Potential reserves and development of non-wood forest resources

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Abstract. In the face of the global economy, the issue of the rational and cost-effective use of the available natural resources is growing more and more relevant. The international community has every reason to be worried. In particular, there is the threat of a significant degradation of the world’s forests, alongside a loss of unique biological systems, biodiversity and ecological situations. Amid the existing economic crisis, much less attention is being paid to this issue due to the lack of financial opportunities for particular states. However, Russia should pay special attention to these issues, as the country’s forests occupy vast areas. Given this situation, there are unlimited possibilities for the industrial harvesting of non-timber forest products (NTFPs), which can additionally bring an additional and significant amount of money to the state budget. These funds can then be allocated for addressing the economic and environmental problems of our modern society.

1. Introduction

In the modern world, the problems of conservation and the use of forests are becoming increasingly relevant and complex. Forest management should meet international social, environmental and economic requirements. Fires, pests, diseases and other adverse factors also increase the threat of forest mortality. The forestry sector is increasingly facing the need to respond rapidly to the evolving technologies and stricter environmental requirements. All of the above calls for each state to pursue long-term forest policies for the benefit of both the participants involved in forestry relations and the citizens of all countries. This is why modern society should pay considerable attention to the use and renewal of our natural resources [1-5].

Forests cover 30% of the planet’s surface. The total area of the world’s forests is 4.1 billion ha, forested land is 3.5 billion ha, and the timber stock is 336 billion m³ [6].

The state of the forest resources varies considerably in different continents and countries. The most productive forests are those of South America, and the same continent has the highest percentage of forest cover. 106 billion m³ of wood, or 32% of the world’s reserves, are accumulated here. The second most productive place is Africa, where the forests cover 826 million ha.

On average, there are 0.6 ha of forest for each inhabitant of the planet [7].

According to expert assessments, at the present time human activity has converted 85% of the world’s land surface. This fact has resulted in dramatic changes to the forests. Modern civilisation is
now running into an array of problems, and their resolution requires modern man’s awareness of himself and his place in the world [8].

The international community has every reason to be worried about the future of the forest resources of Russia, which are enormous according to a wide range of diverse criteria. To date, there is a threat of the degradation of 22 % of the world’s forests, which would result in a loss of unique biological systems and biodiversity, as well as the disappearance of the cultures belonging to small ethnic groups. Russian boreal forests make up 60 % of all the boreal forests in the world and 95 % of the closed forests. The forests of our country also play an important role in the global carbon balance, as they account for 75 % of the carbon stock. There are many areas in Russia, such as Lake Baikal, that are unique in terms of their biodiversity and are the heritage of the entire world.

The forest communities in the territory of Russia are located to the north of the forests of Canada and the United States. They have extreme climatic conditions and are significantly inferior in terms of their productivity. More than half of the forests of Siberia and the Far East grow on soils with permafrost, occupy low-productivity stands and are not of commercial value to the timber industry.

In Russia, three different management periods can be distinguished in the field of forestry management:

1) diverse forms of ownership of the forests in pre-revolutionary Russia (up to the year 1917);
2) a centrally-planned economy (until 1991);
3) a market economy in the present stage.

In pre-revolutionary Russia, the forest fund was utilised to maintain the conditions that would ensure a supply of forest products to the population and allow them to receive an income from timber. State forestry management was composed of a clear hierarchy of regulatory bodies with an allocation of rights and responsibilities, and had a stable legislative framework. The public administration successfully solved the issues related to improving the profitability of the forests, but they did not act to preserve the forests from extermination.

Under the centrally-planned economy, the strategic goal was to provide for the needs of the society and the state in terms of forest products and to expand its reproduction. However, the profitability of the forests decreased (due to the low value of forest resources), which did not provide enough financial resources for advanced, or even for simple reproduction.

