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Economic Incentives for Forest Conservation at Different Scales

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Abstract: The process of deforestation is exacerbated by uncontrolled logging around the world. The forest is valuable, it is uttered everywhere and it seems obvious that the loss of the forest will mean large material losses. This value is largely hidden, that is, many take the forest for granted and realize the size of the loss only in the context of the loss of a significant area of forest plantations. That is why we believe that the economic forest exploitation is of particular importance; it will not only lead to product extraction, but also bring the importance of the forest to public consciousness. In the public consciousness, it is easier to consolidate the value of the forest in view of the forest economic importance for the average citizen. This is possible with the expansion of the forest economic exploitation on a regional scale in a number of sustainable forest management practices not related to logging.

Key words: Economics and ecology, non-timber forest exploitation, deforestation problem.

Introduction

Globally, deforestation is responsible for a significant proportion of anthropogenic greenhouse gases. Forest conservation can reduce emissions, but the cost-effectiveness of this mitigation mechanism depends on the associated costs. We estimated these costs taking into account regional, national and global factors, using a case study of one of the regions of the Russian Federation, namely the Republic of Bashkortostan. The idea of our study is based around a paradox: the preservation and multiplication of the forest area can bring significant benefits compared with logging and agriculture at the local and global levels. However, the financial benefits of industrial logging are greater at the national level. Thus, the forest conservation dilemma can be summarized as global benefits but local costs. This different order of economic incentives at different levels of the economic hierarchy can exacerbate decrease in forest area. The Kyoto Protocol can potentially overcome this obstacle to conservation by creating markets to protect forests and mitigate climate change. But despite conservation efforts, many protected areas, especially in emerging economies, continue to deteriorate, while unprotected forests turn into logging and agricultural land.

The forest is in increasing danger, statistics on forest fires from different countries shows an uptrend and this can be linked to global climate change. Moreover, there is a significant underestimation of the possible dangers

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to the forest due to man-made disasters (Zambrano, 2018).

Considerable urgency at the turn of the millennia in developing countries has acquired uncontrollable processes of environmental destruction, which can become not only the cause of political instability in many regions of the world, but also a source of environmental and epidemiological danger to the entire population of the Earth. A population explosion in developing countries due to a drop in the death rate while maintaining high birth rates as a result of national independence (LAPPÉ, 1998), led to a sharp increase in population in these countries. Over 100 years (1900–1999), the Earth's population has increased 3.5 times, while in developed countries it has increased 2.3 times, and in developing countries 4.2 times. The need to feed all this population, to ensure their employment is often solved by the shortest possible route – due to deforestation and expansion of agricultural land.

The issue of food and economic security of developing countries is closely related to the problem of barbaric logging. For example, more than a third of Asia territory is threatened with deforestation. Nearly 75% of Southeast Asia's original forest cover was destroyed when a forest area equivalent to the size of Switzerland was cut down annually. Loss of forests and land suitable for agricultural activity came from both the desire for economy extensification, and from forest and soil ecology incompetence and ignorance. Poor farmers throughout Asia use outdated irrigation and irrigation technologies, as well as extreme harmful pesticides/insecticides/fertilizers, etc., which leads to toxic and salt contamination of the soil. Regardless of the causes and methods of soil damage, not only the local areas, are directly affected the erosion effect extends to neighbouring territories, especially when this process is intensified by floods and heavy rainfall.

These and similar circumstances indicate the obvious need to invest in the creation and improvement of a system of geo-environmental monitoring, environmental protection, and sanctions enforcement for violating environmental regulations. But all these measures do not eliminate the root of the problem; in developing countries, forest is seen as something superfluous that interferes with agricultural exploitation of land, and deforestation is estimated not as destruction, but as creation – creation of agricultural land, coupled with some earnings from the sale of wood. Developing countries are performing deforestation for: (1) agriculture; (2) wood export to other countries; and (3) wood use as fuel. It is possible to reduce the heat of uncontrolled deforestation by increasing live forest potential for the local population of developing countries (Kremen, 2000). Our proposal essence is to develop the use of forest resources in a different way than by cutting, in particular, as an example of successful practice of the Republic of Bashkortostan, by the development of forest honey resources and the cultivation of honey bees on planted forests. The positive result of this approach implementation is an increase in the value of the forest for local population due to the increased returns from the economic and food exploitation of forest resources.

