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ECONOMICS AND ENVIRONMENT

Journal of the Polish Association of Environmental and Resource Economists

EKONOMIA I ŚRODOWISKO

Czasopismo Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych

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PROBLEMY TEORETYCZNE I METODYCZNE

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DEVELOPMENT OF THE ECOSYSTEM SERVICES APPROACH IN POLAND

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ROZWÓJ BADAŃ NAD ŚWIADCZENIAMI EKOSYSTEMÓW W POLSCE

STRESZCZENIE: W tekście przedstawiono zarys stanu badań nad świadczeniami ekosystemów w Polsce, który zrelacjonowano opierając się na materiałach Sympozjum ECOSERV2014. Na tle zaawansowania prac w instytucjach Unii Europejskiej zestawiono wyniki najnowszych badań w Polsce. Oprócz zagadnień teoretycznych, w tym metod oceny i wyceny, uwzględniono przydatność tego podejścia w zarządzaniu środowiskiem. W sposób szczególny wyodrębniono korzyści oferowane przez ekosystemy terenów zurbanizowanych i ekosystemy terenów wiejskich. Rozpatrując tę problematykę w świetle percepcji przez człowieka, pokazano wyniki badań nad kulturowymi świadczeniami ekosystemów. Przedstawiono ogólną ocenę badań w tej dziedzinie w Polsce i rekomendacje.

SŁOWA KLUCZOWE: świadczenia ekosystemów, teoria ekosystemów, ekosystemy Polski

Introduction

The Millennium Ecosystem Assessment has popularised in the world an approach that defined ecosystem services, although benefits from processes in ecosystems have been known since time immemorial[1]. The rapidly growing interest of researchers in this approach[2] reflects a distinct shift of the paradigm concerning the humans environment relationship. This is shown by moving away from the opposition between the two components, which gives way to a search for harmony between them. In the classical approach, the researchers focused on forms and the scope of the negative human impact on the environment, while the new research area is clearly targeted at various aspects of identifying and stimulating benefits, which people can draw from nature[3]. Such an approach is very attractive politically as it justifies the rationality of efforts and costs incurred to preserve natural systems in an understandable manner.

European context

This was expressed in the EU environmental policy, especially in the formulation of the Biodiversity Strategy, which calls Member States to "map and assess the state of ecosystems and their services on their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting system at the EU and national levels by 2020"[4]. Following the political document, the European Commission took supportive actions initiating the activity of the European Environment Agency as well the Joint Research Centre and creating the process entitled Mapping and Assessment of Ecosystems and Their Services (MAES). The results of this activities include the publication of two MAES reports[5], development of several generations of the Common International Classification of Ecosystem Services[6] and the

[1] E. Gómez-Baggenthun et al., *The history of ecosystem services in economic theory and practice: from early notions to markets and payments schemes*, "Ecological Economics" 2010 no. 69, p. 1209-1218.
[2] R. Costanza, I. Kubiszewski, *The authorship structure of "ecosystem services" as a transdisciplinary field of scholarship*, "Ecosystem Services" 2012 no. 1, p. 16-25.
[3] A. Mizgajski, *Świadczenia ekosystemów jako rozwijające się pole badawcze i aplikacyjne*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 10-19.
[4] Our life insurance, our natural capital: an EU biodiversity strategy to 2020 (target 2, action 5) European Commission 2011, p. 244.
[5] An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020; Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020.
[6] www.cices.eu [20-10-2014].

creation of an online platform[7] facilitate the circulation of information concerning the issues under consideration. During the 3rd ECOSERV 2014 National Symposium, Anne Teller, representing the European Commission, presented a methodological approach and directions for actions conducted at the European level aimed at increasing the recognition of ecosystem services (ES) in member states.

ECOSERV Symposiums

Against this background, it can be concluded that applied work in Poland has not gained momentum yet. However, Poland has vast databases of spatial data, which can be the basis for the construction of indices and the first comprehensive concept of ES for Poland was formulated in 2012[8].

In the latest Polish literature, the issue of environmental values and its resources is currently based on economic sciences[9]. Among naturalists, looking at the nature through the prism of benefits for humans, especially economic ones, is not very popular. However, already in the mid-1970s, Polish geographer Tadeusz Bartkowski formulated the following view: "*At the same time, it should be emphasised that it is necessary to develop geographical information in such a way that it is possible to move from its geographical valuation. It is the first step towards research, in which it will be possible to establish relationships between physicogeographical data and their economically tangible impact*"[10].

National symposiums on ecosystem services (ES) held in Poznań every two years refer to this approach as the object of transdisciplinary studies. These meetings and publications that follow[11] create a very good opportunity to review progress in methodology and application of this concept. The development of cooperation between representatives of natural, economic and social sciences is an element conditioning progress in research on ecosystem services. Both an amateur approach of economists to nature and a non-professional use of tools of economic and social sciences by ecologists significantly inhibit the development of this multidisciplinary research and application issue.

The third symposium in this cycle reflected a new stage of development of ES research in Poland. It is mostly manifested by the reflection on the availability of source data and their quality and the growing number of original research studies conducted mostly on a local and regional scale. The plenary part convincingly showed the necessity of forming a competent connection between the natural

[7] www.biodiversity.europa.eu [20-10-2014].
[8] A. Mizgajski, M. Stępniewska, *Ecosystem services assessment for Poland – challenges and possible solutions*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 54-73.
[9] E.g.: J. Famielec, *Straty i korzyści ekologiczne w gospodarce narodowej*, Warszawa 1999; B. Fiedor, p. Czaja, A. Graczyk, Z. Jakubczyk, *Podstawy ekonomii środowiska i zasobów naturalnych*, Warszawa 2002; T. Żylicz, *Ekonomia środowiska i zasobów naturalnych*, Warszawa 2004.
[10] T. Bartkowski, *Ochrona zasobów przyrody i zagospodarowania środowiska geograficznego*, Warszawa–Poznań 1975, p. 334.
[11] „Ekonomia i Środowisko" 2010 no. 1(37); „Ekonomia i Środowisko" 2012 no. 2(42).

and social and economic areas in a presentation on the importance of ES bundles for the regional development. The recognition of importance of benefits from nature as a developmental factor is not duly reflected in the availability of statistical data; however, it was demonstrated with a well-documented analysis of public statistics, which allows for a quantitative determination of the scope of ES, especially on a local level. These findings correspond with an overview of possibilities of taking into account the benefits drawn from ecosystems in the existing measures. The overview was performed against the background of an original discussion of the national scope of ES. An important theoretical reflection pertained to the importance of time as a factor significantly influencing the results of economic valuation of ES. Attention was paid not only to instability of prices in the market, but also to the assessment of benefits and costs which vary over time.

Data for the valuation of ecosystem services

A large part of presentations refered to the problem of source data and their use for ES quantification. Attention was paid to the usefulness of data collected by base stations of the integrated environmental monitoring and reference values based on multi-year observation cycles. They can be used for the assessment of a range of regulating services of forest and water ecosystems, in particular as regards the regulation of the hydrological cycle. The research was conducted using the example of three municipalities from the Podlaskie province and it focused on the possibility of using various sources of local data for estimating ES supply. At the same time, the need exists for precise distinction between the potential and actual levels (as used by society) of ES. It also resulted from the established findings that although the hierarchy of resources used mostly depended on the land cover structure, the knowledge about the land cover is not sufficient for realistic modelling of the use of the natural capital.

The analysis of the influence of the degree of generalization of spatial data on the estimation of the ES size touched upon an important issue. By using data with a varying degree of aggregation for a selected commune, statistically significant differences were shown unambiguously for the results obtained as regards both provisioning services (production of crops) and cultural services (recreational and aesthetic value).

Using the example of the Gorczański National Park, an attempt was made to use the ES conceptual framework for the analysis of erosion risk using the modelling in the GIS environment. On this basis, the presentation considered the possibility of managing the space in a way that would minimise the erosion risk. In other words, the scope and necessity of human actions to preserve/improve the ecosystem ability to fulfil a given function were analysed. Such an approach, different from the classical way of handling issues pertaining to ecosystem services, is, however, consistent with the model resulting from MAES work, in which ecosystem services are considered to include natural environment functions togeth-

er with human activity that stimulates them. An atypical approach was used for the analysis of environmental consequences of three variants to use a dry flood reservoir in Racibórz. Depending on the capacity for water retention, the surface areas of ecosystems, which can be lost were determined, which was identified with ES elimination. The size of this loss was expressed in monetary units using a controversial evaluation on a global scale[12] for this purpose.

An important group of papers pertained to the differentiation of the perception of benefits provided by the functions of ecosystems in society. The results of surveys allowed for determining the level of knowledge about benefits provided by nature and their assessment by various groups of inhabitants and tourists in the Suwałki and Augustów areas. Research conducted in the Gdańsk Bay area also focused on the differentiation of perception. It revealed distinct conflicts of interests in the assessment of various forms of tourist use, from fishery to the use of aesthetic values and the protection of environmentally valuable areas. The presented study did not answer the question to what degree environmental inequalities result from different perception of the same phenomena and to what degree they have obtained from depriving certain social groups of benefits so far. Other research pertained to the detailed problem of differences in the assessment of the role of benefits from the occurrence of seagrass in marine ecosystems. Basic differences were identified between assessments of experts and assessments of lay people. In many aspects, the social perception of seagrass was distinctly different not only from the actual function of this ecosystem component, but even from the proper identification of this object. Research results documented that the survey of the value attached to specific ecosystem services are heavily dependent on the respondents' level of knowledge.

Urban ecosystem services

A special session devoted to urban ES allowed for an overview of research conducted in this area in Poland. This research is undertaken from the perspective of various scientific disciplines and, although individual researchers still usually fail to go beyond disciplinary boundaries, the early symptoms of such an approach can already be seen. The possibility of distinguishing in the symposium programme of a group of studies devoted directly to ecosystem services in cities constitutes a considerable difference as compared to the previous edition of the symposium when only one study was directly devoted to cities[13]. Practical conclusions developed as a result of research presented during this year's conference seem particularly valuable from this perspective.

[12] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 253-260.

[13] J. Kronenberg, T. Bergier, K. Maliszewska, *Overcoming barriers to the use ecosystem services for sustainable development of cities in Poland*, „Ekonomia i Środowisko" 2012 no. 2 (42), p. 106-120.

The growing interest in ecosystem services in cities and for the urban population reflects a tendency observed in research conducted on an international scale. It is mostly connected with ongoing urbanization – already nearly 55% of people in the world live in cities, and the share of urban population has already reached 75% in the European Union. The fact that the condition of the natural environment in cities and outside of them influences the quality of city dwellers' lives is reflected to an increasing degree in the results of ES research conducted in Poland.

An overview of indices illustrating the situation of green areas in 38 Polish cities has a diagnostic nature. It provides basic information, which should be used in further considerations on greenery management. Another analysis shows differentiation of the spatial structure of urban green infrastructure systems in ten European metropolitan areas. On the basis of land use/land cover data for these areas, the authors prepared maps of ecosystem services provided by these areas. Eventually, this was used as a basis for recommendations for the creation of a system of green infrastructure in Warsaw. The example of Warsaw was also considered in an analysis of land use/land cover changes of selected urban and suburban areas in the years 1972-2012. On this basis, changes in the potential for ES provision were estimated. Another analysis focused on ecosystem services provided by areas set aside (semi-natural or developed but currently not used), based on the example of Poznań. It was found that their area is equal to that of organized green spaces and they are often characterised by a significantly greater biodiversity.

Two reports present the perspective of economic sciences on monetary valuation of selected ES. The first shows the pertinence of the economic valuation of ES provided by allotment gardens, which significantly increases the scope of arguments in discussion on the desirability of keeping this form of land use. An attempt at estimating the monetary value of street trees and the scope of services they deliver in a medium-sized city has a practical application.

The problems reported here do not exhaust the scope of research on urban ecosystem services in Poland. It is worth noting that practical guidelines with regard to the management of ES in urban areas[14] have already started to stimulate a practical use of this approach.

[14] A series of guides published by the Institute of Spatial Management and Housing, e.g.: H.B. Szczepanowska, *Wycena wartości drzew na terenach zurbanizowanych*, Warszawa 2007; A series of guides published by the Sendzimir Foundation: "Nature in the city. Ecosystem services – untapped potential of cities" "Nature in the city. Solutions", "Water in the city", all available in English and in Polish at www.sendzimir.org.pl [20-10-2014].

Ecosystem services in rural areas

A separate session was devoted to ecosystem services in rural areas. The specificity of agricultural ecosystems and forests draws attention to provisioning services. This type of benefits has been known since time immemorial and no significant new research findings are expected in this area. Insufficient knowledge mostly pertains to other types of benefits, i.e. regulating and cultural ones provided by ecosystems of rural areas. The results presented provide significant research findings for both kinds of services mentioned above. Research on ES changes in the Dębnica catchment area (NW Poland) was based on the recognition of changes in biotops used for agriculture during the political transformation. On this basis, directions of ES changes were estimated, which involved the growing role of regulating services at the expense of provisioning and cultural services. Another report focuses on identification and assessment of regulating services using selected villages in S Poland. Based on detailed carthographic sources, the author showed prevention of water erosion, absorption of pollutants, protection of groundwater quality and self-purification of surface water bodies. At the same time, it was established that the size of individual regulating services is varied in individual villages, depending on the properties of the environment and the degree of human pressure.

An analysis on a regional scale of spatial diversity of selected ecosystem services against the background of naturally valuable areas in the Lower Silesian Province has a methodological nature. Thematic maps of spatial diversity, physical and biotic properties of water bodies, soils, forests and the air, plants, animals and land cover are to constitute the basis for ES identification. In the authors' opinion, ES levels in protected areas are to constitute benchmarks, with which the results obtained from other parts of the region will be compared.

