SYLWAN 168 (4): 233-252, April 2024
https://doi.org/10.26202/sylwan.2024005
Journal homepage: https://sylwan-journal.pl

REVIEW PAPER

From forest functions to forest ecosystem services – the evolution of the attitude towards forest benefits in Poland

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ABSTRACT

This article presents the concept of forest functions (FF) as well as the emergence and development of the concept and understanding of FF and its significance for the model of multifunctional forest management in Poland in the last century, since the end of the First World War. Against this background, the concept of ecosystem services (ES) is discussed and the differences to the concept of FF are shown, as well as the possibilities arising from a broader adoption of the idea of ES in practise as a complement to the model of multifunctional forest management. The study was conducted on the basis of a content analysis of legal acts and programme documents on forest management to include issues of FF and multifunctionality of forest management and was complemented by a literature review of the four most important Polish forest science journals ('Sylwan', 'Folia Forestalia Polonica', 'Leśne Prace Badawcze' and 'Polish Journal of Forestry'). Based on the collected source material and its characteristics, four thematic areas were defined, for which a detailed content analysis was carried out: the concept of FF and multifunctional forest management; the concept of ES; FF and ES in Polish literature on this topic; FF and ES in legal acts and programme documents; FF and ES in operational documents of forest management in Poland. We conclude that although both concepts have different origins, they have many points of contact and are largely complementary. Neither concept is free of drawbacks, but the increasing popularity of the ES concept in relation to forests suggests that it compensates for and complements the shortcomings of the FF concept. Although the concept of ES is currently not clearly included in Polish forest-related legislation, which is based on the concept of FF, this is likely to change in the future as this concept is used in more and more strategic and programmatic environmental documents. The ES concept, which offers the possibility to quantify, map, evaluate and value forest ES based on ES indicators, can be a very useful tool for planning forest management and conservation measures at the local level or for designing forest and environmental policies at the regional or national level.

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Received: 31 January 2024; Revised: 23 April 2024; Accepted: 7 May 2024; Available online: 12 June 2024

KEY WORDS

CICES, indicators, multifunctionality, sustainable forest management

Introduction

The aim of sustainable forest management is to maintain the structure of forests and their use in such a way that the fulfilment of all relevant ecological, economic and social functions is guaranteed without damaging other ecosystems. The way to achieve this is through the model of multifunctional forestry, which aims, among other things, to balance the various needs of society. As forests fulfil many important and diverse functions, they are a key element for ecological security, the preservation of biodiversity and the satisfaction of many economic and social needs (Rykowski, 2006).

The understanding of the functions of the forest and the awareness of the importance of the various services provided by the forest have changed over time. With economic development, more and more importance was attached to timber production, which in extreme cases led to the complete destruction of forest ecosystems. The progressive degradation of the natural environment since the industrial revolution and the growing research-based public awareness since the turn of the 20th century have contributed to viewing the forest not only in terms of its production potential, but over time primarily as a complex natural system that provides for human well-being in the broadest sense and is essential for the functioning of the biosphere. The recognition of the importance of natural capital, including forests, as an essential component of the development and well-being of societies has, after a long evolution, been summarised under the concept of ecosystem services (Klocek, 2005).

This article presents the concept of forest functions (FF) as well as the genesis and evolution of the concept and understanding of FF and its significance for the model of multifunctional forest management in Poland in the last century, since the end of the First World War. Against this background, the concept of ecosystem services (ES) is discussed and the differences to the concept of FF are pointed out, as well as the possibilities arising from a broader adoption of the idea of ES in practise as a complement to the model of multifunctional forest management.

Material and methods

The study was carried out on the basis of a content analysis of legal acts and programme documents on forest management in order to include issues of forest function and the multifunctionality of forest management (McNabb, 2010; Weimer and Winning, 2010; van Thiel, 2014). The characteristics of the concept of FF and the concept of ES as well as their interrelationships are presented on the basis of selected literature on this topic, in particular papers published in the journals: 'Sylwan', 'Folia Forestalia Polonica', 'Leśne Prace Badawcze' and 'Acta Scientiarum Polonorum Silvarum Colendarum Ratio et Industria Lignaria' ('Polish Journal of Forestry'), as these are easily accessible open access journals aimed at the Polish research community and foresters (until recently, some of them were published only in Polish), and the paper focuses on the evolution of the FF and ES concepts in Poland. Due to the complexity of the topic, the final selection of the works to be analysed was based on an expert approach, whereby those works and documents were selected that were of fundamental importance for the subject area.

On the basis of the collected source material and its characteristics, four thematic areas were defined for which a detailed content analysis was carried out: 1) the concept of FF and multifunctional forest management; 2) the concept of ES; 3) FF and ES in Polish literature on

this topic; 4) FF and services in legal acts and programme documents; 5) FF and services in operational documents of forest management (instructions and rules used in the State Forests National Forest Holding – the largest Polish forest management enterprise).

Results and discussion

THE CONCEPT OF FF AND MULTIFUNCTIONAL FOREST MANAGEMENT. The importance of the forest in the economic life of Europe began to increase in the 15th century, which went hand in hand with the intensification of the processes of urban development and, in later centuries, industry and the growing demand for wood as a building material and fuel. The unrestricted utilisation of forests led to an unprecedented devastation of forests in the 18th century, especially near cities and in economically developed areas (Klocek, 1999). This critical situation and the increasing scarcity of wood led to the formulation of the principle of sustainability in the 18th century, first for wood supply and then for wood production. This defined the principles of regeneration, care and protection of the forest and its utilisation in such a way as to prevent further destruction and enable the restoration of forest resources (Klocek, 2005). The principle of sustainable forest management served to produce as much timber as possible and thus secure high revenues for the state (Klocek, 1999).

