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CARBON FOREST PROJECTS IN THE CONTEXT OF ENVIRONMENTAL MANAGEMENT EFFICIENCY

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Abstract: Carbon Forests Projects (CFPs) play a significant role in climate change mitigation strategies. Implementation of such projects should bring environmental benefits to companies, as well as contribute to improving the environmental management efficiency in the region. The aim of this paper is to analyze the possibility of developing CFPs as a tool to achieve carbon neutrality, taking into account its environmental and economic benefits. The analysis is undertaken on the example of the Bystrinsky Mining and Processing Plant (MPP), located at the Zabaykalsky Krai (southern Siberia, Russia). The ability of the forest lands to absorb greenhouse gas emissions is assessed using the ROBUL methodology. An important feature of CFPs is the ability to combine a positive environmental effect by contributing to climate change mitigation with strengthening the image of an environmentally friendly company. However, the analysis of CFPs implementation in the example of Bystrinsky MPP shows the excess of costs over benefits. In this regard, more effective projects can be proposed for regions with a high degree of forest cover, such as Zabaikalie. Reducing the risk of forest fires in such regions can have a more tangible environmental impact by preventing additional CO_2 emissions. Identifying and comprehensively assessing the environmental and economic impacts of CFPs in the context of carbon neutrality facilitates the selection of the most relevant solutions.

Keywords: climate change; carbon footprint; Carbon Forest Projects; Zabaykalsky Krai, environmental management efficiency

1. Introduction

In light of global initiatives on decarbonization, such as the UN 2030 Agenda (United Nations General Assembly, 2015) and the Paris Agreement (United Nations Framework Convention on Climate Change [UNFCCC], 2015), Carbon Forests Projects (CFPs) envisaged to play a crucial role in national climate change mitigation strategies. Russia's decarbonization policy is based on the Strategy for Socio-Economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050 (Strategy 2050; Pravitel’stvo Rossijskoj Federacii, 2021) and the Climate Doctrine of the Russian Federation (Federal'naja sluzhba po gidrometeorologii i monitoringu okruzhajushhej sredy (Rosgidromet), 2023), and focuses on coordinating national legislation to climate goals.

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Specifically, the Strategy 2050 defines measures to ensure the reduction of greenhouse gas (GHG) emissions to 70% by 2030 relative to the 1990 level, taking into account "the maximum possible absorption capacity of forests and other ecosystems, and on the condition of sustainable and balanced socio-economic development of the Russian Federation" (Pravitel'stvo Rossijskoj Federacii, 2021, p. 10). In this regard, the relevance of mechanisms for achieving carbon neutrality at the corporate level, including CFPs, is growing.

The prevailing part of the world's terrestrial carbon is stored in forests, which cover about 31% of the land surface (Grafton et al., 2021). This is the reason to develop mechanisms aimed at the preservation of forested areas within Environmental, Social and Governance (ESG) concept framework (Krenke et al., 2021). The importance of strengthening cooperation with Asian countries, where the climatic agenda is actively promoted, encourages Russia to undertake efforts in this direction. For example, China's pilot quota trading market was officially launched in Shenzhen province in 2013 (Chen, 2023). The National Quota Trading System for carbon emissions announced by the Chinese State Committee for Development in December 2017 was officially launched in July 2021. Taking into account rapidly developing cooperation and interrelation between Russian and Asian markets (Eliseeva, 2022; Kai, 2022), CFPs remain highly relevant for Russian companies (Kuznetsov et al., 2022). Researches in the field of forest management widely consider the potential role of forest lands in climate change mitigation (Kaarakka et al., 2023; Lu et al., 2020; van Kooten et al., 2019; Zhou et al., 2017). CFPs can be considered as a tool of the carbon offset mechanisms that allow the reduction of a carbon footprint at the corporate level.

Environmental policy in Russia's regions focuses on activities aimed at carbon neutrality, including incentives to develop CFPs: as it is indicated in the Strategy 2050, the intensive scenario of the Russian economy's development provides for an increase in the absorption capacity of the managed ecosystems from the current 535 million t of CO_2 equivalent to 1,200 million t of CO_2 equivalent. In this regard, specific economic measures at the level of enterprises and companies should include activities on reforestation and afforestation, and forest protection from fires and from harmful organisms. The national priorities to maximize the carbon sequestration potential of national forests are aimed at strengthening institutional and investment support to state forest conservation initiatives, and forest-climatic projects based on public-private partnerships.