The identification of benefits drawn from the structure and functions of ecosystem in the Lębork District pertains to a supralocal level. Using the ES conceptual framework, the authors focused on environmental protection, taking into consideration biological diversity and actions, which need to be taken to maintain sustainable development.

An interesting study of non-productive functions of fish pond ecosystems is presented using the example of Milicz Ponds in the Barycza Valley. Apart from provisioning services connected with food production, they play an important role in retaining and protecting water quality, in maintaining biodiversity (regulating services), and are also characterised by aesthetic and cultural values.

Cultural services

A separate session was devoted to reports on research on cultural services as a special type of services provided to the social and economic system by ecosystems. Their different nature results from the fact that they are the result of subjective perception of the natural reality by individual persons while provisioning and regulating services pertain to goods and services, which have a material dimension. The fact of the subjectivity of the assessment cultural benefits from the functioning of ecosystems constitutes a fundamental difficulty in their quantification. However, cultural services are subjected to research and analyses, including, in particular, attempts at various valuations. Numerous varied methods are used for determining their value.

A meta-analysis of 53 studies on declared and revealed preferences in recreational use of forests, which were conducted in eight countries in the years 1970-2012. Owing to a long time span of the analysis, it was possible to identify their variability in time and space. The research showed that the following factors contribute to an increase in the recreational value of forests: location in a national park, a considerable distance from cities and a relatively large surface area.

A study conducted in the Wielkopolski National Park, in turn, using the WTP (willingness to pay) and WTA (willingness to accept) methods made it possible to estimate its social value. At the same time, it revealed factors, which had a significant influence on the shape of these values. It is striking that the financial readiness to support environmental protection is not significantly related to the respondents' affluence.

A very interesting cost–benefit analysis was conducted to determine the economic efficiency of protecting sites of colonial nesting of white storks and their adaptation to the provision of tourism-related ecosystem services. Creating such "stork villages" required the development of infrastructure, additional expenditures on environmental protection as well as marketing and educational activities. Public benefits were connected with tourist and recreational use of the village and estimated with the travel cost method.

A study of social assessment of forest littering and the degree of readiness to incur the costs of cleaning adopted a different perspective. Such an approach can be treated as an analysis of weight attached by various social groups to restoration of an appropriate level of cultural services, which has been degraded by littering.

Significant recreational services are provided by water ecosystems. An attempt was made for selected lakes in NW Poland to relate the sanitary condition of beaches and bathing areas to the level of recreational services.

Attention was drawn to the difficulty in classification of cultural services in a report on a survey conducted among experts pertaining to the types of ecosystem services, which are of importance for tourism and recreation. The results show that these activities are connected with the use of various types of benefits. This outcomes questioned the legitimacy of treating tourism and recreation as a one separate group of cultural services.

Evaluation and Conclusions

The presented synthetic overview of completed and ongoing research on ecosystem services in Poland distinctly shows a high activity of numerous research groups from various academic centres. It shows that a transition was made from the stage of speculations to a stage of collecting and interpreting information. However, it is quite easy to notice that individual authors use different basic assumptions and different research methods. In particular, the approach to relations between the environmental complex of processes occurring in the environment and ecosystem services. The results presented are generally very interesting, however, they show distinctly that it is necessary to establish theoretical foundations and develop at least an outline of a common methodological platform allowing for an analysis of various problems in a manner, which makes it possible to compare the results obtained by teams from different research centres.

Ecosystem services, as a research approach, have an applied character in the political and social context. Therefore, it is necessary to expect a greater activity from state authorities as regards the implementation of this approach at various levels of society. This would be an impulse for harmonisation of future research and applied work. However, as shown by an analysis of 46 legal acts and strategic documents presented during the symposium, the issue of ecosystem services is only marginally present in legal acts and strategic documents pertaining to environmental protection policy.

The presentation by Leon Braat related the results of Polish research to the international debate on ES, featuring the following four most important issues:

- The boundary between ecosystems and economic systems: functions, services & benefits;
- Biodiversity & Ecosystem Services: causal links and management options;
- Cultural Services: human mental frames of ecosystem information flows;
- Economic & Social Value: ecosystems as the basis of the Value Production Chain.

The list of issues shows that ES as a research field is still at a very early stage of development. The summing-up discussion conducted on the basis of this information identified the following conclusions and future challenges.

ES as a multidisciplinary research field enjoys a constantly growing interest among ecologists, including, in particular, experts in geographic and economic sciences. Representatives of other social science are less numerous, despite the fact that their area occupies an important place in the research. The quality of transdisciplinary ES studies would be higher if joint research projects were undertaken with the participation of representatives of various fields of knowledge.

The notion of ES is understood in various ways, which is understandable at this stage. However, this notion should not be overly extended, e.g. to include all natural processes and phenomena or all humans environment relations, as it might become blurred as a result – as in the case of the notion of "sustainable development".

The ES area is an attractive research and application field as it stimulates a social interest in natural matters, which evokes an interest among politicians. It is to keep the sovereignty of science against unavoidable expectations of politicians regarding the results of the diagnosis of benefits from processes occurring in ecosystems.

ES research should not be reduced to their monetary price. Such a valuation is usually obvious as regards provisioning services connected with the management of natural resources. Their prices are shaped on the market. A large part of benefits, however, has a non-market character, which is why the methods of estimating the monetary value are used. However, economic valuation is always heavily dependent on its context. The context of each valuation study is unique and consists of methodology, sample, place and time what limits validity and comparability of diverse assessments. It is risky to sum up such diverse monetary values or to use the calculated values as the basis for making practical decisions with no further reflection.

So far, research in Poland has focused on the provision of ecosystem services; however, the problem of demand for ecosystem services and ES stimulation by appropriately targeted human activity is beginning to emerge.

As ecosystem services develop as a research and application approasch, the issue of sources of data and the influence of their quality on the results of ES quantification is becoming more and more significant. The qualitative and quantitative recognition of processes in ecosystems is of key importance as without it, even the best interpretations of secondary data as statistics or GIS may be encumbered with unacceptable errors. On the other side, we deal with valuation by recipients, i.e. a subjective area which must become standardized to account for the "average recipient". In this area, there are a large number of possibilities for the occurrence of inadequate findings.

The fact that we are at an early stage of ES research should motivate interested researchers, who should not become discouraged by the lack of precision of the findings made. At the same time, however, it is necessary to perform a reliable analysis of limitations in the interpretation of results.

Leon C. Braat

ECOSYSTEM SERVICES: THE ECOLOGY AND ECONOMICS OF CURRENT DEBATES

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ŚWIADCZENIA EKOSYSTEMÓW: EKONOMIA EKOLOGICZNA

STRESZCZENIE: Koncepcja „świadczeń ekosystemów" jest przedmiotem intensywnych dyskusji w środowisku naukowym. Jej praktyczne zastosowanie na poziomie Unii Europejskiej oraz w poszczególnych krajach spotyka się z pewnym sceptycyzmem. Skutkiem tego szereg zagadnień jest gorąco dyskutowanych. W artykule przedstawiono stan debaty nad czterema tematami, które zdaniem autora zasługują na szczególną uwagę. Są to: (1) Granica pomiędzy ekosystemami, a systemami ekonomicznymi: funkcje i świadczenia ekosystemów oraz korzyści dla człowieka; (2) Zależności pomiędzy bioróżnorodnością, a świadczeniami ekosystemów; (3) Problem identyfikacji i oceny świadczeń kulturowych; (4) Relacje między wartością ekonomiczną, a społeczną, czyli traktowanie ekosystemów jako podstawy wartości łańcucha produkcji.

SŁOWA KLUCZOWE: funkcje ekosystemu, świadczenia ekosystemów, świadczenia, bioróżnorodność, wartość ekonomiczna, wartość społeczna, wartość łańcucha produkcji

Introduction

Current Debates

Ecosystem services are "hot". The concept is intensely discussed in the scientific community, both in the natural and in the social science corners. It is used, developed and customised in the policy arena, with much energy at the European level, and on average a bit less, but increasingly, at Member State and regional levels. And, it is generally considered in a sceptical and apprehensive way in the so called "practice" domain, both in (former) government agencies which have to "get money" out of the market and in the business communities which realise that they should be ready to jump in potentially new markets, but also that they lack the knowledge to do so adequately. In this situation, a number of topics in the wide field that the concept of ecosystem services covers, have become hot debate issues[1]. In this contribution to the Symposium, I highlight four of those debates. The selection is my personal choice, and is based on what I meet in my research and advisory work for DG Environment (the MESEU project) and for DG Research and Innovation (the OpenNESS project), and on manuscripts submitted to the scientific journal "Ecosystem Services", of which I have the pleasure to be the editor-in-chief. The four debate issues are:

1) The boundary between ecosystems and economic systems: functions, services and benefits.
2) The relationship between biodiversity and ecosystem services.
3) Cultural Ecosystem Services.
4) Economic and Social Value: Ecosystems as the basis of the Value Production Chain.

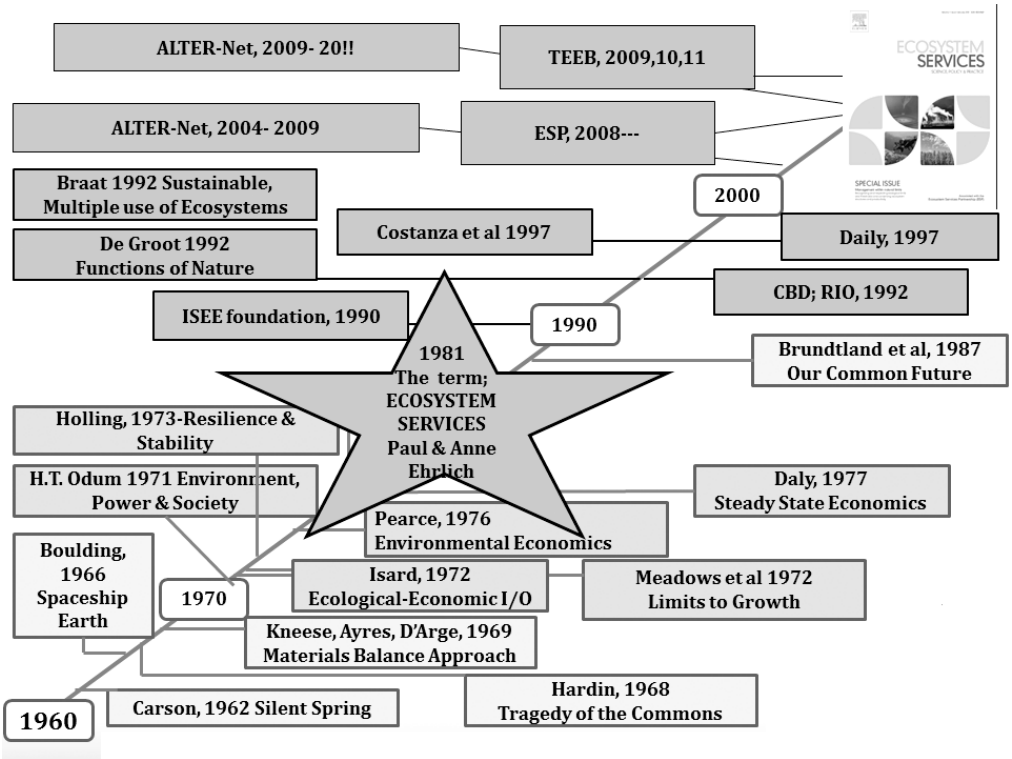
Historical Background of the debates

The diagram in figure 1 illustrates the two decades of ecological (medium grey boxes) and economic (pale grey boxes) concepts and their authors that were blended into the concept of ecosystem services (dark grey boxes) and the discipline of ecological-economics.

From 1981 on, an increasing number of publications appeared, together with international research projects, science-policy processes and political documents

[1] L. C. Braat, *The value of the Ecosystem Services concept in economic and biodiversity policy*. Chapter 10, in: S. Jacobs, N. Dendoncker, H. Keune (eds.) *Ecosystem Services, Global Issues, Local Practices*, Amsterdam 2013.

Figure 1
History of the Ecosystem Services Concept



Adapted from: L.C. Braat, *History of the Ecosystem Services concept*, Introductory presentation, at ESP Conference 2011, Wageningen 2011.

(see for an extensive historical analysis: paper of Gomez and co-authors[2]). The history involves the utilitarian framing of those ecosystem functions which are used by humans, as they are deemed beneficial to society, as economic services. The development continues throughout the 1980s in the sustainable development debate[3] and into the 1990s with the mainstreaming of ecosystem services in the professional literature[4], and with increased focus on methods to estimate their economic value.[5] In the 1970s and 1980s, a growing number of environ-

[2] E. Gómez-Baggethun, R. de Groot, P. L. Lomas, C. Montes, *The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes* "Ecological Economics" 2010 no. 69, p. 1209-1218.
[3] WCED (World Commission on Environment and Development), *Our Common Future*, Oxford 1987.
[4] R. Costanza, H. Daly, *Natural capital and sustainable development*, "Conservation Biology" 1992 no. 6, p. 37-46; G. Daily, *Nature's Services: Societal dependence on natural ecosystems*, Washington D.C. 1997.
[5] R.Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 253-260.

mentally aware authors started to frame ecological concerns in economic terms in order to stress societal dependence on natural ecosystems and raise public interest in biodiversity conservation. Schumacher[6] was probably the first author that used the concept of natural capital and shortly after several authors started referring to "ecosystem (or ecological, or environmental, or nature's) services"[7]. One rationale behind the use of the ecosystem service concept was to demonstrate how the disappearance of diversity of structure and processes in ecosystems (short: biodiversity) directly affects ecosystem functions that underpin critical services for human well-being. The paper by Costanza and co-authors[8] on the total value of the global natural capital and ecosystem services was a milestone in the mainstreaming of ecosystem services. Their monetary figures, although surrounded by caveats, resulted in a high impact in both science and policy circles, manifested both in terms of criticism and in the further increase in the development and use of monetary valuation studies.

