

ORIGINAL PAPER

Implementation of non-productive services of forests in the Kozienice Forest District: an economic consequence assessment

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ABSTRACT


In recent years, there has been a marked change in public expectations of the State Forests National Forest Holding (SFNFH). Increasingly, society is calling for the abandonment of the productive function of forests in favor of protective and social ecosystem services, while at the same time requiring that the State Forests supply timber to the market. This situation gives rise to numerous conflicts between the public and the State Forests. Hence, it is necessary to raise awareness of the cost to society as a whole of based on the public demand.

This article analyzes the costs incurred by the Kozienice Forest District for nature protection as well as the implementation of protective, educational and recreational services, and calculates the opportunity costs resulting from reduced timber harvesting. The analysis of timber harvesting limitations was carried out for the period 2015-2024 which considered current costs and expenditures, as well as forecasting future trends on the basis of expenditures from an earlier period. The value of the opportunity costs due to the exclusion of a part of the stands from felling was calculated as the equivalent of the main use and compiled in two variants of stand use. These include the variant I (purely productive, when all stands are designated for felling of trees regardless of the form of nature protection and forest services), and variant II (multi-functional forest model, which does not include felling in lieu of nature conservation and designating certain stands with important non-productive forest services and special natural value). In addition, the costs of implementation of tasks in the field of nature conservation, recreation and tourism, education and provisioning access to the forest, as well as the timber value of clumps of old-growth trees left on clearcuts were also compiled.

The analysis showed that the total cost that the Kozienice Forest District incurs for the provisioning of non-productive services of forests averages 1,357,862 PLN/year which considers both the value of the opportunity costs due to reduction of fellings and the costs associated of making the forest widely available. The abandonment of timber harvesting is 85.6% of this amount, so the direct cost to the Forest District is 14.4%.

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Received: 24 January 2023; Revised: 19 June 2023; Accepted: 20 July 2023; Available online: 29 August 2023

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KEY WORDS

forest management planning, nature conservation, non-productive services of forests, opportunity costs, simulation

Introduction

State Forests National Forest Holding make an important contribution to the conservation of nature, natural habitats and species, as well as to the protection of water and soil. Every forest has a great potential to become multifunctional, even if it is currently a forest with a focus on production services. After all, over the span of a 100 years, a production forest provides a habitat for numerous species, that are both rare and protected and more common, therefore it is extremely important for biodiversity. The felling of trees, which is an integral part of forest management in production stands, contributes to the creation of specific habitat conditions that allow species associated with open clearings in forests to live and reproduce in their early stages of development (Rutkowski, 2009).

In the forests managed by State Forests, approximately 53.6% of the area is covered by protected forests, 1.5% is covered by reserves, and 38% by Natura 2000 areas. Landscape parks, protected landscape areas and other areas under nature protection (except for national parks) are under the management of the State Forests (Raport, 2021).

The extent of nature protection in State Forests stems not only from statutory forms of nature protection, but also from the legislative need to implement sustainable forest management plans. In the financial reports of the State Forests, we can only find information on the direct costs of nature protection, as well as the amounts of targeted subsidies from the state budget (Referowska-Chodak, 2017). Other costs are not reported, and determining their size requires appropriate analysis and calculations. Many authors have considered the analysis of indirect costs, including the cost of leaving deadwood in forest stands (Janeczko, 2004, 2008; Grzywacz, 2008; Balwierzak and Marszałek, 2010; Gołos and Referowska-Chodak, 2011; Kożuch, 2016). It is estimated that in State Forests the indirect costs can be as high as 500-700 million PLN (Referowska-Chodak, 2017). According to Grzywacz (2019), the ‘servitude’ from forest management conservation can be estimated to be 3 million m³ of timber per year equivalent to a value of PLN 600 million. Therefore, it can be calculated that with 429 forest districts in Poland, this is an average of about 1.4 million PLN per district.

