Bioeconomy of the Irkutsk Region: State and Prospects of Development

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Abstract. Around the world there is a transition to a new economic model focused on environmental and social sustainable development. One of the ways for such a transformation is the transition to bioeconomy. The Irkutsk Region has unique forest resources. And it is the forest sector that is a key element for the development of bioeconomy in many countries. Beside major timber resources, the forests of the Irkutsk Region have a high potential for the use of non-timber resources. The aim of the paper was to assess the state of bioeconomy in the Irkutsk Region in terms of the use of renewable forest resources and the prospects for its development. The paper analyzes statistical information on the forest resources of the region in terms of renewability, primarily of non-timber resources, mushrooms, wild plants, etc. Based on the data of the Forestry Plan of the Irkutsk Region, we determined the volumes of non-timber food resources, and considered the contribution of hunting farms, ecotourism and fish husbandry to the economy of the region. It has been shown that the development of bioeconomy will make a significant contribution to the economy of the region, as well as provide an opportunity to create new jobs in rural and remote areas.

1. Introduction
Modern humanity is concerned with many problems, one of which is demographic and food security. According to forecast estimates, by 2030 the world’s population will increase to 8.3 billion people compared to 6.5 billion in 2005. Population growth [1], an increase in living standards and per capita incomes will increase the demand for natural resources, in particular food, water, feed, and energy resources. At the same time, a decrease in the volume of available natural resources is expected, which is exacerbated by serious climatic anomalies.

Insurance statistics on the number of consequences caused by natural anomalies, and therefore the damage to be compensated, has tripled over the past forty years. Weather anomalies are realized in the form of waves of heat or cold, tornadoes, showers, floods, droughts, etc. Floods, droughts, harsh winters destroy agriculture, lead to famine and epidemics. Storms, hurricanes, heavy rains do not spare anything in their path, forcing people to leave devastated areas.

An example of such an event is a flood in the Irkutsk Region at the end of June 2019, when at the peak of the flood the maximum level of the Iya River in the city of Tulun rose to the level of 14 meters (at a critical level of 700 cm), of the Oka River in the village of Ukhtuy – to 10 meters, of the Uda River in Nizhneudinsk – to 2.5–3 meters, of the Belaya River in the village of Mishelevka – to 2.5 meters. Almost 11 thousand residential buildings were flooded in 107 settlements, a third of the buildings is not to be restored. The state of emergency was announced in six municipalities of the Irkutsk Region. Damage from the flood is estimated at least 29 billion rubles.
Forest fires are raging in the Irkutsk Region and the Krasnoyarsk Territory. Their area is constantly increasing, smog from fires is observed in the territory of the Siberian Federal District.

All these problems require mankind to change its attitude towards natural resources and the economy and take immediate measures to overcome the crisis, moving on to the path of sustainable development.

In June 2009, 34 countries signed the Green Growth Declaration, which states that these countries will “strengthen their efforts to implement green growth strategies, both as part of their efforts to overcome the crisis and beyond, recognizing that the concepts of “green” and “growth” can be inextricably linked” [2]. Green economic growth is a new development paradigm focused on a model of economic growth that is environmentally and socially sustainable. In particular, it is proposed to take into account the environmental damage associated with economic growth and other similar losses of national wealth. Green growth should catalyze investment and innovation, which will form the basis of sustainable growth and lead to the emergence of new economic opportunities [3].

The transformation of the economies of the countries is carried out in four main directions: water and sanitation, green cities, sustainable territories and sustainable energy.

The linear model of the economy that has dominated so far in many countries and is based on the principle of “withdraw - produce - throw away” has been the basis of socio-economic development since the industrial revolution [4]. However, an increasing shortage of raw materials and energy resources, price volatility in commodity markets, increasing environmental pollution, including massive greenhouse gas emissions, rising temperatures and pollution of marine waters with various wastes threatening with irreversible climate change, an increase in the area occupied by landfills for industrial and household waste, etc. pushed the world to rethink the traditional model of the economy.

More and more attention is being drawn to the concept of a circular economy, which is based on the chain of “withdraw - produce - reuse”. Under the circular economy, specialists understand the economy characterized by a restorative and closed nature [5]. It is characterized by minimizing the consumption of primary raw materials and the volume of recyclable resources, which is accompanied by a decrease in waste sent to disposal, while reducing the space occupied by the corresponding landfills and unorganized waste dumps.

This is how circular bioeconomy is developing in the EU countries [6]. Bioeconomy is an economy that uses the renewable biological resources of land and sea for the production of food, biomaterials, bioenergy and bioproducts [7]. It includes the production of biological products and their conversion into food, feed, bioproducts and bioenergy [8].

It covers such sectors as agriculture and forestry, fisheries, food and pulp and paper production, as well as certain areas of the chemical, biotechnological and energy industries [9].