The definitions of the concept have evolved through the various publications, with varying attention for the ecological basis or the economic use. I take the viewpoint that "Ecosystem Services are the direct and indirect contributions of ecosystems in interaction with contributions from human society to human well-being", which is a variation on the definition given TEEB Foundations[9]. Of course, the term ecosystem services was coined, according to most sources, in 1981 by Paul and Anne Ehrlich[10] (although there were many earlier references to the notion of useful work and benefits from ecosystems), but the process of bridging the gaps between ecology and economics, and between the domains of nature conservation and economic development, and the landing in the political arenas took a few decades. And now it is the core of the EU Biodiversity Strategy and enters other EU policies, be it through the side door. With highlighting the four debates in this paper, I aim to vaporise some myths and create some better understanding of the challenging world of ecological economics.

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[6] E. F. Schumacher, *Small is Beautiful: Economics as if People Mattered*. Blond and Briggs, London 1973, p. 288.

[7] W. E. Westman, *How much are nature's services worth?,* "Science" 1977 no. 197, p. 960-964; L. C. Braat, S. W. F. van der Ploeg, F. Bouma, *Functions of the Natural Environment Institute for Environmental Studies*, Amsterdam 1979; L. C. Braat, *Sustainable multiple use of forest ecosystems: an economic-ecological analysis for forest management in the Netherlands.* Dissertation, Amsterdam 1992, p. 195*;* R. S. De Groot, *Functions of Nature: evaluation of nature in environmental planning, management and decision-making,* Groningen 1992, p. 345.

[8] R. Costanza et al., *The value of the world's ecosystem services and natural capital*..., op. cit.

[9] P. Kumar, P. Earthscan (eds.), *TEEB-The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations*, London 2010.

[10] P. Ehrlich, A. Ehrlich, *Extinction: the causes and consequences of the disappearance of species*, New York 1981.

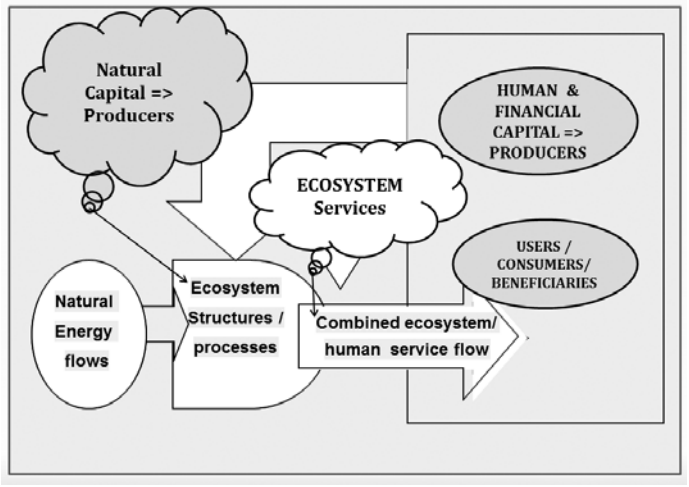
Debate issue 1: The boundary between ecosystems and economic systems: functions, services and benefits

The term Ecosystem Services still causes frowns in many places. It is not immediately clear to all that it is in fact a contraction of Ecosystem-Based Goods and Services. It does also not refer, within the name, to the essential role of humans in influencing the flows of services, either directly by harvesting the biomass and perceiving the information from ecosystems, or by investment and management of the ecosystems that provide the work that regulate the environment for Homo sapiens, humanity. Ecosystem is a concept from the natural science discipline Ecology describing, measuring and analysing the world of biotic and abiotic components, flows and cycles, in biophysical terms and units such as kilograms, meters and seconds (see e.g. Fundamentals of Ecology[11]). Services (from Latin: servus; to serve, to work for….) is a concept from Economics, a social science discipline, describing the organisations and activities of people (Homo sapiens; a particular biological species) developed for their survival (e.g. acquisition of food) and well-being (e.g. through specialisation of skills, trade and financial mechanisms).

The diagram in figure 2 illustrates the relationships between "ecosystem services" which follow from the interaction between energy and matter from Ecosystem Structure and Processes (also called Natural Capital) with the energy and matter from the Society (Aubergine box and circle; Human, Social and Financial Capital). The services are recognised by people via the benefits, which are the (partial) satisfaction of human needs and wants. In the pre-historical Hunter-Gatherer stage, humans can be viewed as still fully living inside as integral part of the ecosystem, and like deer and wolves, enjoying the ecosystem functions, while being part of them. Sometime around 6000 years ago in North-West Europe, Homo sapiens created their own localised agro-ecosystems, with crops and livestock. Humans were still very much dependent for the satisfaction of their needs on the direct supply of goods and services from the local ecosystems, even far into the late medieval times. With the industrialisation, human society developed energy sources independent from current sunlight energy, the so called fossil fuels, in fact: fossilised biomass, so embodied sunlight energy. The mental distance between humans and nature started to become larger and widespread, and more so as a majority of people in the world now lives in cities, where the share of biotic processes has been reduced to marginal proportions. My model of the current ecosystem-(human/social/cultural) economic system is presented in figure 3, which is an adaptation of the TEEB diagram12. Ecosystem functions, following from structure and processes are aggregate dynamics which produce new structure and adapted processed as ecosystems evolve. By "definition", when ecosystem functions are used by humans, they are called ecosystem services. This is the logical corollary of the utilitarian approach to the biology of

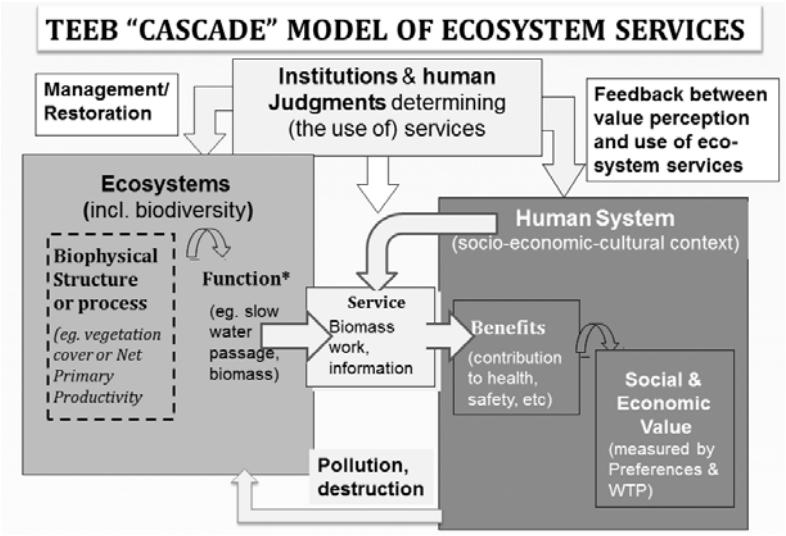
[11] H. T. Odum, *Systems ecology: and introduction,* Wiley, New York 1983.
[12] TEEB, *The Economics of Ecosystems…*, op. cit.

Figure 2
Ecosystem services as the result of ecosystem and human interactive production



Adapted from: L. Braat, R.S. de Groot, *The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy*, "Ecosystem Services" 2012 no 1, p. 4-15.

Figure 3
Ecosystem Services as the linking pin



Adapted, based on: R.S. De Groot, et al., *Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. Chapter 1*, in: P. Kumar (ed.), *TEEB Foundations The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations*, Earthscan, London 2010, p. 9-40, www.teebweb.org [20-10-2014]].

Homo sapiens. We look at (the rest of) nature as a system to feed, comfort and inspire us, in other words, as provider of provisioning, regulating and cultural services.

Following almost 20 years of academic explorations, in the early part of the present millennium a large study of the state and relevance of ecological systems for society was conducted under the umbrella of the United Nations Environmental Program (UNEP): the Millennium Ecosystem Assessment[13]. It was soon followed by an exploration of The Economics of Ecosystems and Biodiversity[14]. This study, building on this initiative, has taken ecosystem services in the policy arena with a clear economic connotation[15]. With increasing research on the monetary value of ecosystem services, the interest of policy makers has turned to the design of market-based instruments to create economic incentives for conservation, e.g. payments for ecosystem services. Both models of ecosystem services position the *natural science domain* on the left side and the *human, social and economic domain* on the right side in the diagram. Ecosystem services flow from left to right. The TEEB diagram places ecosystem services as a linking pin between the natural and human systems and identifies benefits for people following from services (and goods) delivered by ecosystems, and separates benefits and values[16]. It also includes the "feedback" structure of control and investment through institutions and ecosystem management. My diagram in figure 4 is a further elaborated version, which adds a negative feedback of pollution and destruction. The TEEB diagram in turn was an extension of the so called cascade model published by Haines-Young & Potschin[17].

Money comes into the model, if so desired, as a flow which goes from beneficiaries to producers. In the real world, people pay money for goods and services to other people, and never to the ecosystem, even when the ecosystem is clearly a co-producer. There are representatives of the ecosystem collecting money, at least there should be, but they are human owners or managers, not the animals or the plants. These owners and managers should use the money to " buy" resources for the ecosystem to replenish its stocks and buy time to rebuild damaged structure and re-boot processes. In the diagram in figure 4, the ecosystem services flow from natural systems via, agro-ecosystems to urban (industrial) systems, and are exported to other regions. Money flows in the opposite direction, paying for the services and goods, both with the regional system and across the boundaries for imports. Exports generate cash flows to pay for those imports. And again, no money flows to the natural ecosystems, nor to the ecological part of the agro-ecosystems. However if no investment and compensatory management is executed (and adequately paid for), the system cannot be sustained.

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[13] *Ecosystems and Human Well-being: Synthesis*, Island Press, Washington D.C. 2005; www.maweb.org [20-10-2014].

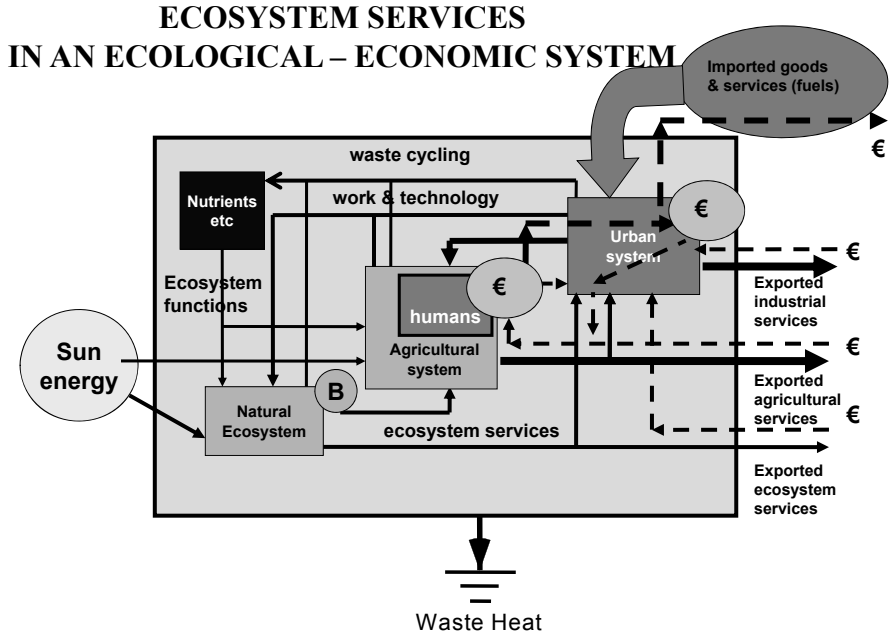
[14] TEEB, *The Economics of Ecosystems...*, op. cit. (again under UNEP umbrella).

[15] www.teebweb.org [20-10-2014].

[16] De Groot et al., *Integrating the ecological and economic...*, op. cit.

[17] R. Haines-Young, M. Potschin, *The links between biodiversity, ecosystem services and human well-being*, in: D. Raffaeli, C. Frid (eds.), *Ecosystem Ecology: a new synthesis. BES ecological reviews series*, Cambridge 2009.

Figure 4
Money flows in an ecological economic system



Source: own elaboration.

Debate Issue 2: The relationship between biodiversity and ecosystem services

There is clear evidence for a central role of various features of biodiversity, e.g. abundance of different gene pools and of populations of key species, of functional traits, and spatial heterogeneity of habitat structure, in the delivery of some – but not all – services, viewed individually. Maintaining functioning ecosystems capable of delivering bundles of ecosystem services requires a consistent approach to sustaining a considerable level of these (and other) aspects of biodiversity. Most of the current measures and indicators of biodiversity and ecosystems were not developed for economic assessment. They are therefore not always able to show clearly the relationships between features of biodiversity and the benefits they provide to people. A reliance on existing indicators will capture the value of only a few species and ecosystems relevant to e.g. food and fibre production, and will miss the role of the biological diversity in species, food webs, nutrient processing chains and ecosystem productivity in supporting the full range of benefits, as well as their resilience in dealing with human induced stress, regulating services. A set of indicators is therefore needed that is not only

relevant and able to convey the message of the consequences of biodiversity loss, but must also reflect the aspects of biodiversity relevant to the ecosystem service of interest, capture the often non-linear and multi-scale relationships between ecosystems and the benefits that they provide, and be convertible into economic terms. A relevant and well-structured overview of relationships between biodiversity features and ecosystem services as they appear in the professional literature is available in paper by Harrison and co-authors[18].

