Contribution of the forests of the Republic of Buryatia to the development of a “green” economy

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Abstract. The article presents the results of a carbon balance study in the forests of the Republic of Buryatia based on the materials taking into account the state of the forest fund and key factors (logging, forest fires) that affect carbon absorption and emission. The research clearly demonstrates that the size of the carbon budget in the forests of the republic is determined by the current age structure of forests and the intensity of destructive disruptions because of carbon losses due to logging, forest fires, and the death of plantations. The carbon absorption by forests is characterized by relative stability. Despite the fact that the forests of Buryatia have a great potential for carbon absorption (deposition), the last one decreases in the context of increasing clear-cutting and fire exposure to forests.

1. Introduction

In international documents, a “green” economy is considered in a general way as an economy that improves people’s well-being and ensures social justice; at the same time, it significantly reduces risks to the environment and its impoverishment [1]. The forest sector in the implementation of the goals of a “green” economy takes a leading role due to the fulfillment of a complex of functions: economic, social, and environmental. The multifunctional nature of the country’s forest complex most fully corresponds to the principles of a “green” economy. Multifunctional character is expressed in the production of not only wood and non-wood products, but also in the provision of vital environmental and social services, such as biodiversity conservation, climate protection, soil, catchment basins, employment. Therefore, there is the task of measuring the contribution of the forest sector to the development of a low-carbon, environmentally friendly, and socially inclusive economy.

In December 2013, at a joint session of the Committee on Forests and Forest Sector of the UN Economic Commission for Europe and the European Forestry Commission of the UN FAO in the Finnish city of Rovaniemi, the Action Plan for the forest sector for the transition to a green economy was developed [2]. Our research objectives are based on the components of this Plan and on the mechanisms for measuring the contribution of the forest sector to the development of a green economy developed by the UNEP, OECD, World Bank, and other organizations collaborating in the framework of the “Green Growth Knowledge Platform” [3]. The work carried out in this area at the global level is consistent with efforts to ensure sustainable forest management, in particular with the criteria and indicators of the Montreal and Helsinki processes for assessing the achievement of sustainability.

According to component B “The low carbon forest sector Action Plan for the forest sector to transition to a green economy,” the contribution of forests and the forest sector to climate change...
mitigation is manifested through sequestration, carbon storage, as well as substitution and adaptation to it. However, this contribution is not uniform at the regional level. It depends on such factors as the forest area, species, age composition of plantations, the volume of logging, the effectiveness of fighting forest fires, etc.

2. Materials and Methods
The assessment of the contribution of forests and the forest sector of the Republic of Buryatia (RB) to the “green” economy was based on an assessment of the carbon budget. For its assessment, the methodology for regional assessment of the forest carbon budget (ROBUL) developed by the Center for Problems of Ecology and Forest Productivity (CEFP) of the Russian Academy of Sciences and Moscow State University was used [4]. The ROBUL methodology estimates the carbon budget of forests by the flow balance, i.e. by the difference in absorption with increasing carbon pools in forest plantations and losses due to disturbances (logging, fires and other cases of forest death). ROBUL calculations are carried out for 4 main pools of the forest carbon: phytomass, dead wood, litter, and soil organic matter. The choice of this technique is due to the fact that for the calculations of the carbon budget, the materials of the State Forest Register (SFR) are used. This technique has been tested by experts of the UNFCCC ONN and is used in the National Greenhouse Gas Cadastre of the Russian Federation for reporting on the forest sector.

The main source of information on forest resources in the RB is the SFR database as of January 1, 2007 and 2017. The increase in the forest fund of the republic by 1179.8 thousand hectares in 2017 (compared to 2007) is due to the transfer of former collective and state farm forests to the Rosleskhoz after 2007 (Table 1).

Table 1. Dynamics in the structure of forest land of the Republic of Buryatia.

| Land category                              | 2007  | %    | 2017  | %    |
|--------------------------------------------|-------|------|-------|------|
| Forested land, thousand hectares           | 19472.9 | 75.4 | 20493.6 | 75.9 |
| Uncovered land, thousand hectares          | 852.2  | 3.3  | 1019.6 | 3.8  |
| including woodland                        | 509.2  | 2.0  | 569.5  | 2.1  |
| fires and dead stands                      | 198.9  | 0.8  | 290.6  | 1.1  |
| felling                                   | 80.1   | 0.3  | 110.5  | 0.4  |
| Non-forested land, thousand hectares       | 5505.9 | 21.3 | 5497.6 | 20.4 |
| including arable land, hayfields, and pastures | 602.3   | 2.3  | 601.4  | 2.2  |
| swamps                                    | 321.4  | 1.2  | 315.9  | 1.2  |
| other lands                                | 4324.9 | 16.7 | 4327.3 | 16.0 |
| All lands, thousand hectares               | 25831.0 | 100.0 | 27010.8 | 100.0 |

3. Results
Calculations of the carbon balance in the forests of the RB show that carbon absorption in all pools of the forest ecosystem is characterized with relative constancy. In 2007-2017, it was 9.205 Mt C/year. Carbon losses, in contrast to carbon uptake, are characterized by inter-annual variability. Carbon losses from logging have increased from -0.761 Mt C/year in 2007 up to -1.078 Mt C/year in 2017 as a result of a 1.4-fold increase in cutting area. Losses from forest fires increased since -0.945 Mt C/year in 2007 up to -1.417 Mt C/year in 2017 as a result of a 1.5-fold increase in the area of fires and dead stands during the period under review (Table 2).