At the beginning of the 19th century, liberal economic theory developed, which recognised the private interest of the individual as the most important driving force behind economic development. The linking of private interests with the interests of society and the achievement of economic equilibrium was to be guaranteed by free competition, which A. Smith described as 'the invisible hand of the market' (Daly and Farley, 2011). The adoption of the principles of classical economics in forestry was reflected in the fact that the land and later the tree stands were recognised as the basic capital of forest management and the income from this management as an annuity on this capital. Instead, the aim of management became the maximisation of profitability (Klocek, 1998). This principle was increasingly criticised and was considerably restricted in the second half of the 19th century (Klocek, 1999). At that time, the various benefits that humans derive from forests and the need for 'modern' forest management to end the intensive exploitation of forests and ensure sustainable timber production were discussed. The first works on the various benefits of forests appeared in the early 19th century (Bader and Riegert, 2011). At that time and in the following decades, however, the term 'forest functions' was not used, but rather its synonyms. In 1894, for example, Schwappach used the term 'economically important forests (direct material benefits and employment) and immaterial benefits of forests', whereby he counted timber and non-timber utilisation among the material benefits and the importance for climate, water and health among the immaterial benefits (Pistorius *et al*., 2012).

It is recognised that the term 'forest functions' was introduced and popularised by Dieterich in 1953 when he formulated the doctrine of FF as the basis of multifunctional forestry based on the principle of sustainability. Dieterich's intention was to describe the relationship between forests and people using the terms 'services', 'effects', 'welfare services' and 'functions' whereby the first two terms are interchangeable. Services are natural effects of the forest that become 'welfare services' when they fulfil societal needs, and societal needs are referred to as 'functions of the forest' (Bader and Riegert, 2011).

Dieterich's concept was expanded in subsequent years to include protective and recreational functions, thus laying the foundation for today's definition of sustainable forest management, which takes equal account of ecological, economic and social aspects and corresponds to the concept of sustainability defined at the Earth Summit in Rio de Janeiro in 1992 (Volz, 2006) and is supported by the Forest Europe Process (MCPFE, 1993).

The concept of ES. The term environmental services was first used in the 1970s in the United States to refer to insect pollination, fisheries, climate regulation and flood control. The term ecosystem services/benefits used today was used a decade later, in the early 1980s, in the context of the extinction and replacement of populations, species and guilds and the resulting loss of ES (Solon *et al*., 2017). An important contribution to the popularisation of the concept was made by Costanza and his colleagues (Costanza *et al*., 1997), who attempted to estimate the global economic value of 17 different ES. The authors estimated their value at around USD 33 trillion per year, which at the time was more than the entire global gross national product (around USD 18 trillion).

A turning point in the popularisation of the concept of ES was the publication of the Millennium Ecosystem Assessment (MEA) (Hassan *et al*., 2005), a human impact assessment developed under the auspices of the United Nations between 2001 and 2005. The MEA defined ES in the broadest sense as 'the benefits people obtain from ecosystems'. Despite numerous proposals by other authors (Boyd and Banzhaf, 2007; Danley and Widmark, 2016), the definition formulated in the MEA is currently one of the most widely used (Bartkowski, 2017).

MEA views ecosystems and society as two different spheres. Nature is seen as a fixed capital stock (functions) that can – with limitations – provide a variety of benefits to humans (Costanza and Daly, 1992). Ecosystems contribute to human well-being through the services they provide, from which society as a whole benefits. ES are thus the link between ecosystems and society, and there is a dynamic relationship between the two spheres: humans cause – directly or indirectly – changes in ecosystems, and changes in ecosystems affect humans (Hassan *et al*., 2005). ES be described at different spatial and temporal scales, and people's perceptions depend to a large extent on perceptions and value systems that are shaped by the cultural context (Pistorius *et al*., 2012).

The MEA distinguishes between four categories of ES: provisioning, regulating, cultural and supporting services (Hassan *et al*., 2005). In the classification of The Economics of Ecosystems and Biodiversity (TEEB) project initiated by the German government, the European Commission and United Nations Environment Programme, the category of supporting services, which is considered by TEEB as a sub-category of ecological processes, is not taken into account. Instead, habitat services were introduced to emphasise the importance of ecosystems in providing habitat for migratory species and protecting genetic resources (Kumar, 2012). The widely used Common International Classification of Ecosystem Services (CICES), on the other hand, distinguishes three categories of ES: provisioning, regulating and cultural services (Haines-Young and Potschin, 2018).

Despite the differences in structure and nomenclature used, the classifications of ES are based on a version of the cascade model, in which ecosystems and biodiversity form the platform for processes that shape biophysical structures (Bartkowski, 2017), while the final ES represent the link between structures, processes and functions, and the goods and benefits that arise for humans from these services (Fig. 1). Ecosystem processes (*e.g.* photosynthesis) lead to the activation of functions (*e.g.* biomass production), resulting in services (*e.g.* wood) and consequently benefits (*e.g.* harvested wood) for humans (*e.g.* contribution to health), which have their own (economic) value (Haines-Young and Potschin, 2018).