Debate issue 3: Cultural Ecosystem Services

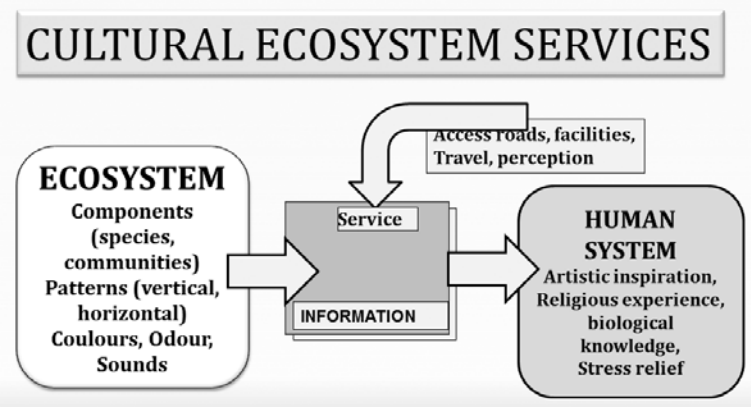
Cultural services are referred to in the professional literature as the group which has not been research as much as the other types of services. This may be true for ecologists and economists alike, but the phenomenon has been receiving much attention in research disciplines dealing with social psychology, recreational behaviour, and especially landscapes.

In my view ecosystems deliver information from their (change in) structure to observers, i.c. humans (see figure 5). Following information theory and various indices that measure aspects of information, the more diverse the source system observed (e.g. in structure, horizontal and vertical patterns, colour, smell, sounds), the more information is available to be perceived (following Shannon-Weaver Index). Humans that "are exposed to the same ecosystem" experience different aspects of the information flows. So artists, priests, professional biologists, outdoor recreationists that all visit a particular ecosystem can see in principle the same, and obtain the same information, with their eyes or other sensory organs, but their minds (mental filter) defines the information that is processed, and therefore the benefits they receive (figure 6a). So culture in the Cultural Ecosystem Services is the Mental Filter (maybe a Cultural frame of filters at group level) that humans consciously or unconsciously apply to the information from ecosystems. Different factors determine in combination the development of the filter, which is the reason that artist, priest, biologist and recreationist all perceive different things in the same forest (figure 6b). The classifications of ecosystem services schemes (MA, TEEB and CICES[19]) refer to these information flows and experiences, but do not clarify the process of information perception and the mental filters. The model of cultural services is in fact very similar to those of provisioning services, except that biomass and water are replaced by information. Similarly, humans have to invest energy to obtain the information, e.g. one may need to invest in access and facilities.

To assess economic or social values of cultural services, one needs to record the values that individuals to the benefits they receive with the experience of the information flows; economic value at individual level is based on "preference" for

[18] P. Harrison et al., *Linkages between biodiversity attributes and ecosystem services: A systematic review,* "Ecosystem Services" 2014 no. 9.
[19] www.cices.eu [20-10-2014].

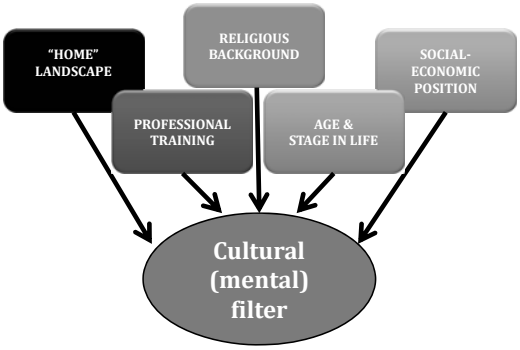
Figure 5
A cultural ecosystem services model



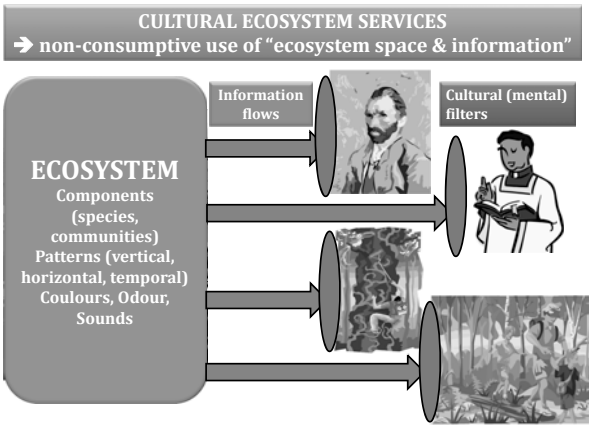
Source: own elaboration.

Figure 6
Perception of information and cultural mental filters

A



B



Source: own elaboration.

which an individual is prepared to "pay" something (or give up something else). Social value is how the ecosystem (via the service) leads to benefits in the social domain (e.g. group excursion enhancing social structure etc. To calculate or estimate such values of an ecosystem's cultural services, one could calculate the sum of values of individuals, but also the values assigned as stakeholder groups (e.g. recreation entrepreneurs) and as society (e.g. subsidies to protect and maintain national landscapes). Monetary equivalents reflecting how important people consider an hour of experience of exposure to ecosystem information can be calculated from Willingness To Pay methods, with all their limitations, and proxy methods as travel cost involved. Recreation entrepreneurs have of course real costs (investment and operation) and their balance sheets provide information on how much people actually spend to recreate and enjoy the information from ecosystem's cultural services.

Debate Issue 4: Economic and Social Value: Ecosystems as the basis of the Value Production Chain

The EU Biodiversity Strategy 2011-2020 has six targets and twenty Actions. Target 2 is about ecosystem services, and Action 5 about the knowledge of ecosystems and their services, which is deemed necessary to make sustainable use of the ecosystems possible. Action 5 includes 3 steps, which are in essence based on the TEEB 3 step procedure, named (1) recognising value (by mapping and assessment of ecosystems and their services), (2) demonstrating value (economic and social valuation) and (3) capturing value (developing policies for sustainable use via accessible data in accounting systems).

Mapping and assessment

It is essential to map the ecological, and also the human user systems, in the landscapes where ecosystem services are to be assessed. Without precise delineations of system boundaries, the quantification processes will be unreliable, and in human systems ultimately legal consequences of policies require exact property boundaries. Maes and co-authors[20] give an introduction to and overview of the challenges of mapping ecosystem services. The PRESS studies[21]. were developed in the context of the EU Biodiversity Strategy 2011-2020[22]. To support EU policy

[20] J. Maes et al., *Mapping ecosystem services for policy support and decision making in the European Union,* "Ecosystem Services" 2012 no. 1, vol. 1, p. 31-39.
[21] J. Maes et al., *A spatial assessment of ecosystem services in Europe: methods, case studies and policy analysis – phase 1, PEER interim report*, Ispra 2011; J. Maes, et al., *A spatial assessment of ecosystem services in Europe: methods, case studies and policy analysis. Synthesis, Phase 2. PEER report*, Ispra 2012.
[22] *Our life insurance, our natural capital: an EU biodiversity strategy to 2020,* COM 244 final, Brussels 2011.

development, clear and specific definitions of the different ecosystems and of the services have been produced in the MAES process (Mapping and Assessment of Ecosystems and their Services) run by the EU with the Member states to implement Action 5[23]. The describe the search for appropriate indicators, mapping methods and techniques, data sources.

Most challenging is the quantification of the so called bundles of ecosystem services. In assessing trade-offs between alternative uses of ecosystems, the total bundle of ecosystem services provided by different conversion and management states should be included. Economic assessment should be spatially and temporally explicit at scales meaningful for policy formation or interventions, inherently acknowledging that both ecological functioning and economic values are contextual, anthropo-centric, individual-based and time specific. Ecosystems produce multiple services and these interact in complex ways, different services being interlinked, both negatively and positively. Delivery of many services will therefore vary in a correlated manner, but when an ecosystem is managed principally for the delivery of a single service (e.g. food production) other services are nearly always affected negatively. Braat and co-authors[24] have examined the practices of mapping and assessment in a number of European countries and regions and provide insight in best practices.

Valuation

Valuation is a mental process which includes assessment of situations and making decisions on whether to act or refrain from action. All people do it, all the time, mostly unconsciously, in view of so-called desirable ends (see figure 7a and b).

However when major changes in ecosystems and ecosystem services are at stake with change in welfare and well-being, for example as a consequence of land use change, economic or environmental policy, structured and transparent valuations need to take place, also in view of desirable ends, but not at the individual but at societal level. Traditionally such projects were concluded with a financial cost-benefit analysis, in which the costs of development as well as the benefits recognised in the market were included. Also traditionally, costs of loss and benefits of conservation of non-market ecosystem services, as most regulating services are, were generally ignored.

A broader approach, including the non-market aspects of welfare and well-being is now being developed in many places, with the aim to integrate the objectives of ecological sustainability, social justice and economic efficiency into the public decision making process[25] (see figure 10b). The understanding of the

[23] See: J. Maes et al., *Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020,* Luxembourg 2013.

[24] L. C. Braat et al., *Mapping of Ecosystems and their Services in the EU and its Member States (MESEU)* ENV.B.2/SER/2012/0016; October 31, 2013: Final Report (1st year contract) Part 1: Introduction, Summary&Conclusions 2013.

[25] J. Farley, *Ecosystem services: The economics debate,* "Ecosystem Services" 2012 no. 1, v. 1, p. 40-49.

Figure 7
Valuation and desirable ends

A

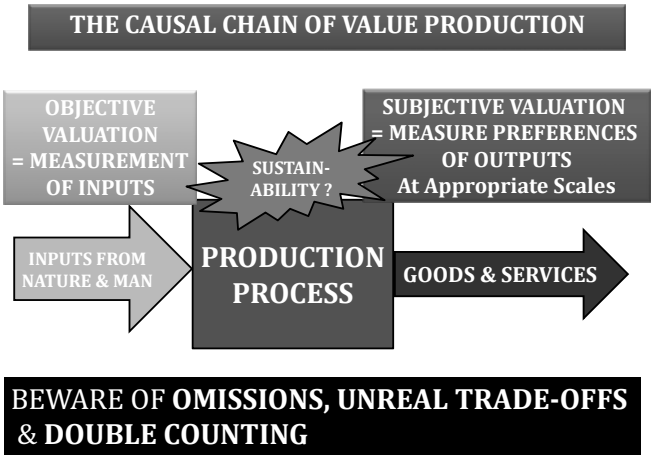
B

Based on: J. Farley, *Ecosystem services: The economics debate*, "Ecosystem Services" 2012 no. 1, v. 1, p. 40-49.

complexity of the development of economic and social value (as depicted in the TEEB diagram) is increasing, but still not generally embedded in decision making. In those situations where goods and services are co-produced by ecosystems and human activity, the "value production chain" should be considered as a causal chain, which implies that the valuation takes place at the end of the chain, based on the preferences of consumers, stakeholder groups or regional to international societies (see figure 8).

This valuation is by definition subjective in that it reflects to what extent the "ends" are realised in the perception of the valuators. The counterpart in this process is the valuation of the inputs, both the biophysical inputs derived from ecosystems (Natural Capital), and the financial capital, labour and technology inputs from humans. One may choose to quantify those inputs, and include these objectively obtained numbers in the "input" or "cost" side of the valuation table, but they should not be included in the total value estimate, as double counting will then occur. One should also not put subjective value assignments on ecosystems features like species richness as a so called ecological value in the cost-benefit equation. Although done in some cases to give adequate attention to the im-

Figure 8
The causal chain of value production



Source: own elaboration.

portance of the ecosystem in producing economic and social values, this is already taken care of as in such value production chains, there is no economic or social value without the ecosystem inputs. In addition, if ecological values are listed as seemingly independent values assigned by people, next to economic and social values, a risky and unreal situation may come into existence where decision makers trade-off economic against ecological values. To avoid omissions of essential factors in producing benefits, a systematic approach which uses the classification tables of ecosystem services as produced by the TEEB project or more recently by the CICES project is an advisable approach.

Many methods have been developed to obtain quantitative estimates of economic and social values, as they are assigned by individuals, groups or societies. For example most provisioning services provide benefits which are readily monetarily valued with market prices, while cultural services are often non-monetarily valued, or with shadow pricing methods. Such combinations are risky if the interdependencies between ecosystem services and their inputs are not accounted for, as indicated above. The HYBRID valuation approaches need therefore to be examined closely for such inconsistencies, and the search is now for "integrated valuation", which "is defined as a systems approach recognising causal relationships between components of ecological-economic systems in assigning values to benefits (resulting from ecosystem services) at individual, social group and society level[26]".

"To value is to monetize" in the eyes of many, some of which state this with enthusiasm, others with horror. The limitations of monetary valuation are many,

[26] E. Gómez-Baggethun et al., *State-of-the-art report on integrated valuation of ecosystem services,* OpenNESS project Deliverable 4.1, Helsinki 2014.

if only that it is always time and location dependent, the currencies employed may be quite instable, the market based methods suffer from the same flaws as the markets themselves, and when ecosystems are near critical thresholds and ecosystem change is irreversible, money values do not help as regulatory mechanism[27]. Terminology is important in scientific and policy debates. A distinction between monetization and expressing ecosystem service values in monetary terms is proposed and discussed in paper by De Groot and co-authors[28]. Monetary valuation is sometimes understood to imply that ecosystem services must be privatized and commodified (traded in the market). This is of course not a necessary corollary. As indicated above, money does not get paid to ecosystems, so the monetary value assigned to services should represent (1) reflect the direct costs for (and therefore payments to) human co-producers of ecosystem services and (2) the costs for (and therefore payments to) maintaining the quantity and quality of the ecosystems (natural capital), which are the other co-producers of ecosystems. Non-Monetary valuation methods are most useful at the level of (stakeholder) groups which have decisions to make which affect all of the participants, but most likely in different ways and degrees. The biophysical assessment methods are alternative ways to assess the input contribution from the ecosystems.