As shown by Marszałek (2005), the average annual share of nature conservation costs in the Dukla Forest District reached a value equal to 16% (*i.e.*, 1381.6 thousand PLN) of the total costs of the forest district’s operations. Other authors (Kożuch *et al.*, 2017) have calculated the opportunity costs of nature conservation for the same forest district and showed that they totaled 161,607.79 PLN per year in 2014. Within the framework of his research, in the Dukla Forest District, Marszałek (2005) further included difficult to measure elements relating to the social environment opportunity costs of the forest district related to hunting and breeding management (in terms of species protection), as well as a forest tax credit for community conservation forests. The author also provided calculations of the opportunity costs related to the local populations loss of income due to restrictions of forestry work (felling of trees, skidding and forest maintenance activities).

In the Kolbuszowa Forest District, the share of these costs (including grants and subsidies) was estimated at 15-31% of total costs with an average annual share of 19%. In studies conducted prior, the impact of natural resource protection on the reduction of the forest district’s revenues was estimated by determining the value of deadwood left in the forest, trees left to die naturally

in ecotones and bio-groups and the cost related to the abandonment of timber harvesting in the protected areas (Peret, 2015). It should be noted that fire protection, protection from wildlife browsing, and the introduction of biocenotic reforestation are all included under the term 'natural resources'. The data above indicates the significant contribution of State Forests to the non-productive service of forests, but does not consider the full value of these ecosystem services to society as many of them are difficult to measure or are not measurable at all (Płotkowski, 2008).

In the Koziencice Forest District, an analysis of the economic consequences and management problems resulting from nature conservation was carried out for the period from 2001-2010. It was found that the lack of a methodical economic analysis of the forest district makes it impossible to state unequivocally what the degree of direct impact of nature conservation is on the financial result known as the efficiency of management (Wasiak and Sot, 2010).

This article analyzes the costs incurred by the Koziencice Forest District for nature protection, the implementation of protection activities, educational and recreational services, and calculates the opportunity costs related to the cessation of forest use.

Characteristics of the research area

The Koziencice Forest District is characterized by its high natural value and is located in an area intensively visited by people interested in various forms of forest recreation. It is also an area which has been the subject of many studies conducted by scientific units. The research area is located in the Koziencicka Forest. The core area of the forest belonged to royal estates for centuries. During the feudal period, hunting and beekeeping were the main activities carried out there. From the 16th century onwards, with the development of lumbering, mass exploitation of timber began. In 1554, the first forest inventory was carried out to determine the timber resources of the royal forests. In the 18th century, the progressive development of agriculture and population growth contributed to the heavy exploitation of timber and a reduction of the forest area. In 1793, one of the first forest inventory in the country was carried out, which consisted of a general description of the species composition of each forest stand, an inventory of the game, determination of the volume of timber to be harvested and designation of forest areas to be felled. Since then, efforts have been made to eliminate over-exploitation and moving towards planned use of forest resources (Wasiak and Sot, 2010).

There are 9 partial reserves in the forest district with a total area of 525.48 hectares. Prof. Ryszard Zaręba's Koziencice Landscape Park was established in 1983 and was enlarged in 2001. It currently covers 10902.91 hectares of the Koziencice Forest, and it aims to preserve the local natural landscape geography and important natural areas of the Koziencice Forest which are rich with herbaceous vegetation and interesting landforms.

The area of the Koziencice Forest District is part of two Natura 2000 areas including: SPA – Birds Directive Site 'Ostoja Koziencicka' which covers 14639.49 hectares of the forest district and SAC – Habitats Directive Site 'Puszcza Koziencicka' which covers 12509.21 hectares of the forest district. In total, Natura 200 areas cover 97% of the territory of the Koziencice Forest District.

In the territory of the Koziencice Forest District, 5 protection zones have been created (all for the black stork) with a total area of 168.08 hectares including 52.20 hectares of year-round protection and 115.88 hectares of periodic protection.