The concept of ES is based on determining the benefits that people derive from ecosystems. In modern economics, the concept of value is identified with the subjective characteristic of a particular good or service, which consists in its utility. The value of environmental goods, which is based on the subjective valuation of goods and services, consists of a number of different categories (Fiedor *et al*., 2002). The ES provided by forests are generally not market goods, but since

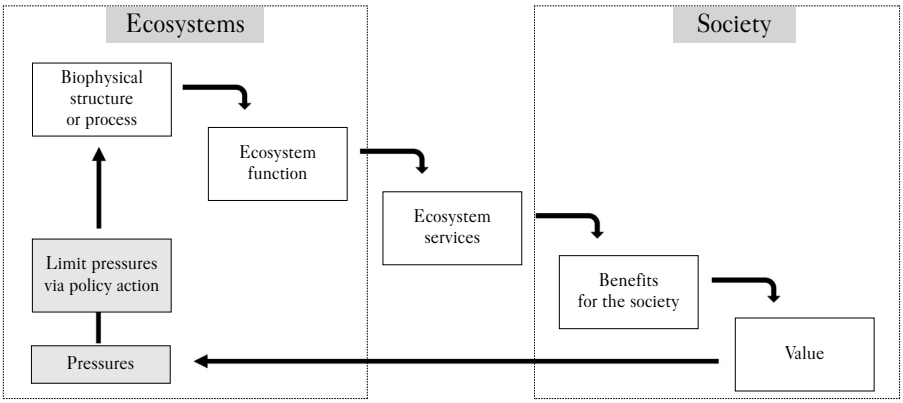

Fig. 1.

Cascade model describing the relationship between ecosystems and society in the context of the concept of ecosystem services

Source: own elaboration based on Potschin and Haines-Young (2011)

they fulfil (directly or indirectly) the needs of society, they have a real value. For many years, the value of a forest was equated with the market value of the raw materials it provides – timber, game, fruits of the undergrowth, and so on. Forests and forest management provide numerous regulating and cultural services (in addition to the provisioning services mentioned above). Most of these services are non-market goods. This means that although they directly or indirectly satisfy the needs of society, they are not traded on the market – their market price is not known.

The development of indicators that describe the individual services at different levels of detail is crucial for the operationalisation of the concept of ES. Indicators can be defined as physical elements of ecosystems that can be measured using available tools and knowledge. They should be easy to visualise for decision-makers and practitioners, support awareness-raising and provide a basis for establishing effective monitoring of the ES under study (Feld *et al*., 2009). In recent years, there have been several attempts to systematise indicators and create a coherent set that allows the scientific community and practitioners to track environmental change (Grima *et al*., 2023). One of the most widely used classifications is CICES, which was developed based on the work of the European Environment Agency on environmental accounting. Table 1 shows the most important forest ES and example indicators that characterise them.

The CICES classification is general in nature and its application in practise requires adaptation of indicators to national or regional conditions and available data sources. The development of forest ecosystem service indicators for Poland was one of the tasks carried out as part of the project 'Services provided by main types of ecosystems in Poland – an applied approach' (Kaliszewski *et al*., 2023b). One of the results of the conducted research was the creation of a set of forest ES indicators that can be used in the planning and decision-making process in Poland. These indicators are presented in Table 2.

FF and ES in the Polish literature on this topic. In the late 1960s and early 1970s, Mierzwiński (1970) focussed on the restoration of protected stands while retaining their landscape functions. In the mid-1970s, Więcko (1975) focussed on the role of FF in shaping and protecting the natural environment. Two decades later, Ważyński (1994) presented an analysis of the complex formation of FF for the purposes of forest management and spatial management, and Łopiński (2008) assessed the need to restore forest stands depending on the predominant forest function.

Table 1.
The most important forest ecosystem services (CICES nomenclature) and the indicators that characterise them

Section	Division	Group	Code	Indicator	Unit
Provisioning	biomass	cultivated terrestrial plants for nutrition, materials or energy	1.1.1.2	growing stock	m^3 or m^3/ha
			1.1.1.2	volume increment	m^3/ha/year
			1.1.1.2	timber harvest / harvest intensity	m^3 or m^3/ha / % of increment
			1.1.1.3	wood fuel stock	m^3/ha or fraction of growing stock
		wild plants (terrestrial and aquatic) for nutrition, materials or energy	1.1.5.1	potential berries production	kg/ha/year
			1.1.5.1	potential honey production	kg/ha/year
			1.1.5.1	wild berries, fruits and mushroom harvest	tons; PLN
			1.1.6.1	amount of meat (hunting)	tons
			1.1.6.1	value of game meat	PLN
	genetic material from all biota (including seed, spore or gamete production)	genetic material from organisms	1.2.2.3	raw materials for medicines	forest floor area; average area covered by an individual; average of dry mass of an individual plant; potential dry mass of plant parts of individual species per hectare
Regulating	regulation of physical, chemical, biological conditions	regulation of baseline flows and extreme events	2.2.1.1	erosion risk mitigation	t, t/ha
			2.2.1.3	water retentio in forests	mm or – depending on a scale – m^3 to Mm^3; WRP index – water retention potential index
			2.2.1.3	water storage/delivery capacity of soil	mm or – depending on a scale – m^3 to Mm^3
			2.2.1.3	water supply and discharge (hydrological modelling)	mm, measures of valume/unit of time also per unit area
	regulation of physical, chemical, biological conditions	lifecycle maintenance, habitat and gene pool protection	2.2.2.1	indicator of relative pollination potential	scale 0 to 1
			2.2.2.3	area of Natura 2000 sites	share, occurrence
		regulation of soil quality	2.2.4.1	forest soil condition: chemical soil properties	t C/ha
			2.2.4.2	amount of dead wood	m^3 or m^3/ha