In the market economy environment, the role of the state is to balance the interests of all the participants in the forest relations, and to work towards the effective environmental, social and economic development of the state (federal) property on forest sites, which constitute a part of the forest fund. The balance of these interests is as follows:

– the state has an interest in the effective use and increasing the potential of the forest resources, as well as an interest in receiving an income from timber and the optimisation of forest protection and the reproduction costs;
– forest owners are interested in increasing their revenue from the harvesting and processing of forest resources, or making a profit;
– citizens are interested in preserving the environment, as well as ensuring free access to the forests for recreation purposes, such as picking mushrooms and berry picking;
– society as a whole seeks social and environmental security.

So far, softwood (pine, cedar, spruce, fir and larch), hardwood (oak, ash and beech) and soft-wooded broadleaf (aspen, basswood and birch) forests, which are suitable for woodworking industries and constructive purposes, have been targeted for exploitation.

In addition to timber, the forests of our country are also rich in other types of forest resources: berries, mushrooms, nuts and medicinal herbs. Forests form the ecological basis of our territories, as well as being the basis of the environmental security of the country and the planet as a whole. The forests in Russia are varied in terms of their natural diversity, which is caused by climatic, soil and other geographical features, as well as by the socio-economic differences between the regions. In addition, the forests perform a variety of functions — land protection, water protection, climate regulation and maintaining biological diversity.
In the modern world, the problems of conservation and the use of forests are becoming increasingly relevant and complex. Forest management should meet international social, environmental and economic requirements. Fires, pests, diseases and other adverse factors also increase the threat of forest mortality. The forestry sector is increasingly facing the need to respond rapidly to the evolving technologies and stricter environmental requirements. All of the above calls for each state to pursue long-term forest policies for the benefit of both the participants involved in forestry relations and the citizens of all countries. This is why modern society should pay considerable attention to the use and recovery of our natural resources, including the use and the recovery of our non-timber forest products.

As of 1 January 2015, the total area of lands included in the forest fund of Russia (according to the State Forestry Register) was 1146.2 million ha, including the land covered with forest vegetation which comprises 770.6 million ha. More than 74 % of the Russian territory has a 45-70 % forest cover, and 59 % of the population resides here. Given these circumstances, there are unlimited possibilities for the industrial harvesting of non-timber forest products. Currently, the constraints on the intensive use of forest products are the lack of an infrastructure, lending and investments for the development of processing industries for forest food products.

2. Materials and Methods

More than half of the Russian forest fund is suitable for setting up systems for the procurement of non-wood products. In the initial phase of forest management, crafts were developed such as charring (the charcoal produced was used for foundries), the production of potash with alkaline salt derived from wood ash, the distillation of resinous wood (with resin obtained from the wood of coniferous breeds by a process of dry distillation) and forest bee-keeping (wild-bee honey was collected in the woods). In recent decades, the priorities have become the harvesting of edible plants, mushrooms, medicinal and chemical raw materials for the production of tannins, tar, fir oil, extraction products and conifer vitamin-enriched flour [2, 9, 10].

In the not-too-distant future, the value of non-timber resources will increase, as their industrial development will facilitate the increase of profitability from the forests, as well as increasing the employment of the population and providing it with natural products. UN FAO has recently begun publishing a professional magazine titled Non-wood Forest Production, and international conferences are regularly being held on this issue [11].

The use of non-wood forest resources in Russia is governed by federal regulations and standards. The accounting of the resources and the productivity of the basic types of food, medicinal and technical plants in Russia is carried out during forestry management that is based on a common methodology. The harvesting of the forest resources of all kinds is also carried out according to the approved regulations and rules: Industry Standard OST 61-6-1-91 Dried mushrooms [12]; TU 10.03.759-89; Standard GOST 28649-90 Salty, pickled and boiled mushrooms [13]; OST 53-83-85 Berries, fruits and wild nuts: Methods of the definition of a crop and resources [14]; Sanitary Rules SR 2.3.4-10 Sanitary rules on the preparation to the processing and sales of mushrooms [15]; Rules on the harvesting and procurement of non-timber forest resources [16]; Rules on the procurement of resin [17]; and Rules on the use of forests for recreational activities [18].

3. Results and Discussion

Increasing the use of non-wood products is a prospective direction for forestry management. Quite often, the value of the forest berries and mushrooms in a unit area is several times higher than the value of the wood [2, 3, 10].