The climate policies of Russian companies in current conditions focus on the adaptation of international mechanisms to national legislation. One of such mechanisms is the Clean Development Mechanism (CDM; UNFCCC, 2013) aimed at the application of a baseline and monitoring methodology in order to determine the amount of Certified Emission Reductions (CERs) generated by a mitigation project activity (Galik et al., 2016). Methodology includes such categories as large-scale and small-scale afforestation and reforestation (A/R) CDM project activities. Since CO_2 from the atmosphere is removed and stored in form of biomass, these projects are fully compliant with the requirements of the Strategy 2050.

This paper considers the possibilities to include the CFPs into corporate policy and their effects for regional environmental management in line with national low-carbon strategy (Pravitel'stvo Rossijskoj Federacii, 2021). The aim of the study is to explore the environmental and economic aspects of CFPs implementation in regions with extensive forest cover typical for southern Siberia.

2. Materials and methods

2.1. Study area

The possibilities of developing the A/R CFPs as a tool of climatic policy were analyzed on the example of the Bystrinsky Mining and Processing Plant (MPP), a subsidiary of Public Joint Stock Company (PJSC) Mining and Metallurgical Company Norilsk Nickel. MPP Bystrinsky is located at the Gazimuro-Zavodskoy district of the Zabaikalsky Krai in the southern Siberia, Russia. The territory is mountainous and rugged, the prevailing heights are 900–1,100 m a.s.l. Permafrost in the area has an insular distribution locating mainly in negative landforms, the climate of the area is sharply continental (Bol'shaja rossijskaja enciklopedija, n.d.). The forest cover of the area is very extensive: the lands of the regional forest fund occupy more than 75% of the territory (Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018).

Figure 1. View on the MPP Bystrinsky's quarry.
Note. Adapted from "*Uvedomlenie o provedenii obshhestvenny`x obsuzhdenij*" [Notice of Public Discussion], by GRK Bystrinskoe, n.d.-a (https://www.grkb.ru/news-and-media/press-releases-and-news/uvedomlenie-o-provedenii-obshchestvennykh-obsuzhdeniy-/?sphrase_id=24734). In the public domain

According to the official information, MPP Bystrinsky "has obtained all the necessary permits from the Federal Agency for Subsurface Use (Rosnedra) to put the facilities into operation" in 2019 (GRK Bystrinskoe, n.d.-b). The production plant belongs to the first category of objects with a negative impact on the environment: the main activity here is the open-pit mining of iron ore and non-ferrous metals, therefore, the actions to mitigate the climate change is an urgent task.

2.2. Methodology

As mentioned above, the CDM methodology can be used as a base for the development of a methodological approach to the implementation of compensating A/R projects. CFPs are of exceptional importance for many regions of Russia due to natural conditions, such as volume of above-ground biomass, trees species and age characteristics, disturbed lands ratio and common land use structure, etc., and other characteristics of CFPs according to the CDM standard. The applicability of the CDM to CFPs implementation is determined by the ability to identify the type of A/R projects and the prevailing type of GHG mitigation actions depending on local landscape structure. The CDM also defines conditions under which the methodology is applicable, such as types of land valid to the CDM project activity, excluding wetlands, as well as physical parameters of the implementation and monitoring results (dynamics of the various categories of lands and forest fire areas, biomass growth coefficients, tree cover area and their diameter in sample plots, etc.; UNFCCC, 2013).

Within the framework of CDM methodology, proposed rules comprise the measures to protect existing forests, to preserve biodiversity for maximum carbon sequestration and to use natural restoration processes as much as possible. Among most significant recommendations are the need for a differentiated approach to assessing the territory for choosing a reforestation region, the importance of using sustainable plant material, the obligation of scientific research and monitoring of results and ensuring the economic sustainability of the project to obtain carbon credits, which will provide income from the reforestation project.

The ability of the forests located in Zabaikalsky Krai to absorb greenhouse gas emissions was assessed in accordance with the Methodology for quantifying the volume of greenhouse gas absorptions (Ministerstvo prirodnyh resursov i ekologii Rossijskoj Federacii, 2022), based on the ROBUL methodology developed by the Center for Ecology and Productivity of Forests of the Russian Academy of Sciences (Zamolodchikov, 2011). The ROBUL methodology is used from 2010 for reporting on the forestry sector in the National Greenhouse Gas Inventory (Federal'naja sluzhba po gidrometeorologii i monitoringu okruzhajushhej sredy (Rosgidromet), Institut global'nogo klimata i ekologii imeni akademika Ju.A. Izraelja (FGBU "IGKE"), 2018). In the frame of that work, the ROBUL system is subject to regular inspections by UNFCCC experts, which confirm the correctness of the system and its compliance with IPCC approaches (Zamolodchikov et al., 2018). The methodology is based on a conversion approach using the data on the volume reserves of stem wood, which are converted into a mass of organic matter or carbon with conversion coefficients. The carbon stock volume in forests wood was estimated, taking into account the conversion coefficients (Ministerstvo prirodnyh resursov i ekologii Rossijskoj Federacii, 2022) and the data on predominant tree species of the region (Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018; Equation 1):