In modern conditions, works on accounting for non-timber forest products seem very promising (Kremen, 2000; Gorbanev, 2018), optimizing their blanks and ensuring their reproduction (Assessment, 2005). An important place among them is occupied by food, medicinal, technical, melliferous feed (Kremen, 2002; Koh, 2016), and other resources. First, it is fruits, berries and mushrooms. Along with this, a large number of honey plants create a reliable feed base for beekeeping. Forest as a storehouse of nature is the source of birch sap, turpentine, game and furs, and the integrated use of all forest resources in the form of waste (stumps, roots, bark, small and low-grade wood raw material obtained from the crown and thinning, technical greenery) provides the farm dozens of valuable products.

Materials and Methods

The territory of the Republic of Bashkortostan by forest vegetation zoning is assigned to the region of deciduous forests of the Pre-Ural forest-steppe zone.

We have analyzed the following indicators of the forest fund: harvesting wild fruit, berries and medicinal raw materials; volumes of hay harvesting on forest hay fields; and forest beekeeping – the amount of honey collection from apiaries, the number of bee colonies in apiaries. The source material for the work was chosen from the annual reports of forest areas for eight years (2010–2018). In total, study involved the materials provided to 27 forest districts, namely used reports from the following forest areas: Avzyan Forestry, Alsheevsky Forestry, Arkhangelsk Forestry, Askin Forestry, Baimak Forestry, Belokatayskoe Forestry, Beloretsk Forestry, Birsk Forestry, Burzyan Forestry, Gafuriysky Forestry, Duvansky Forestry, Dyurtyulinsky forest area, Zilairsky Forestry, Iglinsky Forestry, Inzer Forestry, Kananikolsky Forestry, Karaidelskoe Forestry, Kugarchinskoe Forestry, Makarov Forestry, Salavat Forestry, Sterlitamak Forestry, Tirlyan Forestry,

Tuymazinskoe Forestry, Ufa Forestry, Haybullinskoe Forestry, and Yanaul Forestry. These forest districts were chosen because at the initial stage of the work, the report data provided by the forest areas was checked for the accuracy of the correlation by the critical value of Student's criterion, and those satisfying the confidence interval <0.05 were taken.

Review is based on the literature on economic aspects of forest management and environmental projects. At the first stage, Google Scholar search was conducted for articles with the keywords "forest conservation", "economic incentives", "non-logging forestry", "benefits" and terms defining various types of costs and benefits (for example, "charcoal", "silk", "mushrooms", "berries", "honey") and "medicinal plants"). The keywords were used in various combinations, mainly related by the logical operators "and", to search for "topics" for all the years, a separate search was conducted among the publications of the last ten years, in order to screen out the most relevant sources. We found that many of the documents identified by this search are irrelevant to our analysis. Therefore, at the second stage, we manually selected those sources that evaluated various types of costs or benefits qualitatively or quantitatively, and offered new and non-traditional forest management practices.

We also used the State Programme "Forestry Development of the Republic of Bashkortostan" as a basic and framework document for our case study, because it provided enough statistical data for economic evaluation. The object of study – the forestry of the Republic of Bashkortostan – can be briefly characterized by the following data.