It has a powerful innovative potential due to the involvement of a wide range of sciences, advanced and production technologies [10].

The forest sector is a key element for the development of bioeconomy [11].

Thus, the biomass remaining after logging is the largest source of renewable raw materials for energy production in Europe. According to a number of studies [12], over the next decades, approximately 200 million m³ of wood biomass can be produced each year from forests located in the EU (which corresponds to 400 TW·h of energy) [13].

In Russia, the development of bioeconomy is determined by the state program - the Comprehensive Program for the Development of Biotechnologies in the Russian Federation for the Period until 2020. It provides for the achievement of the goal to create a globally competitive sector of bioeconomy, which, along with nanoindustry and information technologies, should become the basis for modernization and building a postindustrial economy. The long-term goal is to reach the volume of bioeconomy in Russia in the amount of about 1% of GDP by 2020, and at least 3% of GDP by 2030.

The aim of the paper was to assess the state of bioeconomy in the Irkutsk Region in terms of the use of renewable forest resources and its share in the gross regional product.
2. Materials and Methods
The paper analyzes statistical information on the forest resources of the Irkutsk Region in terms of renewability, primarily of non-timber resources, mushrooms, wild plants, etc.

3. Results of the Study and their Analysis
The Irkutsk Region has unique forest resources. According to the state forest register, as of January 1, 2018, lands covered by forest vegetation occupy 64 million hectares, which is 82.6% of the territory of the region. By this indicator, the region is one of the most well forested among the territorial entities of the Russian Federation [14].

The total stand of timber in the Irkutsk Region amounts to 8542.8 million cubic meters. Of these, coniferous stands amount to 7366 million cubic meters. Ripe and overripe stands in the Irkutsk Region in general for the main forest-forming species amount to 4864.3 million cubic meters, of which 85.4% are accounted for by especially valuable pine stands, which are most in demand among loggers. The annual growth of all stands in the Irkutsk Region is 97.1 million cubic meters, including coniferous stands with 70 million cubic meters. Therefore, the most important specialization of the Irkutsk Region is the forest industry, whose branches are widely represented: timber logging, manufacturing of added-value processing products (lumber, fiber boards, particle boards, plywood), pulp and paper industry.

However, beside major timber resources, the forests of the Irkutsk Region have a high potential for the use of non-timber resources.

In addition to harvesting wood in the forest fund, forests are also used in other ways. According to Article 25 of the Forestry Code of the Russian Federation [15], other uses of forests are possible, such as: harvesting of oleoresin; harvesting and collection of non-timber forest resources; harvesting of food forest resources and collection of medicinal plants; implementation of activities in the hunting sector; farming; recreational activities; growing forest fruit, berry, ornamental plants, medicinal plants, etc.

On the lands of the forest fund of the Irkutsk Region, in addition to timber harvesting, the following activities are carried out: harvesting of forest food resources on an area of 199,771.3 ha; activities in the hunting sector - 679,366.2 ha; farming - 533.5 ha; recreational activities - 367.1 ha; and other activities based on lease agreements.

According to the Forestry Plan of the Irkutsk Region [16], harvesting of oleoresin is possible in the territory. The areas of pine stands suitable for tapping are significant and amount to about 2.5 million hectares. The average yield of oleoresin from 1 ha of forest is 107.6 kg and depends on the quality of pine stands. However, currently in the Irkutsk Region there are no leased plots for this type of use.

The resources of fruit and berry wild plants have the lead in the field of harvesting food forest resources and collecting medicinal plants. Large berry fields are concentrated in the Irkutsk Region. According to forest management data, the berry-bearing area amounts to 13.6 million hectares. The most common fruit and berry plants of economic importance in the forests of the region include: arboreal species - bird cherry, Siberian mountain ash, blood-red hawthorn; shrubs - guelder-rose, black and red currants, blue honeysuckle, sea-buckthorn, cinnamon rose; subshrubs - raspberries; dwarf shrubs - cranberries, blueberries, lingonberries, bog bilberries; herbaceous plants - wild strawberries.

The largest areas in the region among berry fields are accounted for by lingonberries - 32% and bog bilberries - 17%. Other berry fields account for only 2% of the berry-bearing area.