$$CAP_{ij} = V_{ij} \cdot KAP_{ij} \quad (1)$$

wherein, CAP_{ij} is the carbon reserve in the aboveground phytomass of tree stands of age group i of the predominant breed j, tC; V_{ij} – the volume stock of stem wood of age group i of the predominant breed j, m^3/ha; KAP_{ij} – conversion coefficient for calculating the carbon reserve in the aboveground phytomass of age group i of the predominant breed j, tC/m^3.

Due to the wide variety of natural conditions in different zones of the territory of Russian Federation, a zonal-provincial differentiation was accounted, since carbon absorption varies depending on the natural zone, region, and climatic characteristics. According to the ROBUL methodology, the assessment of carbon reserves and budget is carried out for 4 pools: phytomass of the stand (tree tier), deadwood, litter, and soil organic matter.

According to the Forest Plan of Gazimuro-Zavodskoy district (Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018), the total area of forest lands in the region of research is 1,233,337 ha. Such tree species as pine and larch predominate among coniferous species in the region, and birch and aspen prevail among the small-leaved species (Table 1). As to conversion coefficients, they vary from 0.266 for the group of aspen young trees to 0.368 for larch growing trees (Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018).

Table 1. Data for calculating CO_2 absorption by selected area

Tree species	Land areas of different age plantings, ha						
	Total	Young trees			Medium-aged	Growing	Ripe and overgrown
		1 class	2 class	Total			
Larch	748,769	42,740	130,354	173,094	198,221	88,326	289,128
Pine	78,580	8,929	6,934	15,863	12,844	7,625	42,248
Birch	310,260	30,596	38,332	68,928	174,098	29,817	37,417
Aspen	42,850	9,035	9,331	18,366	19,662	3,102	1,720

Note. Data are from *"Lesnoy Plan I Lesokhozyaistvennye Reglamenty 2019–2028"* [Forest Plan and Forestry Regulations 2019–2028], by Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018 (https://minprir.75.ru/deyatel-nost/upravlenie-lesopol-zovaniya/131170-lesnoy-plan-i-lesohozyaystvennye-reglamenty-2019-2028-g-g). In the public domain

The main approaches to A/R projects implementation in Russia are described in the Decree of the Ministry of Natural Resources and Ecology (MNRE) No 1024 (Ministerstvo prirodnyh resursov i ekologii Rossijskoj Federacii, 2021). These approaches are consistent with the CDM methodology. Based on the data of GHG emissions, the potential to implement A/R projects was assessed and a methodology for CFPs development was refined.

To select the site which is most suitable for CFPs implementation (CFPs plot), the database was compiled using the information, provided by the Forestry Department of Zabaikalsky Krai. Such indicators as acceptable types of A/R projects, the category of lands, and the intended purpose were defined as the exclusion factors. As to the category of lands, only areas of the forest fund were considered. The limitation by intended purpose was accepted as operational forests. The indicators characterizing the potential of the sites are: fire hazard class, forest pathologic threat, protection of forests from fires, and transport accessibility. Identification of areas requiring reforestation must be undertaken according to the State Forest Register (Ministerstvo prirodnyh resursov i ekologii Rossijskoj Federacii, 2020). In order to select CFPs, a point assessment was applied. This kind of assessment was based on a number of indicators divided into two blocks: economic and environmental. Additional block of exclusion indicators was proposed with the purpose to exclude the areas unsuitable for the project realization (Table 2).

Table 2. Factors of cadastral plots evaluation

Factor	Criteria	Indicators
Economic	Transport accessibility	Length of roads (km per thousand ha)
	Protection of forests from fires	Method of fire detection and firefighting (aviation/ground)
Environmental	Forest pathologic threat	Probability of damage to forests by pathogenic organisms
	Fire hazard class	Probability of a fire on the territory (from weak to very high)
Exclusion	Purpose	Permitted use of a plot as a part of forest fund lands (only operational forests)
	Land category	Legal regime for the use of the territory (protected areas excluded)

3. Results and discussion

The main types of environmental impacts at the Bystrinsky MPP are caused by emissions from an open-pit mining of the quarry and dusting the surface of dumps and tailings. In this regard, PJSC Norilsk Nickel develops an environmental policy taking into account the specifics of divisions and reports annually on the goals of sustainable development (Nornikel, n.d.-b). According to the Report, the company's activities include projects on increasing the share of recycling and reuse of waste, developing closed water circulation systems and reducing greenhouse gas emissions by 25% until 2028. The company also evaluates the carbon footprint of its products. In a line of low-carbon development, PJSC Norilsk Nickel launched production of carbon neutral nickel in 2021 (Nornikel, n.d.-b).