Based on the dominant services of forests, regulatory units called stand management types are designated within the forest concession. In the forest management plan that defines the tasks of forest management in the entire forest district, there are three management categories: special (S), protective (O) and economic (G) stand management types. Special stand manage-

ment type (S) includes forest stands performing specific services that limit or prevent production functions which include the following: reserves, soil-protective forests, forests constituting valuable fragments of nature, seed stands, forests of special importance for the defense and security of the State, forests constituting a refuge for animals subject to species protection, and forests located on permanent research and experimental plots. In the territory of the Koziernice Forest District, the category of forests constituting valuable fragments of native nature with the most valuable natural communities include the following: the habitats of coniferous swamp forests, coniferous mixed swamp forests and mixed swamp forests, as well as the protected natural habitat of the Euro-Siberian forest-steppe with *Quercus* spp. (Forest stand of 9110 Natura 2000 habitat). In total, there is an area of approximately 65 hectares consisting of 27 plots where no final cutting has been planned and silvicultural activities and pre-felling were adapted to the current needs of the stands.

Conservation stand management type (O) is characterized by protected forests not included in the special stand management type (S) The main objective of this type (O) is considered to be the protection of biodiversity and allowing for the possibility of conducting production activities (only in justified cases and to a limited extent).

The remaining stands have been classified economic stand management type (G) with the following subtypes: clearcut stand management type (Z) which either allows clear-cutting (GZ) or partial and group clearcut stand management type (GPZ). In addition, the forest district also has the reconstruction stand management type (R). They are mostly made up of stands incompatible with stand type (TD) and those undergoing or designated for reconstruction (PUL, 2011).

Materials and method

In order to demonstrate the opportunity costs related to the partial exclusion of the stands from felling, a simulation of allowable cut calculations was conducted in two variants for the 10-year period from 2015-2024. The data for the simulation was obtained from the State Forests Information System.

To prepare the simulation, an empirical model based on deterministic assumptions was used which was developed within the framework of the project entitled: 'Management determinants of regulation of utilization taking into account evenness of harvesting and improvement of resources in a regional system' in the Department of Forest Management and Economics of the Warsaw University of Life Sciences (Borecki *et al.*, 2017; Borecki *et al.*, 2018).

Using specialized, original software (Borecki *et al.*, 2017), a simulation was prepared for two forest management following variants:

- Variant I – the model assumes forest management in accordance with the principles of silviculture and forest management in all forest stands, including those recognized as protected under nature protection regulations and the Polish Forest Law, as well as internal regulations of the State Forests. In this variant, all stands described as special (S) and protected (O) will be described in the model as economic (G). Consequently, the simulation of changes in the volume of these stands will not take into account modifications in use related to the protected status. This is a purely productive option of forest management.
- Variant II – baseline model, assumes operations on the basis of the current multifunctional model of forest management in Poland. In this variant, the type of special (S) and protected forests (O) has not been changed to economic (G), and the simulation of changes

in stand volume takes into account the necessity of no action or different forest management in these stands. In this variant, the structure of stand types has not changed and is consistent with the forest management plan (PUL, 2011).

For each of the variants the simulation is done for 10-year periods (an assumption closely related to the duration of Forest Management Plans in Poland) and the basic unit for calculations and simulations is the stand unit. The input data for the model is a database from SILP and the output data obtained is in the form of tabular data and geometric data (.shp files) for each forecast period. The simulation process is based on algorithms that take into account, among other things, the constraints of the State Forests internal regulations. For each stand unit, the increment is decided (taking into account the current forest inventory description), the calculation of the forest stand is conducted (separately for each stand type), and the selection of stands for felling is determined. In addition, at the end of each 10-year forecasting period, the forest inventory is updated (including growing stock, species age and species composition). It is possible to change the parameters affecting the final results, such as stand type or felling type. This following option was utilized in the present research: during the preparation of the database for Variant I, stand types were automatically converted into economic ones, while at the same time the correct type of cutting was assigned to them (including for special stands where no fellings were planned).

The forest management plan for the Kozienice Forest District for 2011-2020 assumes much higher fellings, and at the same time lower pre-fellings than assumed in the above simulation. However, this is a result of lowering the average felling age by 10 years and switching from group felling, used mainly for transformation of solid stands (IIIA), to clear felling (IB) in the fresh mixed coniferous forest (BMśw) habitat. In practice, this will mean a much higher unobserved benefit from forest protection services than assumed.