Currently, the harvesting of the fruits of perennial plants and mushrooms is allowed to be carried out annually; the collection of inflorescences, fruits and other elevated parts of annual plants is carried out once in 2 years; the aboveground parts (leaves, shoots, buds) of perennial plants are harvested once in 4-5 years; and the underground parts are collected not more than once every 15-20 years (to guarantee their reproduction).
According to the Russian Sanitary Rules [15] the industrial collection of 64 species of edible mushrooms (out of over 300 species in Russia) is permitted. These species are divided into four categories according to the nutritional value. Common stocks of edible mushrooms in the forest fund are estimated to reach 4.3 million tonnes, of which 10-12 % is available for collection.

3.1. Wild fruit plants
These are a source of biologically-active substances that are essential for humans. The plants belonging to the lingon berry (Vacciniaceae) and Rosales (Rosacea) families are of the greatest economic importance. Stocks of these berries in the Russian forests have been estimated at 9.5 million tonnes. However, the yield per hectare for berries and other kinds of non-wood products depends on the forest type, where the difference in value can be up to five times (Table 1).

| Forest type and area category | Foxberry | Blueberry | Blackberry | Strawberry | Cranberry | Raspberry | Cloudberry | Bilberry |
|------------------------------|----------|-----------|------------|------------|-----------|-----------|------------|----------|
| Crimson                      | 140      | -         | 40         | -          | -         | -         | -          | -        |
| Oxalydosum                   | 210      | -         | -          | -          | 250       | -         | 410        | -        |
| Myrtillosum                  | 320      | -         | -          | -          | 150       | -         | 420        | -        |
| Polytricosum                 | 240      | 130       | -          | 190        | -         | -         | -          | -        |
| Sphagnosum                   | -        | 190       | -          | 240        | -         | 50        | -          | -        |
| Sphagnosumbogs               | -        | 230       | -          | 700        | -         | 80        | -          | -        |
| Logging area under 5 years   | 410      | -         | 150        | 140        | 300       | -         | -          | -        |
| Logging area over 5 years    | 180      | -         | 190        | 80         | 210       | -         | 180        | -        |
| Burnt area under 5 years     | 560      | -         | 140        | 95         | 350       | -         | -          | -        |
| Burnt area over 5 years      | 320      | -         | 190        | 55         | 320       | -         | 210        | -        |

The common stocks of NTFP resources are scattered over a vast territory and are heterogeneous in terms of their species composition and productivity. Furthermore, the bulk of these reserves are not available due to their remoteness from populated areas and a lack of roads. The stock structure of non-timber forest products, in terms of their accessibility, is given in Table 2.

| Kind of product | Production area, thousand ha | Stocks, thousand tonnes |
|-----------------|------------------------------|-------------------------|
|                 | Biological                   | Trade                   |
| Cranberry       | 201.8                        | 27.2                    | 13.6                    |
| Cowberry        | 112.1                        | 16.8                    | 8.3                     |
| Blueberry       | 47.0                         | 3.2                     | 1.6                     |
| Malines         | 11.1                         | 1.7                     | 0.8                     |
| Bilberry        | 212.0                        | 31.9                    | 15.9                    |
| Cloudberrries   | 23.0                         | 1.2                     | 0.5                     |
| Mushrooms       | 918.4                        | 35.9                    | 17.9                    |

3.2. Medicinal plants
These also constitute a significant part of the NTFP. Since ancient times, people have used various plants for food, while noting the medicinal properties of some of these plants. It is known that 5 thousand years ago in Mesopotamia, pomegranate fruit was used for medical purposes; while in
ancient Babylon and Egypt, the medicinal properties of black henbane were used successfully. The works of Ancient Greek scientists contain records of the healing properties of sage, yarrow, St. John’s wort, peppermint, chamomile and many other herbs [19].

In Russia, the healers were wise men with a perfect knowledge of medicinal plants. In the monasteries, the “lechtsy” accumulated experiences of using herbal medicine. The knowledge of our distant ancestors was also handed down from generation to generation, and was enriched over time by observation and practice. Subsequently, the healing methods using medicinal plants were cited in the manuscripts called “travnik” or “vetrograd”. Herbalists have always been treated with respect in Russia.