During the study period, the carbon sink in the forests of the RB, which consists of the balance of absorption and losses from logging and forest fires, decreased from 7.344 Mt C/year in 2007 to 6.865 Mt C/year in 2017.
Table 2. The carbon budget in the forests of the Republic of Buryatia.

| Carbon flow                      | Flow rate, 10⁶ t C year⁻¹ |
|---------------------------------|---------------------------|
|                                 | 2007          | 2017          |
| Absorption                      | 9.051         | 9.360         |
| Losses from clear cutting       | -0.761        | -1.078        |
| Losses from forest fires        | -0.945        | -1.417        |
| Budget                          | 7.344         | 6.865         |

4. Discussion

First of all, carbon absorption in forests is due to an increase in the area and volume of clear cutting and forest fires. The data characterizing the key factors influencing the carbon balance of forests testify to this (Table 1). During the period from 2007 to 2017, a slight increase in the forest covered area (by 0.5%) was due to an increase in the uncovered area of the forest due to an increase in the area of burning areas and dead plantings by 0.3% (as well as in felling by 0.1%). The increasing uncovered area as a result of logging suggests that the effect obtained during the economic reforms of the early 1990s in Russia, which led to a sharp reduction in timber harvesting, has exhausted itself. So, on the territory of the republic, a total number of 3,757 thousand m³ of wood was cut in 1990, and the figure dropped to 405 thousand m³ in 1998 (in 9 times) (Fig. 1). Then, a gradual growth of clear cutting is observed. They harvested 1094 thousand m³ in 2016, which is 15.7% of the annual allowable volume of timber removal (estimated cutting area).

![Figure 1. Dynamics of wood harvesting in all types in the Republic of Buryatia, 1990-2016.](image)

The slower growth rate of continuous logging compared with selective logging is due to the introduction of environmental restrictions on the Baikal Natural Territory (BNT) since the end of the last century. The Republic of Buryatia, which is largely part of the BNT, is one of the country’s leaders in the environmental regulation of economic activities and the creation of the foundations for environmentally sustainable development. In the region, special standards for permissible impacts on the natural ecosystems of the Lake Baikal and the basins of the main watercourses (Selenga, Upper Angara, etc.) have been developed and approved. Extensive work on the functional ecological zoning of the territories of the central ecological, buffer zones of BNT has been carried out, prohibiting certain activities [5, 6]. Thus, in the region, a number of conditions necessary for the introduction of the principles of a “green” economy into economic activity have already been created.

Environmental restrictions on forest management are expressed in increasing protective forests due to operational ones. In protective forests, depending on the ecological zones of BNT (central or buffer), clear cutting is prohibited or limited, including due to a decrease in the size of cutting areas compared to other regions of the country. Environmental constraints increase requirements for logging operations, the need to introduce environmentally friendly forestry equipment and technology [7].
Thus, the increase in protective forests due to environmental constraints at the BNT inhibits the growth of clear cutting. This contributes to the fact that the removal of wood by clear cutting is going at a slow pace, which leads to an increase in forest areas. Good natural regeneration in logging, characteristic of the Baikal region, also has a positive effect on this process [8].

Forest fires are another key carbon budget impact on forests. Over the past ten years (2007-2016), 10,822 forest fires occurred on an area of 1797.6 thousand hectares, while the average area covered by forest fires for the year was 179.7 thousand hectares [9]. Peaks of large forest fires occurred in 2003 (157.5 thousand hectares), 2009 (242.4 thousand hectares), and 2012 (129.3 thousand hectares). In 2015, the largest fires occurred both in quantity (1,574) and in the area of burnt forests (890 thousand hectares) for the entire observation period. Regarding the catastrophic summer fires in 2003, 2009, and 2015, we can say that the reasons for establishing a high level of forest fires were the imposition of two factors: extreme weather conditions (lack of precipitation and abnormal heat) and lowering of the water level of the Baikal Basin. As a result, the non-accumulation of moisture in the soil, accordingly, accelerated drying of the ground cover and caused an increase in the mass of dry combustible materials in the forest occurs [10].

The deteriorating situation with forest fires is associated both with the problems of organizing and financing the protection of forests and with global climate change, which affects the growth of the number of dangerous hydrometeorological phenomena. Such phenomena include periods of hot and dry weather, creating conditions for catastrophic fires. According to the state service Roshydromet, the number of hydrometeorological hazards has increased by 2 times over the past 15 years [11]. According to one of the climate change scenarios based on the general circulation model of the atmosphere, the duration of the fire hazard season in the middle latitudinal belt of Russia may increase by 50-60 days, i.e. in 30-40% [12].

On the other hand, the prevalence of young and middle-aged stands in the age structure of forests (together they make up 51.2%) contribute to the fact that the value of carbon sequestration by forests has high and relatively stable values. And the presence of a sufficient amount of mature and overmature stands in the forest fund (more than 38%) reduces the amount of carbon deposition. Since, according to experts, ripe and overmature stands of all species are considered the least productive ones, because it gives a minimum increase in wood and phytomass as a carbon accumulator [13].

5. Conclusion

Breed and age composition, structure of forest lands, nature of forest use, organization of forest protection from fires affect the size of the forest carbon budget. Analysis of the carbon budget has shown that the forests of Buryatia have a great potential in the absorption (deposition) of carbon. Despite the gradual reduction of carbon sinks, the forests of Buryatia make a positive contribution to the preservation of the global climate.

In the future, an increase in logging and fire exposure to forests can inevitably lead to an increase in carbon emissions into the atmosphere. Therefore, additional measures to improve the management of both forests and forest management are necessary in order to minimize the negative effects of climate change and to effectively use its possible benefits. The most promising forms of activities to preserve the existing carbon stocks and increase the absorption of carbon dioxide from the atmosphere by forests are the intensification of prevention and control of forest fires, changes in the technologies and regimes of forest use, afforestation of outdated agricultural land, protective forestation in arid areas, etc.

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