Table 1. continued

Section	Division	Group	Code	Indicator	Unit
			2.2.6.1	potential performance of oxygen emissions	t/ha/year
			2.2.6.1	C storage in forests	t/ha
		atmospheric composition and conditions	2.2.6.1	C sequestration by forest (Net Primary Production; Net Ecosystem Production)	t/ha or t/ha/year
			2.2.6.1	regulation of thermal conditions – reduction of air temperature	℃
			2.2.6.2	ozone pollution and particulate matter	ppm; μg/m^3
Cultural	direct, *in-situ* and outdoor interactions with living systems that depend on presence in the environmental setting	physical and experiential interactions with natural environment	3.1.1.1	distribution of wildlife / emblematic species associated with forest	1) presence / absence 2) number of individuals per 1000 ha 3) number of couples per area
			3.1.1.1	stands suitable for recreation	range scale
			3.1.1.1	recreational infrastructure facilities	items/km^2 of forest
			3.1.1.1	length of tourist trails	km/km^2
			3.1.1.1	length of educational paths	km/km^2
		spiritual, symbolic and other interactions with natural environment	3.2.1.1	number of sites with recognised cultural and spiritual value	range scale or number of sites per km^2
			3.2.1.2	number of sites with recognised cultural and spiritual value	range scale or number of sites per km^2
	Indirect, remote, often indoor interactions with living systems that do not require presence in the environmental setting	other biotic characteristics that have a non-use value	3.2.2.1	biodiversity index	unnamed
			3.2.2.1	distribution of sites of community importance (special habitats)	share, occurrence
			3.2.2.1	protective forests - refuges for animals and sites of plants subject to species protection	share, occurrence
			3.2.2.1	conservation status of forest priority species (Natura 2000)	indicator
			3.2.2.2	distribution of sites with forest designated as having cultural values	hectares, share in the area of a forest district

Table 2.
Proposed set of forest ES indicators to be used in Poland (the result of the ECOSER-POL project)

Ecosystem service	Sample indicator
Provisioning services	
Timber	growing stock [m^3 or m^3/ha]
	volume increment [m^3/ha/year]
	timber harvest [m^3 or m^3/ha]
	timber harvest intensity [% of increment]
Forest fruits	potential berries production [kg/ha/year]
Honey	potential honey production [kg/ha/year]
Raw materials for medicines	forest floor area [ha]
	potential dry mass of plant species [kg/ha]
Game meat	amount of meat – hunting [t]
	value of game meat [PLN]
Regulating services	
Erosion control	erosion risk mitigation [t, t/ha]
Regulation of the hydrological cycle	water-protective forests [share in %, occurrence]
	water retention in forests [mm or m^3]
	water storage in soils [mm or m^3]
Conservation of forest genetic resources	forests constituting seed stands [share in %, occurrence]
	area of Natura 2000 sites [share in %, occurrence]
Soil protection	chemical properties of soils [t C/ha]
Water purification	water quality (classification of water quality]
Pollination	indicator of relative pollination potential
Carbon sequestration and storage	carbon stored in forests [t/ha]
	carbon sequestration by forests [t/ha or t/ha/year)
Air purification	ozone pollution and particulate matter [ppm; µg/m^3]
Cultural services	
Recreation and tourism	distribution of wildlife emblematic species associated with forest [occurrence, number of individuals/1000 ha]
	tree stands suitability for recreation [range scale]
	tree stands suitable for harvest and older [occurrence]
	tree stands available for the society [occurrence)
	number of recreational facilities [items/km^2 of forest area]
	length of tourist trails [km/km^2 of forest area]
	length of educational paths [km/km^2 of forest area]
Maintenance of biological diversity	biodiversity index
	distribution of Natura 2000 sites
	conservation status of forest priority species (Natura 2000)
	protective forests refuges for animals and sites of plants subject to species protection [share in %, occurrence]
Cultural, scientific and educational values	distribution of sites with forest designated as having cultural values [ha, share in %]

Source: Kaliszewski *et al.*, 2023b

An important group of publications are the works on the economic functions of forestry. These include the general analyses of the economic functions of the forest published in the first half of the 1970s by Marszałek (1970, 1973) and the analysis of the development of the economic function of forestry against the background of technical and economic progress (Molenda, 1965). Marszałek (1973) also took up the topic of the infrastructure functions of the forest and

expanded it more than a decade later to include issues of the methodological basis for estimating the infrastructure values of a forest holding (Marszałek, 1985). The group of works dealing with economic functions also includes the assessment of changes in these functions as a result of progressive ecological threats (Kamiński, 1991), the analysis of the extent of timber harvesting in relation to the growing demand for the social functions of the forest (Miś, 2005) and the assessment of the need for the conversion of stands depending on the predominant function of the forest (Łopiński, 2008). In this context, work dealing with the ecological and economic functions of the forest in situations of environmental threat should also be mentioned (Partyka and Suwara, 1986), as well as the development of methodological assumptions for the estimation of losses in non-economic functions of the forest (Molenda, 1973).

The above-mentioned social functions of the forest have been taken up by many authors. Many works have focussed on the evaluation of the recreational function. Pioneering work in this field was done by Marszałek (1993), who presented a monetary valuation of the wealth created by the social functions of forests in state forestry. The hypothetical willingness to finance public functions of forests and forest management was analysed by Gołos and Ukalska (2016), Skłodowski and Gołos (2016) and Mandziuk *et al*. (2019). The issue of recreational forest use in the annual balance of the forest district and the estimated value of the recreational function of forests was analysed by Dudek (2017). Kożuch and Adamowicz (2016) analysed the impact of the costs of implementing non-productive FF on the economic situation of forest districts using the example of the Regional Directorate of State Forests in Kraków.

The question of the non-productive functions of the forest as a public good of forest management was taken up by Klocek (1998, 1999). Numerous works dealt with the development of methods for valorisation of forests for recreation, mainly taking into account habitat and stand criteria (Łonkiewicz and Pietrzak, 1986; Wajchman-Świtalska, 2017). The results of the valorisation show the potential and suitability of forests for recreational purposes. They also determine the limits of recreational pressure, which can lead to the natural capacity of the forest ecosystem being exceeded. A separate group is formed by works that analyse the social demand for the recreational and tourism functions of the forest. These include publications by Kikulski (2008, 2009) and Gołos *et al*. (2019). In his work, Ciesielski attempted to determine the actual use of forest areas by the population and to estimate the number of users on the basis of mobile phone data (Ciesielski, 2022).