The multifunctional scenario also consider the presence of clumps of trees left in felling areas. The opportunity costs of leaving clumps after clear-cuts and along roads and watercourses were calculated. The calculations were made based on the current area of tree groups which is 185.23 hectares. 24 years of tree group formation was assumed gives a value of 7.72 hectares when converted to 1 year and 77.20 hectares for 10 years. The estimated stock of these tree groups was determined based on the average stock which is 300m³/ha for clear-cut stands.

The opportunity costs from certain non-productive forests management services was the result of an analysis of the differences in the size of tree fellings in the two variants studied. The difference between the alternatives was then multiplied by the average timber sale price reported by Statistics Poland (GUS, 2020). Average sales prices by assortment class were determined on the basis of data obtained from the Kozienice Forest District for 2015-2020. The average sales price of 1 m³ of wood in the Kozienice Forest District was 207.20 PLN.

Costs for the implementation of tasks in the field of nature protection, recreation and tourism, education and access to the forest were the result of an analysis of expenditure invoices from the Kozienice Forest District from 2015-2020. These invoices, for the purpose of reporting to Statistics Poland, were categorized by codes which made it possible to group them, and then to summarize the cost of task implementation within each of the group categories. For the period from 2021-2024, costs were assumed on the basis of expenses for earlier periods in consideration of their trends in prior years. This was due to the adopted 10-year analysis period.

The total annual costs incurred for nature conservation and providing forests for recreation and tourism were calculated based on the following formula:

$$Kc = (Wuk + Wdnp + Kop)/10 \text{ [PLN/year]}$$

where:

Kc – total costs of protection and providing access to the forest,

Wuk – the value of opportunity costs due to abandonment of cuts in lieu of conservation and non-productive services of forests,

$Wdnp$ – the value of timber left in tree groups,

Kop – the value of costs incurred for nature conservation, recreation and education.

Results

The results of the opportunity costs from the non-productive services of forest management, are based on the difference in the volume of timber harvested between the alternatives.

It was found that that over a 10-year period, the use of clear-cutting in variant II (*i.e.*, with the multifunctional service approach), compared to use of clear-cutting planned in variant I (*i.e.*, with the purely productive approach) will decrease by 42,579 m³. Pre-felling utilization, on the other hand, in variant II will increase during this period by 9,665 m³. The total allowable cut, which consists of the sum of the volume of clear-cutting and pre-cutting utilization, in variant II will decrease in the analysis period by 32,914 m³. The average price obtained in the 2015-2020 period without a small M wood assortment was 207.20 PLN per 1 m³. Converting the total volume into PLN, the lost value would be 6,819,781 PLN/10 years (Table 1.).

The volume of trees left in the tree groups is 23,160 m³/10 years. The opportunity cost of not felling groups of trees amounts to 4,798,752 PLN/10 years (Table 2.).

The results of the Kozenice Forest District's costs of making the forest available for recreational and educational purposes amount to a total value of 1,960,086 PLN for a period of 10 years (Table 3).

The total cost was calculated by substituting the obtained sub-values into the aforementioned formula as follows:

$$Kc = (6,819,781 + 4,798,752 + 1,960,086)/10 = 13,578,619/10 = 1,357,862 \text{ [PLN/year]}$$

where:

Wuk – 6,819,781 PLN,

$Wdnp$ – 4,798,752 PLN,

Kop – 1,960,086 PLN.

Table 1.

Summary of planned stand use for the period 2015-2024 in two variants: economic and multifunctional

Usage variant	Final cutting products	Intermediate cutting products	Allowable cut
Variant I [m ³]	695,213	491,714	1,186,928
Variant II [m ³]	652,635	501,379	1,154,014
Difference [m ³]	42,579	-9,665	32914
Opportunity costs – average price 207,20 PLN per 1 m ³ [PLN]	8,822,284	-2,002,586	6,819,781

Table 2.

Parameters for leaving tree groups during forest management

Clump area [ha/10 years]	Average growing stock [m ³ /ha]	Total growing stock [m ³ /10 years]	Price 1 m ³ [PLN]	Value (Wdnp) [PLN]
77,20	300	23,160	207,20	4,798,752

Table 3.