The indicator of forest cover of the Republic of Bashkortostan in 2013 was 39.82%. In the forest fund, the largest area is occupied by operational (4,051.0 thousand hectares) and protective forests (1,688.7 thousand hectares). There are no reserve forests. Over 75% of the forest area is represented by mountain forests that perform soil protection, water regulation and water protection functions. As a result of horizontal and vertical zonality, the species composition is represented by light and dark coniferous, wide-leaved, and small-leaved, as well as mixed forests. A rich assortment of tree species forms complex tree stands, a variety of types of growing conditions. Practically all types of forests are represented in the republic, and vegetation variety is observed in the living ground cover. More than 99.7% of the land covered with forest vegetation accounts for the main forest-forming species: birch, linden, pine, aspen, spruce and oak, of which coniferous farming is 22.8%, hardwood – 7.4% and soft-leaved – 69.8%.

The ratio of reforestation to deforestation decreased from 118.4% in 2008 to 66.3% in 2013. The decrease in this indicator occurred in 2010 (89.3%) due to a sharp increase in clear cuts made by tenants of forest areas, and their failure to reforestation.

In order to counter deforestation, the strategy of the State Programme "Development of Forestry of the Republic of Bashkortostan" was assumed to ensure the application of the following measures: implementation of highly efficient thinning of forest care and selectively sanitary felling; implementation of forest protection measures; reconstruction of forest plantations; organization of nursery forestry innovations; nature conservation and forest protection from fires; and scientifically based use of forests for recreational purposes. Retention is likely to be successful when the benefits outweigh the costs across all relevant decision makers. To estimate the benefits and costs, we have developed an opportunity cost scenario and compared estimates of the net benefits of integrated forest management with the net benefit costs of the opportunity cost scenario on a regional, national, and global scale. All estimates were calculated as net present value (NPV) based on market value or shadow prices obtained using standard valuation methods and relevant local, national and global data sources (10 and 30 years, based on the duration of the forestry concession in the alternative costs).

Results

Benefit Generation – Non-timber Forest Products

It is known that in the Republic of Bashkortostan there are favourable conditions for the development of beekeeping in the forests of the Bugulma-Belebeev Upland, in the state forest fund of which 66,621 hectares of plantations are concentrated with a predominance of tree stands of heart-leaved trees (*Tiliacordata* Mill.), which makes up 7% of all the linden trees of the Republic of Bashkortostan. It should be noted that other major honey plants grow here, such as European maple (*Acer platanoides* L.) and willow (*Salix*).

More than 1800 species of higher vascular plants grow on the territory of the Republic of Belarus, of which more than 300 species can be used for the needs of official and traditional medicine. In Belarus about 200 species are harvested and sold. According to 2010-2018, total volume of annual procurement of medicinal raw materials has exceeded 150 tons/year in

dry weight by the largest procurers only. The annual volumes of procurement of 47 species of medicinal plants range from 500 to 5000 kg of dry raw material per year (declared procurements only are taken into account), for another 24 types - more than 100 kg. The real volume of procurement is much higher due to unrecorded and uncontrolled procurements of vegetable raw materials by private individuals and some individual entrepreneurs. At the moment the annual harvest of vegetable raw materials is lower compared to 1970-1980 (Assessment, 2005). There is a steady increase in demand for medicines and biologically active herbal supplements.

The price lists of medicinal herbal harvesting include a number of species from the Red Book of the Republic of Bashkortostan (Kremen, 2002): mortification root (*Althaeaofficinalis* L.), barren myrtle (*Arctostaphylosuva-ursi* (L.) Spreng.), pipsissewa (*Chimaphilaumbellata* (L.) W. Barton), licorice Korzhinsky (*Glycyrrizakorshinskyi* Grig.), yellow everlasting (*Helichrysumarenarium* (L.) Moench), restharrow (*Ononisarvensis* L.), shrubby cinquefoil (*Pentaphylloidesfruticosa* (L.) O. Schwarz), needle grasses (*Stipapennata* L., *Stipadasyphylla* (Lindem.) Trautv. and others), thermopsislanceolate (*Thermopsislanceolata* R.Br.), medicinal valerian (*Valeriana officinalis* L.). In most cases, these species are purchased by organizations in other regions; however, some of them are clearly harvested in Belarus territory, which can cause significant damage to populations of rare species. Thus, plants are harvested in plant communities, where they are found with high constancy (more than 40%) and projective cover (more than 5%). The exception is made up of such species as *Orthiliasecunda*, *Gnaphaliumrossicum* and *Veronica spuria*, whose projective cover usually does not exceed 1%. At the same time, it is worth noting that it seems necessary to completely eliminate the harvesting of roots of medicinal species as the most traumatic process for rare species populations and plant communities in general, and limit harvesting of the aerial part of medicinal plants.