In the early 20th century, medicinal plants accounted for 80 % of all the treatment agents used in medicine. However, they were subsequently displaced by synthetic drugs. Nevertheless, even now, despite significant progress in the creation of medicines, herbal drugs account for about 40 % of the total amount of medicines used today. This is because the substances contained in plants are more closely related to the human body than synthetic drugs.

3.3. Mushrooms

These organisms play an important role in the functioning of the forest ecosystems. The mushrooms and the tree roots unite into mycorrhizae. The tree and the mushrooms both benefit from such interactions: the tree provides the mushrooms with carbohydrates; and the mushrooms provide the tree with water, nitrogen and other nutrients. This symbiosis of mushrooms with certain trees is consistently characterised and expressed even in the names of the mushrooms: birch bolete, aspen mushroom, lactarius deterrimus, pine mushroom etc. In Sweden, the pine bolete appeared only after the larch tree was planted.

The spores of some species of mushrooms can withstand negative temperature of below -150°C and can maintain their viability up to 10 years. They can easily tolerate dryness of the air, but they do not tolerate high temperatures.

Mushrooms are an important food product. They are called forest vegetables, forest meat and forest bread - and that is no exaggeration. They contain a lot of protein, fat and carbohydrates, as well as potassium salts, phosphorus and iron, and vitamins A, B₁, B₂, C, D and PP₁. One kilogram of dried Boletus edulis even contains twice as much protein as beef, and three times more than fish.

The accounting of the species composition and the yields of mushrooms is only conducted in areas where their industrial harvesting is planned. The assessment of these mushroom resources (i.e. the average multi-year yield) is made by regional tables, in accordance with the type of the growing stand and its valuation characteristics. A list of the edible species of mushrooms is established by the Sanitary rules for the processing and sales of mushrooms [15].

The poisonous properties of some species of mushrooms have been known to people for a long time. The extant historical information tells about using such mushrooms as poisons. At the same time, poisonous mushrooms were and continue to be used for medicinal purposes. For instance, the national minorities of Siberia and the Far East use poisonous amanita as a remedy for nervous and mental disorders, as well as for relieving physical fatigue and increasing vitality. In Central Russia, amanita has long been used as an effective remedy for diseases of the internal organs, skin diseases etc. In addition, juices, ointments and decoctions of amanita are used to heal skin affected by X-ray radiation and provide effective prophylactics.

Chaga mushroom (Inonotus obliquus L.) extract has unique properties and is also used for medicinal purposes. The most common preparation based on the Chaga mushroom is Befunginum, with a tonic and analgesic effect.

3.4. Sugary juices of woody plants

Methods for the extraction of sugar juices have been known in Russia for a very long time. The first information about using the juices of hardwoods as a healing agent can be found in the manuscripts of books from Ancient Russia. Birch juice was used for many purposes in ancient times. Books from that
time describing home remedies contain many recipes for drinks, healing potions and other products that are based on the sap of woody plants. A book of tips titled Mesytseslov also contains many recipes for the preparation of kvass, beverages and special champagnes using sugary juices.

During World War II, when there was lack of sugar, the saps of woody plants were extensively used for the production of middle syrups, which were provided to kindergartens and hospitals. Middle syrups made of natural sap were used for treatment purposes.

During the post-war years, the tapping of birch and maple stands dropped dramatically. A new increase of industrial hardwood tapping began only at the end of the 60s in the last century. In addition to the food industry, the juice of these trees is used in agriculture, cosmetics and other industries.

Currently 90-110 thousand tonnes of tree sap are procured annually. The raw-material base of hardwood (birch and maple) tapping is over 93 million ha, but the use of the potential sap stock is not more than 7-9%.

3.5. Beekeeping

Honeybees are relict insects, and have existed on Earth for more than 56 million years. Over such a long period, they have learned to make products through varied biological activities, which have allowed them to survive all of the disasters on the planet.

Honey, beeswax, bee pollen, propolis, royal jelly, and bee venom are of interest for human not only in terms of their medicinal value, but also as everyday food products (honey). It has long been known that the regular consumption of honey enhances the vitality and creative activities of humans.