Braat & De Groot[29] summarise the crucial issue of time in valuation: "inter-temporal distribution of costs and benefits is firstly a moral issue for all decision makers in general, and secondly a technical issue for those dealing with ecosystem services, as ecological and economic systems involved in trade-offs may have different clock-speeds. At the ecosystem level, the required natural restoration time may run into decades for wetlands and grasslands and hundreds of years for forests". Another relevant time aspect are of course the time-lags between economic activities and their impacts on ecosystem services, e.g. climate change, extinction debts, etc. The consequence is that the application of fixed discount rates to ecological as well as economic systems, as is common practice in conventional economics and based on national interest rates, leads to results which affect future generations disproportionally. While at the personal level, most people seem very much aware of and concerned with the education of their off-spring and their retirement financing, the awareness at the group level is rather small, and political choices reflect that (lack of) awareness and prioritisation"[30]. It suggests a dual approach to dealing with time in the human mind, which has been labelled "thinking fast and thinking slow"[31].

27 See: L. C. Braat, R. S. de Groot, *The Ecosystem Services…*, op. cit.
28 R. S. De Groot et al., *Global estimates of the value of ecosystems and their services in monetary terms,* "Ecosystem Services" 2012 no. 1, vol. 1, p. 50-61.
29 L. C. Braat, R.S. de Groot, op. cit.
30 See also: J. Gowdy, *Neoclassical economics and its discontents*, in: *TEEB-The Economics of Ecosystems…* op. cit., p. 20.
31 D. Kahneman, *Thinking, fast and slow*, Straus and Giroux 2011.

Capture (and manage) the values

Step 3 in the TEEB procedure is "to capture the values for a sustainable society". In TEEB for Policy Makers[32] the capture message is "providing information about benefits, creating a common language for policymakers, business and society, revealing the opportunities to work with nature, emphasizing the urgency of action and generating information about value for designing policy incentives". The third step is represented in the TEEB diagram (see figure 4) by the feedback loop from the economics box to the ecological box and to the ecosystem services flows, as institutional, policy and societal response. Capturing value thus involves the introduction of mechanisms that incorporate the values of ecosystems into decision making, through incentives, social arrangements and price signals. The capturing also refers to making the "value" in the service actually tangible and visible, in some cases cash-able and accountable, and generally includes payments for ecosystem services, reforming harmful subsidies, tax breaks for conservation, or creating a green market economy. Essential is the development (or adjustment) of the legal system with respect to rights over natural resources and liability for damage to ecosystem service potential. In Action 5 of the EU Biodiversity strategy, the third step is focused on the (accessible) storage of the values of ecosystems and their services in Natural Capital Accounts. The aim is undoubtedly to have these values readily available for use or reference in future decision processes involving expected changes in ecosystems and their services. A lofty aim, but a challenge for all involved, from the scientists and policy makers to the stakeholders and the decision makers. And one which will definitely not make life simpler for those involved and those with ultimate responsibility, but one that definitely holds more promise for a sustainable world.

[32] TEEB, *The economics of ecosystems and biodiversity for national and international policy makers*, P. ten Brink (ed.), London 2011.

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TIME FACTOR IN ECONOMIC VALUATION

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CZYNNIK CZASU W BADANIACH WYCENY EKONOMICZNEJ

STRESZCZENIE: Badania oceniające korzyści czerpane z ekosystemów są obecnie istotną częścią wszystkich badań poświęconych wycenie ekonomicznej. Zjawiskiem niepożądanym jest marginalizowanie czynnika czasu. W artykule skupiono uwagę na pasywnej jak i na aktywnej roli odgrywanej przez czynnik czasu w badaniach wyceny. Przedstawiono analizę dyskontowania, a w szczególności zwrócono uwagę na problem wyboru stopy dyskontowej.

SŁOWA KLUCZOWE: wycena ekonomiczna, dyskontowanie, świadczenia ekosystemów

Introduction

Thanks to economic valuation a lot of intriguing results was worked out and published enlarging our knowledge and understanding of non-market goods and services. Applying economic valuation methods researchers measured consumers' willingness to pay for many goods which do not have any market price. Category of non-market goods includes also environmental goods granted because of the existence and biological production of small and large ecosystems. Among economic valuation studies the most peculiar place belongs to complex studies focused on benefits stemming directly and indirectly from ecosystems.

Unfortunately, time factor used to be marginalized in many valuation studies. This is why this article concentrates on a passive role and also on an active role played by time factor in economic valuation. The paper demands for clear information about the date of implementation of valuation method and also for a more advanced representation of time in valuation studies focused on natural capital. The paper proposes a brief analysis of discounting in general and discusses selection of the discount rate in particular.

A passive role of time factor

Economic valuation studies produce results which need very careful and precise interpreting. Interpretation is not easy because of an inappropriate treatment of time factor. Basically, time plays in valuation process a passive role and also an active role.

In its passive role, time is just a precise information "when" the valuation research was performed. Simultaneously, this is also an implicit information about multiple market-specific relationships. First and direct relationship creates correspondence to all prices of other goods which are available on the market including substitutes and/or complementary goods. Moreover, this relationship includes also, implicitly, a hint on trade-offs between valuated good and regular market goods.

Obviously, economic valuation occurs in one strictly defined moment or period. In its passive condition, time is represented by the calendar date. The research itself reveals the value of a non-market good but this assessed value is constrained to a very limited period and space. In other words, information on timing is an important part of the context "label" giving an insight into the technical parameters of any valuation research.

However, this quite basic meaning of time has also its important consequences for the result. The number being an outcome of any valuation study has its significance and validity which is no more stable and no more reliable than any

other dynamically evolving market price. There is nothing like universal, fixed and true valuation assessment. Calendar date, place, sample, and applied methodology determine the context, thus, they contribute to the result of calculation. It is crucial that some contextual elements like place, sample and method can be, more or less exactly, replicated in the future. However, the identity created by the moment of time remains unique both in material and in philosophical sense.

Monetary assessments still experience rather limited understanding and confidence. This is one more argument why it is evidently important to eliminate valuations without transparently explained context from any serious scientific discourse. In principle, economic values which are lacking calendar date, are not up-dated, are wrongly transferred from other studies, or are presented without necessary disclosure of their methodology may create, per balance, more problems than cognitive benefits.

It is always a matter of professionalism and responsibility of researcher to find out to what extend existing economic valuation assessments are still valid and can constitute reliable and significant arguments. In conclusion to the passive role of time factor, it should be requested that each economic valuation attempt has to be supplemented by its technical description. This "label" should inform on the context ("why", "what", "where", "how") with a clearly expressed calendar date ("when").

An active role of time factor

The problem of time is much more sophisticated with regard to an active role of time factor. This statement is justified by a common fact: some costs and benefits generated by non-market good have their complex distribution in time. Quite often, costs and benefits can be observed every day and year by year what suggests that researcher has to decide about the present value of future costs and benefits. This calls for discounting calculation which is quite indisputable in the case of market goods but not easy in the case of natural environment and some non-market artifacts. An active role of time factor becomes extremely crucial when time horizon of the study is very long and concerns future generations. This observation applies also to the case when irreversibility phenomenon occurs and makes its impossible to consume some goods in the future.

Economic valuation remains still a lovely domain of academic studies. It is very popular topic among students writing their master or doctoral thesis but at the same time this topic occupies a marginal place in real-life economics and economic decision making. It is very likely that more intensive and practical applicability of empirical valuation to day-to-day practice of insurance business and its compensation schemes would result much earlier in a more careful treatment of time factor. Unfortunately, it did never happen on a large scale.

Therefore, the following five questions should be addressed to improve the theory and practice of time perception in valuation studies:

1) Do considered benefits and costs occur only once or do they take a form of a stream in a course of time and their volume will be of varying intensity?
2) Are we in a position to foresee physical quantities of benefits and losses which will occur in the future and assess their monetary value?
3) Can we define discount rates which will be appropriate coefficients for any defined time horizon of the study?
4) What kind of correction will be needed for discounting when the time horizon is extremely long or infinite?
5) How to proceed with discounting when irreversibility phenomenon causes that some benefits will never occur in the future?

Questions enumerated above will be developed a bit in the next section of this paper. However, it is perfectly clear that do not exist perfect answers to all these questions. This paper does not pretend to give final and universal ("one size fits all") prescription for valuation studies but rather wants to encourage further debate and some improvement.

In addition, non-market goods do not create any homogeneous category. In particular, ecosystem services are not isolated from their ambient and have a long term impact on biosphere, society and economy. Moreover, time horizon in the case of benefits from ecosystem services exceeds standard time horizon appropriate for economic investment. Obviously, ecosystem services perspective goes beyond a regular time-span of strategic documents which used to be limited to a period of 20-25 years. Thus, it seems to be too trivial and artificial to limit valuation practice to an assessment of willingness to pay for an isolated, one-time (just today) and on spot transaction.

Discounting and discount rate

Discounting is the process of expressing future values in present value terms which allow for the comparison of cost and benefit flows regardless of when they occur. It sounds to be a realistic and logic observation that people, in general, do prefer experience benefits now and paying costs in the far future. The present value of a future flow of benefit or cost will be lower than the future value because of discounting. The mathematics of discounting meets a lot of criticism[1], mostly expressed by non-economists, and any discounting with non-zero discount rate can be accused to promote so called "tyranny of the present".

This problem is very transparent and hot in the environmental management. Discounting the value of one development project's future environmental benefits makes their future value disappointingly low compared to the present costs of ensuring them for the next generation. The same controversy applies to dis-

[1] B. S. Matulis, *The economic valuation of nature: A question of justice?*, "Ecological Economics" 2014 no. 104, p. 155-157.

counted value of a development project's future environmental damage which will be drastically low compared to the present cost of avoiding it.

"Discounting can easily become a pseudoscientific way of making the ethical judgment that the future is not worth anything"[2]. This opinion of Herman Daly[3], one of the most influential ecological economists, should raise our attention. Daly gives one strong argument why the attempt of standard economics to solve the intergenerational distribution problem by a market driven discounting is illegitimate: "The discount rate (interest rate) is a price, and like all prices it is determined subject to a given distribution of income and a given scale of the macro economy. Different distributions of the ownership of the resource base over generations, and a different scale of the macro economy, will result in different prices, including different interest rates. Since the interest rate is determined by the scale and intergenerational distribution of the resource base, it cannot be used as the criterion for determining either scale or intergenerational distribution via discounting. To do so would be circular reasoning"[4].

In principle, the problem with intergenerational equity is rather a normative economic ethics than pure microeconomics. Using market rates of interest as a guide to setting discount rates does not necessarily distribute the burdens and benefits of investment decision fairly between the present and the future. The supposed basis of markets is the self-interested actions of mortal individuals. The notion of discounted present value represents "the value to present people derived from contemplating the welfare of future people. It does not reflect the welfare of future people themselves, or even our estimate of their welfare. Rather it reflects how much we care about future people compared to ourselves"[5]. However, communities outlive their individual members and what may make sense for individuals seeking to maximize short-term present value may threaten the long-range interests of communities.

In his conclusion, Daly is extremely critical with respect to discounting as a panacea for intergenerational distribution and scale problems: "Standard economics routinely seeks to solve the intergenerational distribution problem by discounting, as if it were a single generational problem of inter-temporal allocation of consumption over the life stages of a single group of individuals, forgetting that different generations are different people and therefore the problem is one of just distribution, not efficient allocation. (…) Ecological economics insists on the basic distinction between allocation and distribution, and even for single-generation temporal allocation suggests the logistic rather than the exponential function as a more realistic representation of how people actually relate present and future value"[6].

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[2] T. Prugh et al., *Natural Capital and Human Economic Survival*, Solomons 1995, p. 98.
[3] H. E. Daly, *Steady-State Economics*, Washington 1991.
[4] H. Daly, *Ecological economics and sustainable development. Selected essays of herman daly*, Cheltenham 2007, p. 29.
[5] H. E. Daly, J. Cobb, *For the common good: redirecting the economy toward community, the environment and a sustainable future*, Boston 1989, p. 154.
[6] H.E. Daly, *Ecological economics …*, op. cit., p. 253.

In economics, exponential discounting is a specific form of the discount function, used in the analysis of choice over time. Exponential discounting implies that the marginal rate of substitution between consumption at any pair of points in time depends only on how far apart those two points are. For its simplicity, the exponential discounting assumption is the most commonly used in economics. However, alternatives like hyperbolic discounting have more empirical support.

Hyperbolic discounting is a time-inconsistent model of discounting. A large number of studies have since demonstrated that the constant discount rate assumed in exponential discounting is systematically being violated[7]. Hyperbolic discounting is a particular mathematical model devised as an empirically based improvement over exponential discounting, in the sense that it better fits the experimental data about actual behavior.

There is some empirical evidence in economic valuation studies that criticism of discounting in a form of the inverse of the exponential function was right[8]. For instance, in the case of future safety effects, it seems reasonable to assume that an individual's anticipated utility loss associated with the prospect of premature death (or injury) remains effectively constant over time. There is also some evidence that individuals do discount the future "hyperbolically" rather than "exponentially". The evidence comes from several psychological and medical studies.

In hyperbolic discounting, valuations fall very rapidly for small delay periods, but then fall slowly for longer delay periods. This contrasts with exponential discounting, in which valuation falls by a constant factor per unit delay, regardless of the total length of the delay. However, the time inconsistency of this behavior has some quite perverse consequences[9]. Individuals using hyperbolic discounting in their decision making reveal a strong tendency to make choices today that their future self would prefer not to have made, despite using the same reasoning[10].