The issue of forest ES is very rarely covered in Polish forestry journals, especially in recent years. An example of this is the work of Stępniewska (2020), which deals with forest ES as a subject of research on Integrated Monitoring of the Natural Environment. The article by Kornatowska and Sienkiewicz (2018) provides an overview of the methods used to estimate the value of forest ES. Outside of forestry journals, the concept of ES is much more widely used, particularly in the geographical sciences. Solon *et al*. (2017) mapped the ES potential of different ecosystems, including forest ecosystems, for the Wigry National Park. Among other things, they used the work of researchers in the field of FF (*e.g*. berry productivity, potential honey productivity of individual species) and recognised the importance of individual ES among respondents (beneficiaries of the study area). A mapping of the assessment of the potential of Polish forests by natural forest areas was done by Affek *et al*. (2023).

The problem of mapping more than a dozen ES at national, regional and local levels and analysing the relationships between the services was solved by Kaliszewski *et al*. (2023a). Janeczko *et al*. (2023) assessed the relevance of forest ES depending on the socio-demographic profiles of respondents based on a survey. In the survey, respondents rated 12 different types of

ES. Regulatory services were most important to respondents, followed by cultural services and least important were provisioning services. Mikusiński and Niedziałkowski (2020) used the concepts of ES to identify and reconcile the interests of different groups in relation to the benefits of an ecosystem such as the Białowieża Forest through a survey. They analysed how the distance to the Białowieża Forest affects the perception of environmental benefits.

FF AND SERVICES IN LEGAL ACTS AND POLICY DOCUMENTS. Beyond the production of timber and non-timber products, the role of forests and forest management in Poland was already recognised by law in the interwar period. Although both the 1927 Decree of the President on the management of non-state forests (Rozporządzenie, 1927) and the 1928 Decree of the President on the management of state forests (Rozporządzenie, 1928) made no direct reference to the functions or 'effects' of forests, they contained provisions introducing the category of protective forests for the conservation of forests due to their particular importance for soil and water protection, soil stabilisation, defence, nature and science and, in the case of state forests, also for health (Table 3). The division of forests into managed (commercial) and protective forests, which functioned in the post-war period and was refined in the following decades, and the associated separate management formed the basis for the later concept of the multifunctional forest (Bernadzki, 2006).

The positive effects of forests on the environment and humans were also repeatedly discussed in the literature of the time (Kinle, 1934; Milewski, 1935), but the importance of the non-productive functions of forests was treated rather marginally. When discussing the positive 'side effects of the forest' (including climatic soil protection and wind protection), Ludkiewicz (1921) came to the conclusion that they did not provide any reasons 'that would justify restricting the individual in the practise of forestry' and that possible restrictions could only take place in protection forests.

The legal acts adopted and entered into force in the following years did not directly use the term forest function either, but the emphasis on the special role of forests beyond the provision of wood was present.

The presidential decrees of 1927 and 1928 were also in force in the first years after the Second World War. They were replaced by the Decree of 1948 on the protection of forests that do not belong to the state (Dekret, 1948) and the Act of 1949 on the state forest management (Ustawa, 1949). The 1948 Decree obliged forest owners to manage their forests 'in such a way as to ensure their conservation and the full and lasting satisfaction of the social needs of timber production, as well as their impact on the physical condition of the land, social culture and the defence of the State'. The Act on the state forest management, in turn, stipulates that forest management shall be based on the guidelines of the national economic plans and aim at sustainability and continuity of use in order to meet the current and future needs of the national economy for timber and non-timber production, increase the natural productivity of the forest and ensure the positive effects of the forest on the country's climate, water management and the health and culture of the population (Table 1).

The Act on the management of forests and fallow land not owned by the State and of some forests and fallow land owned by the State (Ustawa, 1960) slightly reformulated the provisions of the 1948 Decree by stating that 'forests shall be managed in such a way as to ensure their conservation in full productivity, their favourable effect on the physical conditions of the soil, social culture and the interests of the State, taking into account the tasks of meeting the needs of agricultural holdings'. The Act of 1973 on the management of forests that do not belong to the State (Ustawa, 1973), on the other hand, brought a significant change by explicitly referring

Table 3.

References to the various functions (benefits) of forests in the forestry legislation in force in Poland after the First World War

Legal act	Description
Decree of the President of 1927 on the management of non-state forests	No direct reference to forest functions. Introduction of categories of protective forests for forests: (a) protecting soils from scouring, preventing erosion of soil or stones, preventing the formation of torrents, rockfall and avalanches; (b) protecting the banks of watercourses from scouring and springs from burial; (c) preventing the formation and spread of drifting sand and evaporites; (d) of particular importance for the defence of the State; (e) of natural and scientific importance
Decree of the President of 1928 on the management of state forests	as above + extension to the forests within the boundaries of the sanitary protection district of spas that have the character of public facilities
Decree of 1948 on the protection of forests that do not belong to the state	Article 4. Forests shall be managed in such a way as to ensure their conservation and the full and lasting satisfaction of society's needs for timber production, as well as their impact on the physical conditions of the country, social culture and national defence.
Act of 1949 on the state forest	Article 9 The management of state forests should aim at the fulfilment of the following tasks, based on the guidelines of the national economic plans: (a) maintaining sustainability and continuity of use to meet the present and future needs of the national economy for timber and non-timber production, (b) intensifying the natural productivity of the forest, (c) ensuring the positive effects of the forest on the climate, water management and the health and culture of the population. The objectives of nature conservation are taken into account in the development of reserves and national parks.
Act of 1960 on the management of forests and fallow land not owned by the State and of some forests and fallow land owned by the State	Article 7. Forests shall be managed in such a way as to ensure their conservation in full productivity, their favourable effect on the physical conditions of the soil, social culture and the interests of the State, taking into account the tasks of meeting the needs of agricultural holdings.
Act of 1973 on the management of forests that do not belong to the State Forest Act of 1991 (as originally enacted)	Article 7. Forests shall be managed in such a way as to ensure their productivity and their capacity to fulfil protective, health and cultural functions. Forest management shall be carried out in accordance with the forest management plan, taking particular account the following objectives in particular 1) preservation of forests and its positive effects on climate, air, water, soil, living conditions and human health as well as on the natural balance, 2) the protection of forests, in particular forests that are natural fragments of indigenous nature or forests that are particularly valuable due to the following factors (a) conservation of forest genetic resources, (b) landscape values, (c) the needs of science, 3) protection of soils and areas that are particularly vulnerable to pollution or degradation and of particular social importance, 4) timber production based on the highest profitability of raw materials and by-products of forest use.