All plants that produce nectar and pollen provide a good fodder base for beekeeping. But the forest is not homogeneous and consistent space in terms of the quantity and quality of honey production. For example, high-density coniferous forests are of low value for beekeeping. This is especially applicable to pure spruce forests, where usually neither scrub nor grassy melliferous herbs grow under the canopy.

The creation of gardens in the forest districts is helping to strengthen the fodder base for beekeeping. The melliferous capacity of 1 ha of fruit plants is about 25-30 kg, and berry-bearing plants are usually more productive than fruit plants. Therefore, a combination of berries with fruit trees provides early and long forage sites for bees. For example, gooseberries and currants will blossom before fruit trees. The garden raspberry occupies a special place, as its melliferous capacity usually reaches 100 kg, and in particularly favourable conditions it can reach 160-200 kg/ha.

3.6. Procurement of bark

Tree bark serves as the raw material for obtaining tannins, and the procurement of spruce, larch and willows bark is carried out for this purpose. In addition, the bark is used to make compost, organic and organo-mineral fertilisers, as well as for the production of baskets and household utensils, biofuels and extractive substances, building material and absorbents.

Spruce and larch bark can be procured throughout the year from felled trees. However, outside of logging areas, the procurement of bark from the above species is prohibited.

The procurement of willow bark is performed only in the spring, during the sap ascent period. At this time, the bark can be easily separated from the timber and the amount of labour effort required for the procurement is minimal. The areas of procurement for willow tanbark are specified in a felling license, and the procurement from growing trees is forbidden by the rules of the final felling operations.

Silver bark is an outer suberized layer of birch bark without the bast. It serves as a raw material for making tar. The procurement of silver bark is performed with both growing trees within designated logging areas and also by obtaining bark from assortments, windfalls, deadfalls etc. For trees that are designated or designed for the production of veneer or special assortments, such procurement is prohibited. Depending on the location and type of tree, the birch bark is subdivided into three classes: Extra Class, Class I and Class II. From a 1 ha birch tree stand, 1 to 2 tonnes of bark can be obtained, and when the bark procurement is carried out simultaneously with the felling of a forest stand this can
reach up to 8 tonnes. The procurement of bark from dead trees and dead fallen wood can be performed all year round, both in logging areas and outside the site.

Bark can be used as feed additives, raw materials for extraction and pyrolysis (tannins and tar), materials for making household utensils, the manufacturing of construction materials and can also be used as a biofuel.

Economic evaluation of non-wood forest products is difficult because there are no exact volumes by species and therefore these products are not yet involved in the market process. We are still far from making full use of forest resources. Expert estimates show that the fee for the use of 50% of the biological reserves of mushrooms and berries in the Russian Federation will allow the state to obtain an additional about 2 billion rubles. Taking into account the main types of non-wood resources, the income from forests can grow many times. For this reason, the assessment of additional forest resources is very relevant. With the development of the economy, the cost of environmentally friendly forest products will increase. Priority will be given to the rational and sustainable use of the entire diversity of forest resources. Economic assessment of forest resources should be based on objective data obtained during the study. Unfortunately, there is still no single methodology for economic assessment of forest resources that could facilitate both a comprehensive assessment of non-wood forest products and of each type separately. Today, in most cases, harvesting of non-wood forest products is carried out spontaneously and uncontrollably.

4. Conclusion
Along with the implementation of the silvicultural requirements for growing high quality wood, it would be economically feasible to carry out the industrial procurement of non-timber forest resources, which would result in a significant profit at all levels. The industrial procurement of mushrooms and berries alone could add 2 billion roubles annually to the country’s budget.

The systematic and rational organisation of the procurement of non-wood forest products inextricably linked to the conservation of forest resources. Preventive measures aimed at the preservation and improvement of the natural conditions for the growth of various resources and species include sustainable forestry management practices.

Forests can provide a wide variety of benefits to humans. Therefore, it is important to establish the industrial development of non-timber products, which is an urgent task in improving the efficiency of the forestry industry in Russia.

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