The use of forest resources in the Irkutsk Region includes the harvesting of resources and the collection of medicinal plants, such as birch sap, mushrooms, wild fruits and berries, nuts and Christmas trees. The data on the dynamics of the actual use of food forest resources are provided in Table 1 and approved by the Decree of the Governor of the Irkutsk Region dated May 29, 2019 No. 112-ug “On approval of the Forestry Plan of the Irkutsk Region for 2019-2028”

Berries and fruits are used in the food and chemical pharmaceutical industries, as well as in traditional medicine, which leads to growing demand from various procurers.
| Type of use | Unit | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | Total for 6 years | Average annual volumes |
|------------|------|--------|--------|--------|--------|--------|--------|-------------------|------------------------|
| Harvesting food forest resources and collecting medicinal plants, including: birch sap | kg    | 0.00   | 90,990.00 | 185,338.00 | 406,674.00 | 425,909.69 | 252,803.40 | 1,361,715.09 | 226,952.52 |
| medicinal plants | kg    | 0.00   | 0.00   | 0.00   | 0.00   | 100.00  | 100.00  | 200.00           | 33.33                  |
| similar forest resources | kg    | 0.00   | 82,650.00 | 162,476.00 | 262,650.00 | 320,204.00 | 172,290.40 | 1,000,270.40 | 166,711.73 |
| nuts | kg    | 0.00   | 7000.00 | 17,461.00 | 23,463.00 | 97,862.69 | 74,347.00 | 220,133.69 | 366,889.5     |
| berries | kg    | 0.00   | 1340.00 | 5401.00   | 10,031.00 | 7743.00  | 6066.00  | 30,581.00       | 5096.83               |
| other food forest resources | kg    | 0.00   | 0.00   | 0.00   | 110,530.00 | 0.00   | 0.00   | 110,530.00 | 18,421.67        |
| Christmas tree | pcs of trees | 8863.00 | 7050.00 | 5247.00 | 7145.00 | 5741.00 | 6528.00 | 40,574.00 | 6762.33          |

Forests in the region are also rich in mushroom resources. The species composition of mushrooms is quite diverse. The total mushroom-bearing area of the Irkutsk Region is approximately 5.4 million hectares, and the annual economic collection is 13,505 tons [16].

The annual economic collection of medicinal herbs in the Irkutsk Region amounts to 166,711.73 tons. The value of medicinal plants is due to the content of a whole complex of biologically active substances.

In the Irkutsk Region, there are 6.9 million hectares of pine forests. Some of them are represented by non-fruiting young growths, as well as overgrown large-sized trees of large diameters that are not amenable to threshing. A significant part of pine forests is inaccessible for collecting nuts due to the lack of access roads, and mountainousness. The area of pine-nut harvesting zones is 3.3 million hectares. The total area of nut-bearing pine forests is determined at 4.7 million hectares, the average biological reserve is 699.7 thousand tons, the operational reserve is 342.3 thousand tons, and the annual economically possible harvest is 36.6 thousand tons.

Pine nuts are of great value as a food product, they contain fats (55-68%), proteins (18% and more), starch (more than 12%), carbohydrates, trace elements, sugar, citric acid, tannins, vitamins. They are used to produce pine oil and halva.

More than 10 companies involved in the collection and processing of pine nuts are working in the region [17].

Another food forest resource is birch sap. The area of birch forests in the region, as of January 1, 2018 [14], is 9276.7 thousand hectares, including mature and overmature, possible for exploitation - 2696.0 thousand hectares. Usually, 2-3 liters of sap per day are obtained from a birch. A large tree can produce about seven or more liters of sap per day. Currently, commercial harvesting of wild plants in the region is carried out, but in small volumes and by private companies. According to the information for the meeting of the Public Council of the Legislative Assembly of the Irkutsk Region “On the organization of procurement and processing of wild fruits and berries” [18], entities engaged in the collection, processing and sale of wild plants are represented by 23 enterprises located in 15 municipalities of the region.
The largest manufacturers are: Regional Consumer Association, Irkutskzveroprom CJSC (Shelekhov), Taiga-Product CJSC (Angarsk), Kiprey LLC (Ust-Ilimsk Municipality), IE Poplevin Nikolai Ivanovich (Tulun Municipality), Balagansk Food Company LLC (Balagansk Municipality), and Tofkardon LLC (Tulun Municipality).

According to Article 36 of the Forestry Code of the Russian Federation, forests can be used to carry out activities in the hunting sector.

As of December 31, 2017, the area of hunting lands of the Irkutsk Region assigned to hunting providers for hunting is 50,913.82 thousand hectares, or 71.9% of the total area of hunting lands of the region. The area of generally accessible (not assigned) hunting lands of the region is 19,066.38 thousand hectares, or 26.95% of the total area of hunting lands of the region. According to the Service for the Protection and Use of the Wildlife of the Irkutsk Region, for 2017, the population size of red deer is 61.9 thousand individuals, wild boar - 7.7 thousand individuals, musk deer - estimated at 113.4 thousand individuals, roe deer - 74.6 thousand individuals, elk - 60.2 thousand individuals, sable - 220.5 thousand individuals, squirrel - 729.0 thousand individuals, fox - 16.2 thousand individuals, wolf - 5.4 thousand individuals, brown bear - 16.5 thousand individuals, etc. The limit on hunting was approved by the governor of the Irkutsk Region by Decree No. 142 of July 19, 2018 “On approval of the limit on hunting in the territory of the Irkutsk Region until August 1, 2019”. In 2017, 4,045 hunting permits of a uniform federal standard were issued in accordance with the established procedure; fees for use amounted to 17,645.7 thousand rubles.