to the concept of FF and obliging owners to manage forests in such a way as to ensure their productivity and their ability to fulfil protective, health and cultural functions (Table 1).

A fundamental change in the perception of forests and their importance for the economy was brought about by the changes in Poland in the late 1980s and early 1990s, which were associated with the collapse of communism and the transition from a centrally controlled economy to a free market economy. The systemic change was accompanied by a fundamental reorientation of the goals and principles of forestry, and the changes took place simultaneously at many levels: political, economic, legal, organisational and social (Rykowski, 2020). The new form of Polish forestry was outlined by the Forest Act of 1991 (Ustawa, 1991), which states the objectives of forest management as 'preservation of forests and its positive effects on climate, air, water, soil, living conditions and human health as well as on the natural balance', on a par with the 'rational production of wood and raw materials and by-products of forest use' (Article 7.1). As a result of a legislative amendment in 1997 (Ustawa, 1997), a definition of 'sustainable forest management' was added, which refers to the definition adopted in Resolution H1 of the Forest Europe Process (MCPFE, 1993), *i.e.* 'activities aimed at managing the structure of forests and their use in such a way and at such a scale as to ensure the maintenance of their biological diversity, high productivity and regeneration potential, vitality and capacity to fulfil, now and in the future, all important protective, economic and social functions at local, national and global levels, without causing damage to other ecosystems'.

In addition, the Forest Act (Ustawa, 1991) provides for the possibility of setting up promotional forest complexes (LKP), which are functional areas of ecological, educational and social importance (Article 13b). Promotional forest complexes are usually large, compact forest areas that belong to one or more forest districts. There are currently 25 LKPs established across the country with a total area of around 1,275,000 hectares (Statistics Poland, 2023).

The law also provides for the possibility of recognising forests as protection forests, *e.g.* to protect soils from erosion or leaching, to prevent deforestation and avalanches, to protect surface and underground water resources or to preserve biodiversity (seed stands, wildlife sanctuaries and protected plant sites) (Article 15). Currently, 42.1% of all forests in Poland are under special protection due to their various natural and social functions (Statistics Poland, 2023).

The term 'multifunctionality' in forest management was already used in the 'National Forest Policy' of 1997 (Polityka, 1997). The overall objective of forest policy in Poland was 'to define a complex of activities (…) aimed at maintaining, in the changing natural and socio-economic reality, the conditions for sustainable and indefinite multifunctionality of forests, their comprehensive utilisation and protection and their role in shaping the natural environment in accordance with the present and future expectations of society' (III.1). This follows directly from the assumption that forests 'fulfil a variety of functions by nature or through forest management measures', whereby 'at the same time many types of FF are complementary or derived from each other and vary in time and space' (I.4-5). Accordingly, 'an important task of multifunctional forest management is to mitigate and avoid conflicts between the different FF and to promote their complementarity' (II.3).

One of the most important documents at EU level dealing with the issue of ES is the Biodiversity Strategy to 2020 (European Commission, 2011), the EU Biodiversity Strategy for 2030 (European Commission, 2020) and the Nature Restoration Law (European Parliament, 2024). This is one of the first documents to contain recommendations on ES. Objective 2 of this document requires Member States to map and assess the status of ecosystems and the services they provide and to determine the value of these services. Poland has transposed the provisions

of the Strategy into Polish law in a document entitled Programme for the Conservation and Sustainable Use of Biodiversity with an Action Plan for 2015-2020 (Resolution, 2015). Until the publication of this document, ES were mostly described indirectly in Polish legal and formal documents. There were provisions in the legislation that referred to the concept of ES and, among other things, pointed to the benefits and goods provided by ecosystems (Maczka *et al*., 2016). Currently, all major environmental policy documents refer to ES as one of the key concepts used to assess the value of nature when planning the sustainable use of natural capital. The topic of ES has entered the mainstream of political discussion and decision-making processes, for example in:

- National Spatial Development Concept 2030 (Koncepcja, 2011),
- Strategy for Responsible Development (SRD) to 2020 (with an outlook to 2030) (Ministerstwo Rozwoju, 2018),
- The 2030 National Environmental Policy – the Development Strategy in the Area of the Environment and Water Management (Polityka, 2019),
- National Strategy for Regional Development 2030 (Uchwała, 2019).

The National Spatial Development Concept 2030 of 2011 considers ES in the context of society's dependence on nature. The ES provide an instrument for determining the capacity of ecosystems to provide certain services. At the same time, the document points out the fundamental contradiction between the objectives of the strategy for the protection of natural resources and processes and the objectives of socio-economic development and recommends that an analysis of land functions and ES be carried out so that the development of land use at least does not reduce the potential of the natural environment to provide these services.

In the SRD to 2020 (with an outlook to 2030), adopted in 2017, the natural environment is regarded as natural capital whose resources (renewable and non-renewable) generate a flow of benefits (ES). The strategy calls for a comprehensive mapping, assessment and evaluation of ES.