Total production of iron ore at the Bystrinsky MPP was about 2 million t in 2020, and of copper concentrate—about 60 thousand t (Nornikel, n.d.-a). According to Sustainable Development Report 2023, the carbon footprint of copper production is 6.0 kg of CO_2-eq per 1 kg (Nornikel, n.d.-c). Open-pit mining of iron ore is accompanied by the emission of about 0.1 t of CO_2 per 1 ton (Obrazczov, 2021). Taking into account the data on the volumes of Bystrinsky MPP production (iron ore and copper concentrate) and on the carbon footprint of these products, the total emissions can be estimated at least in 0.5 million t of CO_2-eq. According to this estimation, the CFPs role in corporate climate policy was reviewed with attention to environmental and economic aspects.

To choose the most suitable plot, specific indicators, such as the location in relation to the road network, and the area of the plot were taken into account, as well as the excluding factors: types of A/R projects, land category, and intended purpose. On the basis of the average carbon stock value, the average annual carbon absorption by pools of phytomass and dead wood for every age group of the predominant species (tC/ha/year) was estimated. With average annual carbon absorption of 0.58 tC/ha/year on the territory of Gazimuro-Zavodskoy district, the total area of afforestation, required for natural absorption and full compensation of greenhouse gas emissions amounted to 80,600 ha.

The score rating, derived for the cadastral plots suitable for A/R projects, allowed to define the most appropriate plots within the research area. The assessment of the economic effect of the afforestation project was based on the difference in the level of carbon absorption with the implementation of the project and without implementation. According to the available data, the net carbon absorption by planting forest crops at the area of 100 ha for 20 years reaches 2.5 thousand tC or about 9 thousand t of CO_2 (Fomenko et al., 2022; Romanovskaya, 2023).

The maximum duration of climate projects with carbon absorption from the atmosphere can be 45 years (Smyth et al., 2018). According to known methodological approaches to CO_2 absorption projects, the difference between the situation "with" and "without" CFPs is about 960 tC from a 20-hectare plot (Fomenko et al., 2022). Since it is approximately 3,520 t of CO_2, its cost (based on quota price on the European market of 53.1 €/t of CO_2 in 2022) will be 16.2 million RUB.

To estimate the price of the project, the seeding material costs were calculated, as the main primary costs. Based on the Rules of afforestation, the ratio of tree species in the forestry must be saved in any project implementation (Ministerstvo prirodnyh resursov Zabajkal'skogo kraja, 2018). Since there should be at least 2,000 seedlings per ha, the total number of seedlings will be 40,000. The total cost of seedlings for the territory of the afforestation project will be 11,600,000 RUB, which is close to the carbon credit value. Taking into consideration additional risks associated with high probability of fires (Makarenko, 2022; Zengina et al., 2022) and price fluctuations in the carbon credits market (Blanc et al., 2018; Lyu et al., 2020), there is a necessity to develop measures of additional state support for CFPs to justify their ecological efficiency.

4. Conclusion

Assessment of economic and environmental aspects of CFPs potential shows that for MPP Bystrinsky case it may be more relevant to protect forests from fires as opposed to A/R projects. Fire protection activity is less costly, can be implemented in a shorter period of time, and therefore more effective taking into account the extremely high risk of fires in Siberia forests. The cost-benefit analysis of MPP Bystrinsky case shows a significant excess of economic costs over benefits. The profitability of CFPs in the regions of southern Siberia with high proportion of forest lands is more associated with the extension of managed forests, since it will increase the accuracy of the absorption potential estimation. Another important factor is the development of a system of carbon credits and quotas. Comprehensive consideration of the wide range of economic and environmental aspects of CFPs contributes to most effective solutions for both regional administrations and corporative governance.

The results of the study confirm the significance of accounting the geographical aspects for choosing the climate policy priorities in order to increase the environmental management efficiency. Certain limitations concern the need to take into account the absorption potential of the managed forests, while not all the forest lands in the study region belong to this category. Future research implies more detailed comparative analysis of the environmental and economic effects of various scenarios of CFPs implementation in regions with different natural and socio-economic conditions.

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