It was established that the area of lindens, which are sources of nectar for bees, has strong correlation with the total area of the forest fund, correlation coefficient $r = 0.76$ (Table 1).

This is due to the fact that lindens make up a significant part of the forest area, 26.7% in the region. The correlation coefficient between the area of linden groves and the number of bee colonies is 0.75, which indicates a strong correlation.

Table 1: Correlation coefficients between the indicators of the forest area and forest by-products harvesting volumes, $r_{01} > 0.05$

Indicator	*Forest area, ha*	*Thinning volumes, m^3*	*Honey flow volume, dt*	*Fruits and berries harvesting volume, dt*	*Medicinal raw materials volume, dt*	*Hay harvesting volume, dt*	*Linden area, ha*	*Bee colonies, number*
Forest area, ha	1.00	0.75	0.29	0.91	0.86	-0.24	0.67	0.54
Thinning volumes, m^3	0.75	1.00	0.64	0.92	0.59	0.22	0.64	0.86
Honey flow volume, dt	0.29	0.64	1.00	0.57	0.28	0.75	0.63	0.93
Fruits and berries harvesting volume, dt	0.91	0.92	0.57	1.00	0.84	0.00	0.74	0.8
Medicinal raw materials volume, dt	0.86	0.59	0.28	0.84	1.00	-0.02	0.76	0.51
Hay harvesting volume, dt	-0.24	0.22	0.75	0.00	-0.02	1.00	0.41	0.52
Linden area, ha	0.67	0.64	0.63	0.74	0.76	0.41	1.00	0.76
Bee colonies, number	0.54	0.86	0.93	0.8	0.51	0.52	0.76	1.00

Forest melliferous resources are associated not only with the area of linden groves, but also with other lands. In this regard, the volume of hay bales from natural hayfields is strongly associated with honey flow (r = 0.75) and, to a lesser extent, with the number of bee colonies (r = 0.52). Consequently, hayfields make an equally important part of the beekeeping feed base, but with much less attention, since the change in grasslands area shows insignificant effect on the number of bee colonies due to the fact that beekeeping is oriented towards lime.

The areas of lindens are very strongly linked with the volume of fruit and berry harvesting (r = 0.7). However, it is difficult to judge the nature of this relationship, since this correlation may be not direct, but indirect, and determined simply by large volumes of arrays of this breed, such a nature of links was also found for the volumes of preparation of medicinal raw materials (r = 0.76).

Comparing thinning volume index, we can say that the areas cut down due to active growth of herbaceous melliferous plant (French willow, raspberries, etc.) make a rich forest forage base for beekeeping. Our study determined this indicator as the volume of forestry-harvested wood. The rather high correlation coefficient between the volumes of honey collection and of harvested timber confirms that honey plants in the clearings also largely determine the honey harvest.

Volume of logging volume was found to determine the volume of fruit and berry production harvesting directly (r = 0.92) and is less associated with medicinal raw materials harvesting (0.59). Along with this, the clearing for timber is strongly associated with the gross yield of honey (r = 0.64). This can be explained as follows. After logging in the areas with enough light actively plants medicinal and nutritional value begin to grow (fruits and berries). The latter are also sources of nectar, and there stands a connection between the volume of harvesting fruit and berries raw materials and gross yield of honey flow. In all the cases described, the correlation reliability was evaluated by the critical r_{01} value or the t-Student criterion due to large number of data sources.