Simultaneously, a good number of new studies wants to address adoption of the discount rate in a more complex way. The study by Daniel Read introduces "subadditive discounting"[11] where discounting over a delay increases if the delay is divided into smaller intervals. This sophisticated hypothesis may explain the main finding of many studies in support of hyperbolic discounting – the observation that impatience declines with time – while also accounting for new and unconventional observations not predicted by hyperbolic discounting.

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[7] S. Frederick, G. Loewenstein, T. O'Donoghue, *Time discounting and time preferences: a critical review*, "Journal of Economic Literature" 2002 no. 40, p. 351-401.

[8] I. J. Bateman et al., *Economic valuation with stated preference techniques*, Cheltenham 2002.

[9] The standard experiment used to compare short-term preferences with long-term preferences. For instance: "Would you prefer a dollar today or two dollars tomorrow?" or "Would you prefer a dollar in one year or two dollars in one year and one day?" For certain range of offerings, a significant fraction of subjects will take the lesser amount today, but will gladly wait one extra day in a year in order to receive the higher amount instead.

[10] D. Laibson, *Golden eggs and hyperbolic discounting*, "Quarterly Journal of Economics" 1997 no. 112, v. 2, p. 443-477.

[11] D. Read, *Is time-discounting hyperbolic or subadditive?*, "Journal of Risk and Uncertainty" 2001 no. 23, v. 1, p. 5-32.

There is also a "component based" approach providing a rationale for social discounting within the natural resource damage assessment[12]. "The proposed approach is a combination of some theoretical foundations of dual-rate discounting and time-declining social discounting. The former provides the principle that different discount rates should be used when considering either tangible (cost components) or medium-long term intangible effects (i.e. welfare losses), the latter that uncertainty and intergenerational equity issues play in favor of time-declining social discount rates"[13]. This approach agrees on the principle that very long-term welfare losses have to be discounted at low rate in order to mitigate the "tyranny of the present" effect. As a result, each damage component is discounted with a constant separate rate chosen from a menu of declining rates prescribed by the government. The choice of the rate is anchored to the damage component duration.

The consistency of optimal growth and sustainable growth depends very much on the relationship between the productivity of the resource base and the social discount rate. The higher the discount rate, the more is sustainable development at risk from the deliberate planning of "optimal" growth. The lower the discount rate, the less is the risk of "optimal extinction" for future generations. In particular, discounting is consistent with the sustainable use of renewable resource as long as the discount rate does not exceed the regeneration rate of the resource[14].

Obviously, for a non-renewable resource, regeneration is zero and there is no sustainable rate of consumption when the resource base consists solely of a non-renewable resource in fixed supply. Discounting merely brings forward the day when consumption falls to zero. Hence, the discount rate can have a profound implications for sustainable development. Hotelling's rule requires that resource rents in an efficient market will increase at the rate of exchange equal to the interest rate. This economic concept considers more profoundly economic efficiency conditions and gives less attention to physical constraints and multiplied consequences of scarcity of the resource.

The choice of rapid-exploitation, slow-exploitation, or non-exploitation depends crucially on the discount rate. The discount rate reflects the long-term profitability of different investments. Sustainability objectives could thus be introduced into investment decisions by stipulating a "social" discount rate for the use of environmental assets. The social discount rate would usually be lower than the market one to ensure the availability of natural resources assets for future generations. However, the rate is difficult to determine. Moreover, the normative (ethical) choice of low social discount rate for international and intergenerational equity takes a risk to be very discretionary. As a result, if it is not firmly

[12] E. Defrancesco, P. Gatto, P. Rosato, *A component based approach to discounting for natural resource damage assessment*, "Ecological Economics" 2014 no. 99, p. 1-9.
[13] Ibidem, p. 7.
[14] C. W. Clark, *Mathematical bioeconomics*, New York 1990.

founded in the theory, it may raise even more objections and receive more negative opinions than the regular market discount rate.

While a range of discount rates is possible, growth theory suggests that the social rate of return on investment is equal to the current social discount rate expressed by the following formula: $s = r + u \cdot \hat{c}$, and here: r – is the pure rate of time preference (or rate of impatience, the rate at which future utility is discounted), u – is the elasticity of the marginal utility of consumption, $\hat{c}$ – is the percentage rate of growth in per capita real consumption or its equivalent. It should be stressed again that "r" may be based on the myopic notion of "pure" time preference, as well as the risk perception that future consumption will never take into account.

The key point is that it may be misleading to choose discount rates without assuming some consistent scenario. The main obstacle is that the social discount rate needs empirical research and coefficients of elasticity of the marginal utility of consumption. The second best solution is to agree that the social rate of discount is equal to the growth rate of real consumption per capita or its close equivalent. Familiar approach was applied to the calculation of future costs and benefits resulting from the climate change policy. In particular, the growth rate of world GDP was supposed to indicate the global social discount rate.

Some recent studies suggested that it is inappropriate to use the same annual discount rate into the distant future. Weitzman (2001) argued that serious uncertainties about future economic magnitudes imply smaller discount rates as one imagines years deeper into the future[15]. Davidson published that zero discounting can compensate future generations for climate change[16]. In turn, Frederick et al. (2002) have published a survey of empirical evidence that tends to undermine traditional time discounting altogether[17].

It is worth mentioning that economists are not unanimous on the effect of interest and discount rates on natural capital management, even when they are sympathetic to the need to conserve natural capital. Some argue that although high interest rates tend to encourage depletion of resources now and thus shift ecological costs to the future, high rates also discourage investment in general, since it costs too much to borrow money and few projects will earn a high enough return to pay off loans or compete with leaving the money in the bank. Since natural capital is necessary for investment, when investment is low, so is the demand for natural capital. Thus, Pearce and Turner conclude: "exactly how the choice of discount rate impacts on the overall profile of natural resource and environment use in any country is ambiguous"[18].

"In the economists' perfect world, the market discount rate and the discount rate required for sustainability are brought into equilibrium, provided society

[15] M. L. Weitzman, *Gamma discounting*, "American Economic Review" 2001 no. 91, p. 260-271.
[16] M. D. Davidson, *Zero discounting can compensate future generations for climate change*, "Ecological Economics" 2014 no. 105, p. 40-47.
[17] S. Frederick, G. Loewenstein, T. O'Donoghue, *Time discounting and time preferences: a critical review*, "Journal of Economic Literature" 2002 no. 40, p. 351-401.
[18] D. Pearce, R. Turner, *Economics of natural resources and the environment*, Baltimore 1990, p. 224.

maximizes some inter temporal welfare function and is operating at the boundary of an inter temporal production possibility frontier. But there are many distortions that are likely to force market rates to be above the "true" marginal product of capital. (…) This implies that the social discount rate will be below that produced by market forces"[19].

These considerations suggest that sustainability can be more guaranteed if the "true" value of marginal capital productivity could be determined and be used as the actual discount rate, and if the economy is not heavily reliant upon non-renewable resources. Ecological economists pay much attention to the principles of sustainable development. They argue that it would be better to build sustainability into economic decisions by setting an a priori requirement that the total stock of natural capital be left constant, regardless of the other benefits and costs[20]. Certainly, sustainability criterion would suggest the discount rate differing from market discount rate.

Aiming to conclusions, it should be stressed that in business practice discount rates are set more or less equal to prevailing rates of interest and exponential discounting is most widely used. In contrast to this, hyperbolic discounting is an alternative in a form of "slow discounting" such that the future is discounted at a rate less than that implied by exponential discounting. It is worth mentioning that stated preferences valuation techniques may be used to derive discount rates[21].

In general, discounting with market discount rates has extremely significant, far reaching and negative consequences for all non-market goods. In particular, a lot of environmental non-market goods, and ecosystem services, occur outside the market and without legally confirmed ownership what implies overexploitation. Daly's reservation concerning the distribution of benefits explains that using market discount rates for environmental non-market goods is not fair with regard to the future generations.

Summarizing, it should be stressed that there is no a priori and correct way to discount all future gains and losses. Sustainability concept opens new opportunities for discounting and there is both reason and room for maneuver in selecting discount rates. On the one hand, concerns such as those discussed above prompt some environmentalists to urge use of low rates with projects entailing large environmental impact. On the other hand, however, subjective and too much relaxed choice of discount rate tends to be very discretionary, thus, a controversial and politicized process.

[19] G. Atkinson et al., *Measuring sustainable development. Macroeconomics and the environment*, Cheltenham 1997, p. 5.
[20] Ph. Lawn (ed.), *Sustainable development indicators in ecological economics*, Cheltenham 2006.
[21] I. J. Bateman et al., *Economic valuation with stated preference techniques*, Cheltenham 2002.

Conclusions

The strength of the economic valuation methods is that their concept of value incorporates the relationship between humankind and ecosystem products. However, the economic valuation methods also face severe difficulties. Often they do not adequately take account of the internal structure of ecosystems. Hence, they neglect the ecological interdependencies of different ecosystem entities. As many of the ecosystem services have public good properties, there is no simple way to imitate markets for these services. Therefore, there is also a place for ecological valuation methods in physical units[22].

Valuation of ecosystem services experience time factor in two ways. Firstly, valuation is very specific with regard to timing of the study. Thus, assessed economic value has to be clearly identified by its contextual "label". Role of this label is to declare openly all details about the method used for valuation including information when the survey was conducted. Secondly, managed ecosystem services[23] should be examined as streams of benefits. Thus, without anthropogenic damages or natural turbulences ecosystem services will be delivered now and will be delivered in the future. This feature has to be represented in economic valuation and aggregated over time, especially in all attempts to valuate the natural capital.

Our human impatience and hedonic reasoning about the future will always support decision on discounting but policy oriented on non-market environmental goods and public goods (e.g. sustainable development) can modify market discount rates. However, the decision how the discount rate for ecosystem services should be defined is not obvious and has not been made yet, thus, this issue will require intensive research.

[22] The ecological valuation methods are either based on an energy theory of value or on an economic-ecological analogy. They are clarified in: R. Winkler, *Valuation of ecosystem goods and services. Part I: An integrated dynamic approach*, "Ecological Economics" 2006 no. 59, v. 1, p. 82-93.

[23] It seems to be both important and stimulating to develop discussion on difficulties associated with the provision of ecosystem services. Because, "to understand the processes, it is necessary to clearly distinguish ecosystem functions, ecosystem service potential and ecosystem services" (J. H. Spangenberg, Ch. von Haaren, J. Settele, *The ecosystem service cascade: Further developing the metaphor. Integrating societal processes to accommodate social processes and planning, and the case of bioenergy*, "Ecological Economics" 2014 no. 104, p. 31).

ECOLOGICAL POLICY AND ENVIRONMENTAL MANAGEMENT

POLITYKA EKOLOGICZNA I ZARZĄDZANIE ŚRODOWISKIEM

Marek Degórski • Jerzy Solon

ECOSYSTEM SERVICES AS A FACTOR STRENGTHENING REGIONAL DEVELOPMENT TRAJECTORY

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ŚWIADCZENIA EKOSYSTEMOWE JAKO CZYNNIK WZMACNIANIA TRAJEKTORII ROZWOJU REGIONU

STRESZCZENIE: Koncepcja świadczeń ekosystemowych i krajobrazowych jest obecnie szeroko dyskutowana w literaturze i ciągle pojawiają się mniej lub bardziej udane próby uwzględnienia koncepcji w działaniach praktycznych. Niestety wokół tego podejścia badawczego narosło wiele niejasności i nieporozumień, czego efektem jest między innymi nieporównywalność proponowanych rozwiązań i raczej tylko postulatywny charakter planowania rozwoju regionów oparty na świadczeniach ekosystemowych. Celem artykułu jest próba odpowiedzi na kilka podstawowych pytań dotyczących istoty świadczeń ekosystemów w kontekście aplikacyjnym.

SŁOWA KLUCZOWE: świadczenia ekosystemów, rozwój regionalny

Introduction

In regional development, the natural environment is increasingly being perceived as a factor capable of generating development trajectories. These trajectories may locally become dense, forming so-called attractors occupying a region referred to as the basin of attraction, which determines, among others, the viscosity of the region. One way to identify and then appraise the value of environmental potential that can influence the direction of development of regions is by analysing ecosystem services. They fit with the latest concepts of environmental management and environmental economics.

The concept of ecosystem and landscape services is currently being widely discussed in the literature, with repeated attempts, more or less successful, to incorporate this concept in practical action. Regrettably, this approach has accumulated a good deal of obscurity and misunderstanding, one of the consequences being the existence of non-comparable solutions and some wishful thinking, as opposed to detailed plans, in the planning of regional development based on ecosystem services.

The present article sets out to address several basic questions regarding the essence of the applicative dimension of ecosystem and landscape services in the local scale.

Theoretical foundations of modelling of reality vs. environmental resources

Spatial econometric models have been used with considerable success in the work on regional analyses[1]. These models more and more often incorporate the value of environmental resources[2]. Reality modelling is very often founded on the theory of chaos and based on non-linear system dynamics. It originated within the natural sciences, where it was observed that many interrelated elements influence the outcome of natural processes under investigation. Computer simulations have similarly shown that identical data input to the same system of equations may generate different results even with small changes of the degree of freedom. Thus, such procedures are founded on the theory of deterministic

[1] W. Ratajczak, *Modele ekonometrii przestrzennej w analizie regionalnej*, in: T. Stryjakiewicz, T. Czyż (eds.), *O nowy kształt badań regionalnych w geografii i gospodarce przestrzennej*, „Biuletyn Komitetu Przestrzennego Zagospodarowania Kraju Polskiej Akademii Nauk" 2008 no. 237, p. 186-202.