The 2030 National Environmental Policy of 2019 is based, among other things, on the conservation and restoration of ES for humans. The document assumes, among other things, that the development process will be monitored with indicators to assess, among other things, the level of ES. The policy, like other documents, emphasises the need to assess ES based on their impact on human well-being and economic development and calls for the value of ES to be taken into account in decision-making processes. The document also links socio-economic development to the need for rational management of ecosystems and the services they provide and emphasises the need to conserve and, where appropriate, restore natural ecosystems. National Strategy for Regional Development 2030, adopted in 2019, on the other hand, recognises, among other things, the problem of climate change and considers the importance of natural resources as a potential factor of regional development, based on ES and implemented in a sustainable manner, taking into account the needs of future generations. The document recognises natural capital and ES as a factor for development and sees the increasing pressure on natural ecosystems and declining environmental quality as a significant threat to the provision of ES.

FF AND BENEFITS IN FOREST MANAGEMENT DOCUMENTS. The instructions for forest management planning are internal documents of the State Forests National Forest Holding (PGL LP), which define the direction, scope, form and technical execution of the documentation for the draft forest management plan. Although these documents apply only to the State Forests, due to the dominant share of forests under the management of PGL LP in Poland and their strong economic position, they are often treated as a reference point for activities in forests of other forms of ownership. Detailed guidelines for forest management are developed on the basis of the instructions.

The Forest Management Planning Instruction of 1957 (IUL, 1957) introduced the principle of assigning dominant functions to the forest. It distinguished between protection forests, *i.e.* group I, in which the general social functions of the forest take centre stage alongside timber production. They were divided into different categories: soil-protective forests, water-protective forests, climatic healing forests, high green zones and landscape forests. Group II comprised commercial forests whose main purpose was timber production.

The later Instruction on Forest Management Planning of 1970 (IUL, 1970) categorises (§ 4-5) forests according to their benefit to society: reserve forests, group I forests and group II forests. Separate regulations applied to reserve forests. Group I forests had a protective character and their main function was soil protection, water protection, recreation, protection of the green high zone, the spa and climate function or the protection of forests at the forest boundary. Timber production in these forests was subordinate to the fulfilment of the protective functions, which were either permanent or temporary. The forests in group II were of an economic nature and focussed on timber production.

In the Instruction on Forest Management Planning adopted in 1980 (IUL, 1980), the categorisation of forests into nature reserves, group I forests and group II forests was retained (§ 3-6). The list of protection categories in group I forests was expanded to include forests in the industrial influence zone and landscape forests, while forests used for mass recreation and areas in the diluted tourism and recreation zone were excluded.

The Instruction on Forest Management Planning of 1994 (IUL, 1994), which was created after the fall of communism with the adoption of the Forest Act (Ustawa, 1991), defines the long-term conservation of forests as an overriding objective so that they can continue to fulfil their multiple functions – ecological, social, protective and economic. The instruction distinguishes between so-called protection forests, which include forests that form nature reserves, are recognised as protective, are located in the buffer zones of national parks, belong to landscape parks and are located in a landscape protection area. Protective forests also include: soil-protective forests, water-protective forests, industrially damaged forests, forests that are valuable elements of native nature, forests in permanent research and experimental areas, seed stands, animal protection areas, forests within the administrative boundaries of cities and up to 10 km from cities with more than 50,000 inhabitants, forests in health resorts with a protection zone and around sanatoriums, and forests of special importance for defence. All forests that were not classified as reserves or protection forests were treated as economic, multifunctional forests, meaning that their main purpose was timber production and they simultaneously fulfilled ecological and social functions.

The 2003 Instruction on Forest Management Planning (IUL, 2003) states that forests fulfil a variety of functions, either naturally (by their very existence) or as a result of human action (through a particular direction of forest management). The statement categorises naturally multifunctional forests into three basic forest groups for the purposes of management planning, depending on the predominant role of the functions fulfilled: reserve forests, protective forests and commercial forests. The categories of protective forests, which were very similar to the 1994 instruction, have also been retained. The most recent instruction from 2012 (IUL, 2012) did not contain any changes in this regard.

Conclusions

The above review presents the genesis and development of the concept and understanding of forest functions and their importance for the model of multifunctional forest management in

Poland in the last century. It also refers to the new – rapidly spreading since the beginning of the 21st century – concept of ES. Although both concepts have different origins, they have many points of contact and largely complement each other. Neither concept is free of drawbacks, but the increasing popularity of the ES concept in relation to forests suggests that it compensates for and complements the shortcomings of the forest ES concept.

The ES concept may be seen as the extension of the well-recognized and commonly used concept of FF and multifunctionality of forest management. The ES concept, which offers the opportunity to quantify, map, evaluate and value forest ES based on ES indicators, which can be a very useful tool for planning forest management and conservation measures at local level or designing forest and environmental policies at regional or national level. In this way, a contribution can be made to the optimal utilisation of natural capital based on its potential, which is determined, among other things, by the functions of the forest.

Currently, the concept of ES is not clearly included in Polish forest-related legislation, which is based on the concept of forest functions. However, this is likely to change in the future as this concept is used in more and more strategic and programmatic environmental documents. Finding a common denominator for both concepts – FF and ES – and implementing them in daily practise can lead to better use of forest resources in line with the needs and expectations of society and various stakeholders.

Authors' contributions

A.K. – conception, methodology, collection of materials, investigation, writing – preparation of original draft, manuscript review, editing; E.W-F. – conception, methodology, investigation, writing – preparation of the original draft, manuscript review, editing; M.C. – conception, methodology, investigation, writing – preparation of the original draft, manuscript review, editing; K.S. – conception; P.G. – conception, editing.

Conflicts of interest

The authors declare that there are no potential conflicts of interest.