In addition to the richest forest resources, the Irkutsk Region has a promising fishery water fund, which includes more than 65 thousand waterways with a length of about 310 thousand kilometers, Lake Baikal and a number of large water reservoirs: The Irkutsk, Bratsk, Ust-Ilim, Mamakan and Boguchansk water reservoirs. In the waters of the Irkutsk Region there are 67 species and subspecies of fish, including 18 species of commercially important fish.

The main fishery reservoirs in the region are the Bratsk and Ust-Ilim water reservoirs with more than 95% of the total fish volume caught in the region. Commercial fishing is also carried out on Lake Baikal (despite the fact that on October 1, 2017 commercial fishing (catching) of Baikal omul on Lake Baikal was banned, other fish species are caught in fishing areas in accordance with issued quotas).

At the same time, stocks of valuable fish species in the water reservoirs of the Angarsk cascade and in Lake Baikal are largely dependent on fish-breeding and acclimatization activities. In the Irkutsk Region, great positive experience has been accumulated on the formation of ichthyofauna [19].

And one more type of activity within the framework of the principles of bioeconomy which must be developed in the Irkutsk Region is ecotourism. The largest natural wealth is located on the territory of the Irkutsk Region - Lake Baikal, a UNESCO World Heritage Site.

According to FSBI Zapovednoye Pribaikalye, which includes the Pribaikalsky National Park and the Baikal-Lensky Reserve, 17 approved ecological tourist routes currently operate. In 2017, these territories were visited by tourist groups in the amount of 83,870 people. In recent years, there has been a tendency to increase the tourist flow to Lake Baikal of both domestic and foreign tourists.

Beside Lake Baikal and the adjacent specially protected natural areas, in the region there are: Vitimsky State Nature Reserve, Krasny Yar State Nature Reserve, Tofalarsky State Nature Reserve. Specially protected natural territories of regional significance are represented by 13 state nature reserves and 81 natural monuments.

However, for now ecotourism is only gaining its popularity, although all the prerequisites for its active development are available. According to the report of the tourism agency of the Irkutsk Region for 2018 [20], the Great Baikal Trail project, implemented in the Irkutsk Region, was recognized as the best Russian brand in the nomination “Tourist and Ecological Routes” according to a study conducted by the Rating Information Center and Vacation in Russia, a magazine about domestic and inbound tourism. The most popular vacation spots for residents and guests of the Irkutsk Region are the territories adjacent to Lake Baikal (Irkutsk Municipality (Listvyanka, Bolshoye Goloustnoye), Olkhon Municipality (the shore of the Maloe More and Olkhon Island), Slyudyanka Municipality
(Baikalsk, Slyudyanka, Utulik, Kultuk), territories along the shore line of the Bratsk water reservoir (Osa, Nukutsk and Bratsk Municipalities), as well as the city of Irkutsk.

The volume of tourist flow in 2018 amounted to 1,655.8 thousand people, and the amount of tax revenues from the activities of hotels, restaurants and travel agencies to the consolidated budget of the Irkutsk Region amounted to 869.9 million rubles.

4. Discussion
Having studied the Irkutsk Region from the point of view of the bioeconomic path of development, we can conclude that this direction is promising.

The development of the region is possible not only due to the available mineral resources, but also renewable biological resources. The Government of the Irkutsk Region is already developing a draft strategy for socio-economic development of the Irkutsk Region until 2030, which includes the development of the reproduction, procurement, processing and marketing of biological resources [21].

There already have been examples of positive experience in implementing such projects in the Siberian Federal District. The Tomsk Region implemented the state program “Development of the sphere of harvesting and processing of wild-growing raw materials in the Tomsk Region for 2013-2015”.

The resource potential of the Irkutsk Region, the high demand for food and biologically active supplements from wild plants contribute to the development of a sustainable system for the collection, harvesting and processing of forest non-timber resources, as well as forest (mushrooms, berries, pine nuts, wild garlic, fern) food resources and medicinal raw materials. This will make a significant contribution to the development of the region’s economy and increase the employment of residents, especially in rural and remote areas.

5. Conclusion
The geographical proximity to the countries of Asia and its transport accessibility gives the Irkutsk Region the opportunity to enter giant Asian markets of consumers who are aware of the value of natural products. The Irkutsk Region has all the necessary resources in order to satisfy this growing consumer demand and enter the competition for foreign markets.

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