[2] M. Degórski, *Quality of life and ecosystem services in rural-urban regions. Europa XXI*, Warszawa 2012, p. 137-148.

chaos, which defines a property of equations or systems of equations consisting in high sensitivity of the solutions to an infinitesimally small disturbance of the parameters describing dynamic systems. Thus, small differences in input data generate a different series of solutions to non-linear equations. This property of non-linear equations exposes the sensitivity of final results to very small differences in initial conditions given a sufficient period, referred to as characteristic time. Thus, the amplification of minor changes of the initial conditions over a sufficiently long time may generate diametrically different outcomes[3]. In line with this assumption, it can be assumed that environmental resources as a significant element of sustainable development, barring substantial differences between socio-economic determinants, may or may not exert the same influence on regional development. Many researchers have also observed that predictions regarding unstable systems in time will not easily produce reliable results[4]. Nonetheless, searching for attractors is an important research direction in many fields of science. An attractor is a hidden, barely perceptible, ordering of a process. If an attractor is known, predictions can be made and the course of processes can be influenced, including the development of regions or supraregional units.

Assuming, in line with the premises of Lorenz's model[5], an emerging order, where a non-measurable and non-linear reality becomes comprehensible, it has to be stated that the direction of regional development becomes predictable too. Chaos transforms into order not only as described by the attractors of Lorenz or Henon, but also as described by strange attractors, such as solions, bifurcations or fractals, which can be regarded as mathematical models of the creation of order in nature.

Domański[6] notes that the identification of attractors and their properties is a difficult mathematical problem. The difficulty stems from the non-linearity of systems of equations describing the behaviour of dynamic systems. For such systems, it is difficult to analytically introduce the properties of equilibrium systems. A characteristic trait of non-linear systems is the presence of simultaneous attractors[7]. Depending on the initial conditions and at given parameter values,

[3] R. Domański, *Przyczynek do modelowania rozwoju zrównoważonego w długim okresie*, in: T. Stryjakiewicz, T. Czyż (eds.), *O nowy kształt badań regionalnych w geografii i gospodarce przestrzennej*, „Biuletyn Komitetu Przestrzennego Zagospodarowania Kraju Polskiej Akademii Nauk" 2008 no. 237, p. 203-224; M. Degórski, *Wielofunkcyjność przestrzeni przyrodniczej szansą zwiększenia potencjału rozwoju regionów poprzez grawitację atraktorów i wzrost lepkości*, in: Z. Strzelecki, P. Legutko-Kobus (eds.), *Oblicza współczesnego kryzysu a polskie regiony*, Warszawa 2010, p. 280-287.

[4] K. Życzkowski, A. Łoziński, *Chaos, fraktale oraz euroatraktor*, „Foton 80" 2003, p. 4-9.

[5] M. Waszczyk, *Wpływ teorii chaosu na niektóre tradycyjne stanowiska ontologiczne oraz na spór o redukcjonizm*, „Zeszyty Naukowe Politechniki Gdańskiej. Filozofia VI" 2002 no. 589, p. 1-15.

[6] R. Domański, *Przyczynek do modelowania rozwoju zrównoważonego w długim okresie*, in: T. Stryjakiewicz, T. Czyż (eds.), *O nowy kształt badań regionalnych w geografii i gospodarce przestrzennej*, „Biuletyn Komitetu Przestrzennego Zagospodarowania Kraju Polskiej Akademii Nauk" 2008 no. 237, p. 203-224.

[7] T. Kapitaniak, *Niestabilne jak wahadło*, "Academia" 2006 no. 3(7), p. 109-114; R. Domański, op. cit.; M. Degórski, *Are environment conditions among factors behind new spatial pattern*, in:

a non-linear system may evolve towards different attractors. One parameter of importance for regional development comprises determinants related to environmental potential8 and social potential [Degórski 2012], construed as a generator of development, as well as those related to the system's resilience to external factors, such as those related to climatic change. This type of modelling is an ideal setting for the conception of ecosystem and landscape services. However, one methodological problem arises, namely, that there is no unity in the understanding and definition of ecosystem services as they are a conceptual entity.

The nature of ecosystem and landscape services

Even a brief review of the classic literature of the subject will reveal considerable chaos and variation in the scope of the concept of ecosystem services (Table 1).

As can be seen from the above listing of definitions, the term "ecosystem services" may refer to just about anything: from the physical goods produced by ecosystems, to components of nature or functions, conditions and processes, to the productive capacity of ecosystems. Against this background, the very general definitions proposed by TEEB, MEA and MAES seem to hold considerable promise, but do so only at first glance. According to these definitions, ecosystem services comprise everything of benefit to humans. It should be stressed at this point that such broad definitions allow for wholly subjective approaches to the issue and actually only make the identification and valuing of services more difficult.

In the light of our experiences to date, a sensible and effective application of the conception of ecosystem services to practical action and the comparability of the solutions suggested requires a sequence of at least four steps:

- providing much more precise definitions for individual terms and concepts;
- introducing appropriate procedures for the identification of services in specific areas and ecosystems;
- introducing appropriate standardised measures of services; and
- linking individual measures to practical activities, especially in the area of spatial planning.

With this approach, economic appraisal (valuing) is secondary to and entails directly from the adopted measures and indices defining the supply of and demand for ecosystem services.

A. Kovacs (ed.), *Old and new borderlines – frontiers – margins, Discussion Papers, Special Issue*, Pecs 2009, p. 29-39.

[8] J. Glasson*, Socio-economic impacts*, in: *Socio-economic impact assessment (SIA)*, London, New York, 2000, p. 20-41; P. Morris, R. Therivel, *Methods of environmental impact assessment*, London, New York 2000; B. Degórska, M. Degórski, *The environmental dimension of European space according to the concept of trajectory*, *Europa XXI*, Warszawa 2003, p. 37-44.

Table 1
Different conceptualisations of ecosystem services

Ecosystem services – definition	Ecosystem attribute	Social perspective
The capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly[a]	the **capacity** … to provide goods and services	to satisfy human needs
The set of ecosystem functions that is useful to humans[b]	set of **functions**	useful to humans
Conditions and processes through which ecosystems and species sustain and fulfill human life[c]	**conditions** and **processes**	to sustain and fulfill human life
A collective term for the goods and services produced by ecosystems that benefit humankind[d]	**goods and services** produced	benefit humankind
Components of nature, directly enjoyed, consumed or used yield human well-being[e]	**components** of nature	enjoyed, consumed or used for human well-being
The direct and indirect contributions of ecosystems to human well-being[f]	**ecosystems**	contributions to human well-being
The benefits that people obtain from ecosystems[g]	**ecosystems**	benefits to people

[a] C. Kremen, Managing ecosystem services: what do we need to know about their ecology?, "Ecology Letters" 2005 no. 8, p. 468-479.
[b] G.C. Daily (ed.), *Nature's services: societal dependence on natural ecosystems*, Washington D.C. 1997.
[c] W.A. Jenkins, B.C. Murray, R.A. Kramer, S.P. Faulkner, *Valuing eco-system services from wetlands restoration in the Mississippi Alluvial Valley*, "Ecological Economics" 2010 no. 69, p. 1051-1061.
[d] J. Boyd, p. Banzhaf, *What are ecosystem services? The need for standardized environmental accounting units*, "Ecological Economics" 2007 no. 63, p. 616-626.
[e] TEEB,*The economics of ecosystems and biodiversity*. *Mainstreaming the economics of nature: a synthesis of the approach*, conclusions and recommendations of TEEB, 2010; MAES, *Mapping and assessment of ecosystems and their services*. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Discussion paper – Final, European Union 2013.
[f] MEA, *Millennium ecosystem assessment, Ecosystems and human well-being*, Summary for decision makers, Washington D.C. 2005; TEEB,*The economics of ecosystems*…, op. cit.; *Mapping and assessment*…, op. cit.

Source: authors' own compilation based on different sources.

The above postulates are consistent with the list of tasks named by de Groot et al.[9], who state that the integration of ecosystem services into landscape planning, management and decision-making requires a detailed investigation of the following topics:

- Understanding and quantifying how ecosystems provide services
- Valuing ecosystem services
- Use of ecosystem services in trade-off analysis and decision making
- Use of ecosystem services in Planning and Management
- Financing sustainable use of ecosystem services.

[9] R. S. de Groot et al., *Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making*, "Ecological Complexity" 2010 no. 7, p. 260-272.

The quest for appropriate methodology

In the light of our experience to date, it appears clear that the methodologies employed for identifying ecosystem services and then for determining their resources and value should match particular spatial scales and analytical objectives. Methodologies based mainly on assessing the value of biodiversity (TEEB) or aiming to produce all-European comparison maps (MAES) are of no use for analyses of individual administrative districts (Table 2). Furthermore, if automatically applied for regional and local spatial planning purposes, they may clearly do more harm than good.

Table 2
Place and role of ecosystem services in planning development

Scale	Importance of ecosystem services	Detail level	Place of ecosystem services	Methodological platforms for evaluation
Household	no	no	no	no
Local (e.g. village)	medium	high	landscape gardening, planning of activities	lack of general approach
Subregional (e.g. commune)	high	high	spatial planning, planning of activities	lack of general approach
Regional (e.g. province)	medium	medium	spatial planning	MAES (doubtful)
National	low	low	strategies, programs, politics	TEEB, MAES
International	low	low	strategies, programs, politics	TEEB, MAES

Source: authors' own compilation based on different sources.

Of particular importance for practical applications, especially at the level of regional and subregional analyses, is conceptual precision and identification of the spatial extension of validity of individual concepts. In particular, the following should be determined:

(a) The provider of service – is it a specific narrowly-defined ecosystem, an ecosystem type not tied to a specific spatial location, a demarcated fragment of the Earth's surface that supports a diversity of ecosystems, or, finally, "nature" in general, whose territorial extension cannot be specified unambiguously;
(b) The natural resource (that is, an existing resource/state of the service provider) and its resultant natural potential (defining the service-providing capacity, which is determined not only by resource size, but also by other factors, such as ease of access). It is the potential rather than the resource that influences the potential and actual supply of ecosystem services.

Table 3
Sample detailed indices of selected ecosystem services

Ecosystem Service	Category of ecosystem service	Indicator		Type of indicator		Service provider (reference unit)
		name	formula / unit	direct / indirect	supply / flow / demand	
Timber	provisioning	standing timber stock	[m^3] or [m^3/ha]	indirect	potential supply	forest district
Timber	provisioning	sales of timber by auction	[m^3] or [m^3/ha]	direct	flow	forest district
Mushrooms	provisioning	area of mixed and coniferous forests	[ha]	indirect	potential supply	ecosystem
Mushrooms	provisioning	mushrooms gathered at, delivery points	[Ton]	indirect	flow	village
Game	provisioning	population of wild game	[piece]	indirect	potential supply	hunting circuit
Game	provisioning	number of hunting permits	[piece]	indirect	demand	hunting circuit
Game	provisioning	game weight	[Kg]	direct	flow	hunting circuit
Cereal production	provisioning	sown area (with respect to soil class)	[sum (soil class * area)]	indirect	potential supply	municipality, village or single field
Cereal production	provisioning	cereal yields	[ton] or [ton/ha]	direct	flow	municipality, village or single field
Honey	provisioning	number of hives	[piece]	indirect	supply / flow	municipality or village
Water supply	provisioning	the number of intakes in lakes and rivers	[piece]	indirect	supply	municipality or village
Water supply	provisioning	number of groundwater intakes	[piece]	indirect	supply	municipality or village

Water supply	provisioning	the amount of water taken from lakes and rivers	[m^3/year]	direct	flow	municipality or village
Water supply	provisioning	the amount of water abstracted from groundwater	[m^3/year]	direct	flow	municipality or village
Water supply	provisioning	number of operated wells	[piece]	indirect	flow	municipality or village
Parasites and pathogens	regulating	share of linear and other small habitats	[% of area] or [km^2/km^2]	indirect	flow	landscape
Pollination	regulating	share of habitats good for pollinators	[% of area] or [km^2/km^2]	indirect	flow	landscape
Water quality	regulating	chemical composition at the outlet of the catchment		direct	flow	catchment
Water quality	regulating	land cover pattern in the catchment		indirect	flow	catchment
Biodiversity	supporting	number of plant species		indirect	flow	ecosystem
Biodiversity	supporting	field fragmentation/ length of field margins		indirect	flow	landscape
Biodiversity	supporting	number of nests of white storks		indirect	flow	landscape
Biodiversity	supporting	conservation status of habitats N2000		indirect	flow	ecosystem

Source: authors' own compilation based on different sources.

(c) The potential and actual supply of services, which depends not only on the potential, but also on the needs and other conditions, including formal and legal ones. The separation of these categories is important insofar as the size of each of them can be determined using different indices (direct and surrogate) that are not wholly mutually exchangeable;
(d) The recipient of services (an individual or a social group), the demand for services, the preferences and needs hierarchy.

Only such defined conceptual framework will make it possible to unambiguously specify the size of services actually provided (as relations/ transactions between the provider and the recipient).

Only within relations so defined is it possible to juxtapose the measures and indices relating to the quantity of services available. It is also important to distinguish indices of supply and demand and direct vs. indirect indices, as exemplified in table 3.

Service-related information as a tool supporting regional development

Appropriately collected and processed information on ecosystem services can be used to strengthen the trajectory of regional development. Importantly, it is not service resources as such, but service-related information and ideas on how to utilise these resources that is conducive to development. Otherwise, the state of the natural environment (including potential ecosystem services) may be seen as a barrier to development, examples of which can often be witnessed, especially in areas occupied by national parks and large-area refuges within the Natura 2000 network.

Any deliberations and plans for the utilisation and amplification of the supply of ecosystem services should, however, take into account the fact that it is principally impossible to maximise all services and, consequently, it is necessary to choose a selection of objectives and ways to use them, taking into account societal preferences and financial possibilities. On the other hand, there is also the danger of fetishisation of particular services (for example, the regulatory role of biodiversity). A preference for such services at the local level may cause a marked reduction in the supply of other services that are considered locally more important and more valuable.