Funding source

The research was funded within the project 'Services provided by main types of ecosystems in Poland – an applied approach', under the EEA Financial Mechanism 2014-2021 (project number 510401).

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STRESZCZENIE

Od funkcji lasu do leśnych usług ekosystemowych – ewolucja podejścia do korzyści z lasu w Polsce

Celem pracy jest przedstawienie pojęcia funkcji lasu (ang. *forest functions* – FF), a także genezy i ewolucji koncepcji oraz rozumienia funkcji lasu i jej znaczenia dla modelu wielofunkcyjnej gospodarki leśnej w Polsce w ostatnim stuleciu, od zakończenia I wojny światowej. Na tym tle omówiono koncepcję usług ekosystemowych (ang. *ecosystem services* – ES) oraz wskazano różnice względem koncepcji funkcji lasu, jak również omówiono szanse wynikające z szerszego przyjęcia w praktyce idei ES jako uzupełnienia modelu wielofunkcyjnej gospodarki leśnej. Badanie zostało przeprowadzone metodą analizy treści aktów prawnych i dokumentów programowych dotyczących gospodarki leśnej pod kątem uwzględnienia w nich problematyki funkcji lasu i wielofunkcyjności gospodarki leśnej. Charakterystykę koncepcji funkcji lasu i koncepcji ES oraz ich wzajemnych powiązań przedstawiono w oparciu o wybrane pozycje literatury przedmiotu. W pracy omówiono 5 zasadniczych zagadnień: koncepcję funkcji lasu i wielofunkcyjnej gospodarki leśnej; koncepcję ES; funkcje lasu i ES w polskiej literaturze przedmiotu; funkcje i świadczenia lasu w aktach prawnych oraz dokumentach programowych; funkcje i świadczenia lasu w dokumentach operacyjnych gospodarki leśnej.

Uznaje się, że termin „funkcje lasu" wprowadził i upowszechnił Dieterich w 1953 r., formułując doktrynę o funkcjach lasu, stanowiącą fundament leśnictwa wielofunkcyjnego, opartego na zasadzie trwałości. Koncepcja Dietericha została w kolejnych latach rozszerzona o funkcje ochronne i rekreacyjne, tworząc fundament dzisiejszej definicji trwałej gospodarki leśnej, uwzględniającej w równym stopniu aspekty ekologiczne, ekonomiczne i społeczne, spójnej z koncepcją trwałości ustanowioną w ramach Szczytu Ziemi w Rio de Janeiro w 1992 r., a także wspieranej w ramach Procesu Forest Europe. Koncepcja ES jest rozwijana dynamicznie od lat 90. XX w. Usługi ekosystemowe definiowane są jako „korzyści uzyskiwane przez ludzi z ekosystemów". W koncepcji tej ekosystemy i społeczeństwo rozpatrywane są jako dwie odrębne sfery. Przyroda jest widziana jako stały zapas kapitału (funkcji), który może, z ograniczeniami, dostarczać ludziom różnorodnych korzyści. Ekosystemy przyczyniają się do dobrobytu ludzi za pomocą usług, których dostarczają i których społeczeństwo, jako całość, jest beneficjentem. ES stanowią zatem łącznik między ekosystemami oraz społeczeństwem, a między tymi dwiema sferami zachodzi dynamiczna zależność: ludzie wywołują – bezpośrednio lub pośrednio – zmiany w ekosystemach, a zmiany zachodzące w ekosystemach oddziałują na ludzi (ryc. 1).

ES charakteryzowane są za pomocą zestawu wskaźników, które można zdefiniować jako fizyczne elementy ekosystemów mierzone przy pomocy dostępnych narzędzi i wiedzy. Powinny być one łatwe do przedstawienia decydentom i praktykom, wspierać kształtowanie świadomości oraz stanowić podstawę do stworzenia skutecznego monitoringu badanych ES. Jedną z najpowszechniej stosowanych klasyfikacji jest Common International Classification of Ecosystem Services (CICES), opracowana na podstawie prac Europejskiej Agencji Środowiska (EEA) nad rachunkowością środowiskową. Najważniejsze ES związane z ekosystemami leśnymi oraz przykładowe wskaźniki przedstawiono w tabeli 1, natomiast wskaźniki uszczegółowione oraz dostosowane do polskich warunków i dostępności danych w naszym kraju zawarto w tabeli 2.

Pojęcie funkcji lasów ewoluowało w czasie, czego przykład stanowią odniesienia do funkcji/świadczeń lasów w aktach prawnych dotyczących leśnictwa w okresie ostatnich 100 lat (tab. 3), a także m.in. w dokumentach programowych i instrukcjach urządzania lasu obowiązujących

w Lasach Państwowych. Pojęcie ES nie zostało dotychczas wprowadzone do polskich aktów prawnych dotyczących lasów i leśnictwa, jednak pojawia się w wielu dokumentach programowych i strategicznych przyjętych w ostatniej dekadzie, w tym w „Polityce ekologicznej państwa 2030" i „Krajowej Strategii Rozwoju Regionalnego 2030".

Obie koncepcje – funkcji lasu i leśnych ES – mają różną genezę, wykazują jednak wiele punktów stycznych i w znacznej mierze się uzupełniają. Koncepcja ES w oparciu o wskaźniki ES oferuje możliwość kwantyfikacji, kartowania, oceny i wyceny leśnych ES, co może stanowić bardzo przydatne narzędzie z punktu widzenia planowania działań gospodarczych i ochronnych w lasach na poziomie lokalnym czy też kształtowania polityki leśnej i polityki ochrony środowiska na poziomie regionalnym bądź krajowym. W rezultacie może przyczyniać się do optymalnego wykorzystania kapitału przyrodniczego w oparciu o ich potencjał, wyznaczany m.in. przez funkcje lasów.