 2022. [Online]. Available: https://pkk.rosreestr.ru/

13. O.A. Sorokina, L.E. Petrova, A.V. Dontsov, A.V. Fedorinov, D.V. Antropov, IOP Conf. Ser. Earth Environ. Sci. **350(1)**, 012070 (2019). https://doi.org/10.1088/1755-1315/350/1/012070
14. S. Sternik, I. Gareev, T. Akhmetgaliev, SHS Web of Conf. **106**, 10012 (2021) https://doi.org/10.1051/shsconf/202110601012
15. K. Zhichkin, V. Nosov, L. Zhichkina, M. Alborova, A. Kuraev, E3S Web Conf. **175**, 06014 (2020). https://doi.org/10.1051/e3sconf/202017506014