Costs incurred for non-productive services of forests [PLN]

Years	UT-PROLKP	UT-TURYST	UT-POZINF	UT-CZYLKP	Total
2015	10,104	68,886	19,753	66,016	166,774
2016	16,499	70,764	9,891	60,000	159,170
2017	32,828	94,644	11,101	67,266	207,856
2018	34,736	99,738	12,602	58,184	207,278
2019	42,545	101,952	15,868	63,142	225,526
2020	6,450	43,416	5,037	61,168	118,091
2021	37,000	99,329	17,556	61,972	200,322
2022	38,000	100,000	18,000	62,000	220,022
2023	38,000	100,000	18,000	62,000	220,023
2024	40,000	110,000	19,000	64,000	235,024
Total	296,162	888,729	129,252	625,748	1,960,086

Abbreviations in the table: UT-PROLKP – promotion, participation in actions, festivals, forest education, UT-TURYST, UT-POZINF – tourist management of the forest, vehicle parking places, shrines, national memorials, cleaning work, maintenance, UT-CZYLKP – forest education facilities, protection, cleaning, maintenance

The total cost of maintaining the non-productive services of forest from 2015-2024 in the Kozienice Forest District will total 13,578,619 PLN. Therefore, the average annual total of opportunity costs and costs incurred by the Forest District for nature protection, tourism and recreation, education and providing forest accessibility will total 1,357,862 PLN/year.

It should be noted that the aforementioned opportunity costs do not consider various costs and unobserved benefits that are difficult to measure. This includes, for example, leaving deadwood in the forest, the foraging utility of mushrooms and berries, increasing biodiversity, collection of medicinal plants and various other benefits. Unlike the study conducted in the Dukla Forest District (Marszałek, 2005), unobserved benefits in the social environment of the forest district (including those related to species protection and forestry works) were also not included.

Discussion and conclusion

In recent years, State Forests National Forest Holding is expected, on the one hand, to increase timber harvesting for the timber industry, and, on the other, to reduce harvesting and allocate parts of forests to strict nature conservation. The Biodiversity Strategy for 2030 (European Commission, 2020), which is currently being widely discussed in forestry, envisions the placement of significant areas of forest and possibly water under strict protection. It is planning to place approximately 10% of the country's area under strict protection, possibly allowing recreation and non-productive use of forests.

Since the 1990s, forestry has increasingly made the forest available for public use, but public opinion in an era of increasing affluence and environmental awareness is moving in the direction of the gradual abandonment of timber harvesting. In the future, pressure for providing public benefits in forest management and the forest is expected to continue to increase at the expense of reduced production services (Gołos and Kaliszewski, 2016). A similar trend applies not only to Polish forestry but in other countries as well (Kniivilä and Saastamoinen, 2002; Webb *et al.*, 2007; Stachova, 2019).

The ideological approach to forestry of a small segment of society which has a strong influence on public opinion shaped by media is often a source of conflict between the public and foresters. A strong belief in their own interests and unwillingness to consider rational arguments means that attempts to foster discussion with this segment of society most often fail.

The results of this study confirm the calculations of other authors, who reported the amount of forest service opportunity costs incurred by one forest district at about PLN 1.4 million per year (Grzywacz, 2019). In our analysis, both sets of data were collated and analyzed, and illustrate the costs of making the forest available for recreational and educational purposes (based on expenditure invoices) and data from the computer simulation (from which information on the opportunity costs from the implementation of non-productive service of forest management was obtained). Despite the significant differences in the methodology adopted [unlike Marszałek (2005) or Grzywacz (2019)], the study did not take into account the social environment opportunity costs of the forest district, the average annual total of opportunity costs and costs incurred by the Koziencice Forest District's by broadly defined nonproductive forest services will be PLN 1,357,862/year. Thus, this result is comparable to the costs presented so far in other literature.

Despite the gradual increase in the public's knowledge of nature conservation, the majority of people are still unaware that they are participating in the creation of the non-productive service of forests and nature conservation. Thus, it incurs direct costs for the implementation of nature protection (national parks, Natura 2000 and conservation authorities), as well as indirect costs that are generated by the State Forests. The lack of such societal knowledge results in conflicts or stereotypes about the exclusively exploitative nature of a forester's work (Olaczek, 2012).