Study results show an interesting synergistic effect of forest beekeeping; in order to intensify the honey harvest you need to rejuvenate the forest area after selective cutting of old trees, thus this forest management practice looks as the most preferable. Result will be some amount of wood raw material, intensification of honey harvesting and collecting medicinal plants, as can be seen from Table 1.

Economic Valuation of Non-wood Products

We analyzed the economic benefits of conserving forests from a local, national, and global perspective to determine the structure of incentives that can eventually compensate for the expected benefits of deforestation or the conversion of forests into agricultural land. It is the interaction of these incentives at different scales that will determine the fate of forests. In our article, we present a new approach to the problem of combating uncontrolled deforestation. The essence of the proposed approach is to expand the range of ways to exploit non-logging forest land, increase the economic and nutritional potential with synergistic effects, preserve biocenosis diversity, increase the economic well-being of the local population, and expand the diet of the local population. To this end, we have compared the economic attractiveness of various forest management models and on this basis we single out more preferable ones for incentives.

We calculated annual revenues from NTFP, taking into account current prices on the market (Marquele-Oliveira, 2017; Monteiro, 2010; Singh, 2015; Lima, 2016; Matthews, 2018; Popescu, 2017), and appreciated the potential for increased usage. As a commentary, the smallest growth potential is demonstrated by the use of medicinal plant resources. This direction should be developed most carefully, because rare plants are primarily of interest to traditional medicine in Asian

Table 2: Comparison of the cost of supporting and expanding the forest fund with the income from non-timber forest products

Funds required for the programme of restoration and expansion of forest plantations	$ 9.4 million	
Non-timber forest products	Current harvesting, million dollars	Growth potential, million dollars
Honeyflow	7.2	12.0
Mushrooms and berries	0.142	2.38
Medicinal raw materials	0.118	0.147
Total	7.46	14.527

markets, and often not only fruits, but plants whole or in large part of them. In some cases the roots and rhizomes of the plant, this implies the destruction of the plant during the collection process, which should not be encouraged. Picking berries and mushrooms is the least used resource with the greatest collection potential. Insignificant quantities of harvested resources today are associated with a small number of people involved in harvesting. While doubling the staff leads to doubling the collection, according to forestry estimates, no more than six percent of the available raw materials in the wild forests is collected. Making a reservation, we consider some practices of collecting nuts, including pine nuts, as not sparing enough for forests, in particular, the beaters used by harvesters can damage the cedar pine integument and thus cause fungal infections of the plant. Honey harvest is the most promising. It can bring sufficient funds, and in view of the synergistic effect mentioned above, it does not create risks for the forest estate. Though, due to measures required for intensification of honey collection (in particular, thinning), it can rejuvenate the forest.

Conclusion

In Republic of Bashkortostan, correlation relationships between the forest fund and the volume of harvesting of non-timber forest resources were established. They include: volumes of honey flow, harvesting of fruit and berries and medicinal raw materials. Volumes of by-products, including honey, fruit, berry and medicinal raw materials are associated with strong correlation links with the areas of forests and especially lindens.

Estimates of correlations were made. In some cases, significant correlations were found between the efficiency of beekeeping, the areas of thinning, and the grasslands in the forest fund. On the basis of this, the important role of these sites in the general scale of non-timber forest use is shown.

The amount of harvested fruit and medicinal raw materials is determined both by the total area of forests and lindens and by thinning volumes. Strong connection between these two types of forest by-products indicates the common places of their growth, i.e. thinning plays a positive role not only as measures for the formation of high-quality stands. This makes it possible to harvest wood restore secondary forest resources. Haylands in the forest fund contribute to the strengthening of the forage base of forest beekeeping.

Such a methodology can be used to estimate under-utilized forest resources in order to intensify their use and thus preserve forests due to the increase in their economic value to the local population and local authorities. We believe that similar situations with the separation of forest use incentives exist in many countries.

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