It seems, however, that evidence in the form of concrete financial cost calculations incurred by the State Forests for making forests available for non-productive purposes and the associated forgoing of income by reducing timber harvesting for nature conservation will help make society aware of the actual cost of multifunctional forest management. The method of forecasting the volume of use adopted in this article, which depends on the adopted assumptions of the procedure, should be applied in all forest districts of Poland.

Authors' contributions

K.S. – the research concept, methodology, analysis, manuscript preparation; T.S. – sample collection, analysis, manuscripts corrections; N.Z. – sample collection, analysis; K.Z. – analysis, manuscript corrections; R.W. – the research concept, methodology, analysis, manuscript review and corrections.

Conflicts of interest

The authors declare the absence of potential conflicts of interest.

Funding

This research received no external funding.

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Ekonomiczne konsekwencje realizacji pozaprodukcyjnych funkcji lasu w Nadleśnictwie Kozienice

W ostatnich latach obserwuje się wyraźną zmianę oczekiwań społecznych wobec Lasów Państwowych. Coraz częściej społeczeństwo postuluje zaniechanie funkcji produkcyjnych lasu na rzecz funkcji ochronnych i społecznych, jednocześnie, niekonsekwentnie, wymagając od Lasów Państwowych dostaw surowca na rynek drzewny. Sytuacja ta rodzi wiele konfliktów i napięć, stąd niezbędne jest uświadamianie, jaki koszt ponosi całe społeczeństwo z tytułu wysuwanych żądań.

W artykule przeprowadzono analizę kosztów ponoszonych przez Nadleśnictwo Kozienice na ochronę przyrody i realizację funkcji ochronnych, edukacyjnych i rekreacyjnych oraz wyliczono koszty utraconych korzyści (koszty alternatywne) wynikające z zaniechania użytkowania lasu. Analizę ograniczenia pozyskania surowca drzewnego przeprowadzono za okres 2015-2024, uwzględniając w obliczeniach aktualne koszty i nakłady ponoszone w obecnym stanie prawnym i sytuacji społecznej, jak również prognozując przyszłe trendy na podstawie wydatków za wcześniejszy okres (tab. 1). Wartość kosztów alternatywnych z tytułu wyłączenia części drzewostanów z użytkowania stanowiły wyliczenia etatów użytkowania głównego zestawione w 2 wariantach użytkowania drzewostanów: wariant I (model produkcyjny, w którym do cięć przeznaczono wszystkie drzewostany bez względu na formę ochrony i pełnione funkcje) oraz wariant II (model lasu wielofunkcyjnego, w którym nie zaplanowano cięć rębnych w obszarach ochrony przyrody, drzewostanach z ważnymi funkcjami pozaprodukcyjnymi oraz w drzewostanach o szczególnych walorach przyrodniczych). Dodatkowo zestawiono koszty realizacji zadań z zakresu ochrony przyrody, rekreacji i turystyki, edukacji i udostępniania lasu (tab. 3) oraz wartość drewna pozostawionego na kępach (tab. 2).

Całkowite roczne nakłady ponoszone na ochronę przyrody i udostępnianie lasów do rekreacji i turystyki obliczono na podstawie wzoru:

$$Kc = (Wuk + Wdnp + Kop)/10 \text{ [zł/rok]}$$

gdzie:

Kc – łączne koszty ochrony i udostępniania lasu;

Wuk – wartość kosztów alternatywnych z tytułu rezygnacji z wyrębów dla funkcji ochronnej i pozaprodukcyjnej lasów;

Wdnp – wartość drewna pozostawionego w grupach drzew;

Kop – wartość nakładów poniesionych na ochronę przyrody, rekreację i edukację.

Analizy wykazały, że całkowity koszt, jaki ponosi Nadleśnictwo Kozienice na utrzymanie funkcji pozaprodukcyjnych, uwzględniający zarówno utracone korzyści, jak i koszty związane z szeroko rozumianym udostępnianiem lasu, wynosi średnio 1 357 862 zł/rok. Rezygnacja z pozyskania drewna to 85,6% tej kwoty, zatem bezpośrednie koszty ponoszone przez Nadleśnictwo stanowią 14,4%.