Conclusion

Preliminary data indicate that the use of well-defined concepts and appropriate measures/indices facilitates discussion with local communities, which constitutes an important precondition for the effective implementation of the participatory approach in planning. Planning is to be understood broadly in this context, embracing both classic spatial planning, the result of which is the local land-use plan, as well as conservation plans for protected areas (national parks and Natura 2000 zones).

The issue of scale of analyses and their measurability remains an open question for future research. Reality modelling efforts, i.e. works in the realm of spatial planning, will benefit from clearly defining the area of interest for measurable (empirical) and non-measurable (complementary) research. Providing precise definitions may be decisive for the success of ecosystem services in spatial management.

Analysis of these issues constitutes the topic of the research project "Ecosystem services in a young glacial landscape – an assessment of resources, threats and use", funded by the National Science Centre (NCN) and carried out by a team of researchers from the Polish Academy of Sciences Institute of Geography and Spatial Organisation (ST10/04344).

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BENEFITS FROM ECOSYSTEM SERVICES VERSUS MEASURES OF SOCIOECONOMIC DEVELOPMENT

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KORZYŚCI Z USŁUG ŚRODOWISKA A MIERNIKI ROZWOJU SPOŁECZNO-GOSPODARCZEGO

STRESZCZENIE: Świadczenia ekosystemów, określane także mianem usług środowiska, są już uznaną kategorią. Ma ona interdyscyplinarny charakter. Nadal brakuje metodologicznych podstaw ich identyfikacji oraz opisu. Ekonomistów interesuje przede wszystkim wartościowanie świadczeń ekosystemów, co nie zawsze jest możliwe, choćby dlatego, że wiele z nich nie jest jeszcze zidentyfikowane. Ponadto nauka nie wypracowała jeszcze wielu funkcji użyteczności tych świadczeń. W opracowaniu podjęto próbę skojarzenia usług środowiska z wartością dostarczanych przez nich korzyści. W literaturze spotyka się już liczne próby wartościowania tych korzyści, w ujęciu pieniężnym na realnych rynkach lub też na rynkach warunkowych. Autorka podejmuje próbę skojarzenia wartości korzyści świadczeń ekosystemów ze znanymi już miernikami rozwoju społecznego-gospodarczego. Są to: produkt krajowy brutto, wskaźnik rozwoju społecznego, oszczędności netto. Rozważania są prowadzone na gruncie filozoficznej koncepcji pomiaru.

SŁOWA KLUCZOWE: usługi środowiska, korzyści usług środowiska, kategorie korzyści usług środowiska, kryteria wartości funkcji usług środowiska, metody i techniki pomiaru korzyści usług środowiska

Introduction

Ecosystem services are an underestimated factor of production and socioeconomic development. Economic science, with the help of natural science, deals increasingly with the issue of pollution and its impact on the present state and damage to ecosystems. The new, interdisciplinary approach that is developed particularly within regular Ecoserv Conferences, seeks for the valuation principles of ecosystem services by means of organizing interdisciplinary discussion panels and publishing their findings.

It is assumed in the paper that the valuation of the ecosystem services in a monetary form is impossible and irrelevant although there are attempts to valuate such objects as forests or national parks. In such cases the commercial aspect is significant. Values are established for the sake of selling goods that are associated with the depreciation of ecosystem services or when there is a necessity to pay for a private or public access to such services. However, all ecosystem services cannot be valuated for the simple reason that many of them have not been identified yet and science has not established their utility functions, which is the condition for the determination of their effects/benefits.

However, economics should make attempts to determine the causative force of ecosystem services in manufacturing and consumption processes which play a decisive role in socioeconomic development. At present, such valuations concern mainly the role of natural resources and the hazards related to their exhaustibility. Consequently, a numerous group of other services that are significant to human processes and industry (e.g. photosynthesis) has not been valuated yet.

The valuation of ecosystem services cannot be conducted autonomously. In her previous paper, the author discussed the thesis that the value of ecosystem services should be distinguished from the structure of processes, resources and their development that are measured by GDP[1].

A further research on that concept turned the author's attention to the issue of measurement in general. A question was raised whether the hitherto measurement methodology of socioeconomic development can constitute the basis for the assessment of the value and significance of ecosystem services to socioeconomic changes. The attempt to answer that question was preceded by the justification of a new methodological assumption. The author considers the category of the value ecosystem services as a mental shortcut. Ecosytem services are described by natural processes that converse matter, energy and space, which is already an accepted approach to the way they are defined[2]. Thus, such processes

[1] J. Famielec, *Ecosystem services as part of the Gross Domestic Product account*, „Ekonomia i Środowisko" 2012 no. 2, p. 39-53.

[2] Cf. among other sources: R. Costanza, *Ecosystem functions and services*, „Ekonomia i Środowisko" 2012 no. 2, p. 9-17; A. Mizgajski, Świadczenia *ekosystemów jako rozwijające się pole*

cannot be subject to valuation, especially in a monetary approach, as it is neither possible nor purposeful. However, valuation should and can be applied to the economic and social effects that are added to economy and society by the services in question. Consequently, the term *benefits from ecosystem services* is used in the paper and its title in order to define precisely the object of valuation and assessment. What is more, an attempt is made to analyze that term on the grounds of the concept of value measurement. A model to measure the benefits from ecosystem services was built and the examples of value categories, value measurements and methods/techniques of measuring the benefits are defined and presented. The author points at an indirect connection between the elements of the suggested measurement model and the selected development measures, particularly the GDP, SDI and total net savings. None of the measures of economic and social development meets completely the requirements for measuring the benefits from ecosystem services.

The concept of ecosystem services

Having considered several definitions, the author accepted the one that defines ecosystem/environmental services as natural processes that are realized by geophysical forces and living organisms which transform matter, energy, information and space with a beneficial effect on the processes of management and sustainable growth[3]. That definition makes it possible to recognize the subjects of ecosystem services as flows of materials, energy and information from natural capital stocks which combine with the services of the manufactured capital to produce human welfare[4].

Systematization and classification of ecosystem services varies. Costanza identifies 18 types of ecosystems (biomes) and 17 groups of ecosystem services which, however, do not share one common criterion. The criteria include climate regulation, water regulation, erosion control, soil formation, etc. In the case of other type of services the criteria include raw materials, genetic resources, food production[5].

The Millennium Ecosystem Assessment[6] methodology distinguishes four categories of ecosystem services[7]:

- provisioning (e.g. food, potable water);
- regulating (e.g. climate regulation, water regulation, disease regulation);
- cultural (educational values, social relationships, cultural heritage);

badawcze i aplikacyjne, „Ekonomia i Środowisko" 2010 no. 1, p. 10-19; A. Michałowski, *Ekonomiczne podstawy usług środowiska*, „Optimum. Studia Ekonomiczne" 2011 no. 6, p. 105-120.

[3] Ibidem.

[4] R. Costanza et al., *The value of the world's ecosystem serviuces and natural capital,* "Nature" 1997 no. 387, p. 254.

[5] Ibidem, p. 254.

[6] *The Millennium ecosystem assessment. Ecosystems and human well-being: Synthesis*, Washington D.C. 2005.

[7] Ibidem, p. 40.

- supporting (e.g. photosynthesis, biochemical cycles).

Michałowski distinguishes four groups of ecosystem services[8]:

- material – processes conversing the matter, e.g. the production of biomass or waste decomposition;
- energy – processes conversing energy, e..g. the accumulation of solar energy in the tissue of living organisms and the supply of energy from the Earth's interior;
- information – processing information, e.g. scientific and artistic inspiration, landscapes and the beauty of nature, genetic information;
- spatial– processes conversing space, e.g. site preparation for housing and reclamation of land destroyed by human activity, land;
- stabilizing – processes maintaining a dynamic balance of the ecological conditions for the conversion of mater, energy, information and space.

That division of ecosystem services refers to the type of consequences/effects of the services and their substance that may be associated with the production and consumption growth factors.

In the course of their work on updating the System for Environmental Flow Analysis SEFA), the European Environment Agency (EEA) initiated the development of the Common International Classification of Ecosystem Services (CICES), where provisioning, regulating and cultural services are distinguished. The supporting services, which in other classifications play a fundamental role, are not listed. CICES employs a hierarchical structure as follows:

- theme, e.g. provisioning,
- class, e.g. nutrition,
- group, e.g. terrestrial plant and animal foodstuffs
- type, e.g. grains,
- sub-type, e.g. wheat.

The usefulness of such classifications – although some categories recur – is not complete. They are not sufficient in the valuation of ecosystem benefits as they do not make it possible to distinguish the object of the services and the value of their function (purpose) is even more difficult to assess.

Measurement and measures

Ideas concerning the theory of measurement should be searched in philosophy and logics. One should refer to K. Ajdukiewicz, who states that measurement constitutes the next type of quantitative observation after counting. According to K. Ajdukiewicz, measurement is the designation of numerical measures to the objects being measured as well as to their specific features[9]. In 1950 he wrote

[8] A. Michałowski, *Usługi środowiska w badaniach ekonomiczno-ekologicznych*, „Ekonomia i Środowisko" 2013, no. 1 and A. Michałowski, *Efektywność gospodarowania w świetle usług środowiska*, „Optimum. Studia Ekonomiczne" 2012, no. 1, p. 99-118.

[9] K. Ajdukiewicz, *Logika pragmatyczna*, Warszawa 1975, p. 232.

that "measurement alone requires some manipulation. However, once the manipulative treatment is done to the objects and they are assigned certain numbers, the discovery of numerous relations between them is made possible… Mapping objects to numbers enables us to apply the powerful instruments of mathematics to study relations between objects …"[10].

Later, R.L. will state that "there is no common agreement among scholars and philosophers as regards what measurement is and how it should be performed. The existing viewpoints range from extremely narrow to very general"[11].

Varied approaches to measurement result in the following categories[12]:

- measurement as any scientific experiment or observation. i.e. any acquisition of data;
- measurement as a set of operations required to define measurement results;
- measurement as a procedure closely related to scientific definition;
- measurement as the assignment of figures to objects, events and features;
- measurement perceived through axiomatic and philosophical consequences;
- measurement with the application of a mathematical model concept.

The measurement model makes it possible to standardize measurement procedures and to distinguish various measurement methods in accordance with them. The methods vary as regards the procedures, the structure of the measurement system and the algorithm for determining the measurement results[13].

From the comparatively sophisticated theory of measurement one can draw several practical conclusions that are significant as regards the valuation of ecosystem benefits.

Measurement requires the determination of its domain, i.e. the selection of the objects to be measured and their features. Consequently, the answer will be obtained whether they are measurable. Objects can be measured if they can be scaled. Scaling is an operation that in a homomorphic way represents the ordering relation of a set of objects with specific features by a majority relation between figures. The selection of the measurement domain involves significant issues[14]:

- variability of the measurement range;
- changes in the range of measurable and non-measurable values;
- changes in the measurability criteria;
- the scale of the objects of measurement.

The variability of the measurement range may be caused by the evolution of measurement techniques, the expansion of the measurement domain by objects that have not been measured or been measurable so far and by the extrapolation of measurement methods and techniques from one field of study to another.

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[10] K. Ajdukiewicz, *Propedeutyka filozofii,* Wrocław-Warszawa 1950, p. 12.

[11] R.L. Ackoff, S.K. Gupta, J.S. Minas, *Decyzje optymalne w badaniach stosowanych*, Warszawa 1969, p. 244.

[12] Author owes this and other approaches to defining and learning about measurement to a difficult, yet extremely valuable publication of R.M. Olejnik, *O pomiarze. Pomiar i mierzenie – koncepcja Kazimierza Ajdukiewicza i jej krytyka,* Częstochowa 1998, p. 15-22.

[13] H. Szydłowski (ed.), *Teoria pomiaru*, Warszawa 1978, p. 207.

[14] R.M. Olejnik, op. cit., p. 66-67.

A particular role is played by measurement as such. It is a cognitive operation that makes it possible to find a numerical measure of the value under investigation in selected measurement units[15]. There are two types of measurement: direct and indirect.

Direct measurement is the determination of the magnitude of an object by means of comparing it with a standard model in order to determine the unit of measure. Objects are subject to direct measurement on the condition that they commensurate with the measure unit.

Indirect measurement can be applied to objects as regards their particular properties or it is based on the analysis of other related or derived properties It is applicable in relation to values that can be measured only implicitly and to values whose direct measurement is practically impossible (e.g. astronomy measurements).

Measurement requires the application of a measurement function that signifies an unambiguous relation, which makes it possible to describe every property by a positive real number.

Measurement requires ordering. The ordering of the elements of measurement implies setting the elements of each set in accordance with certain relations (criteria) that are attributed to them.

The ordering process is associated with numbering or placing the elements in a particular order. Therefore relevant and coherent classification of objects under measurement is essential. Classification should result from the structure of elements (e.g. the graph theory) that is generated by a particular type of ordering.

Measurement requires the application of defined principles. They include:

- definition of the measurement – what is measured and how?
- determination of formal properties – what types of mathematical and statistical operations on the measurement results are acceptable?
- determination of the degree of accuracy – how can the measurement results be adjusted to conditions that are less ideal than the ones determined by definitions?
- determination of the measurement control method – i.e. the method of ensuring the degree of measurement accuracy.

In the course of measurement procedures errors are inevitable and their value should be estimated. The sources of measurement errors are as follows:

- observer,
- measurement instruments applied,
- environment,
- object (process) under observation.

Each type of errors should be analyzed separately. Measurement error may result from logical, methodological and philosophical determinants. They include[16]:

- conventionalism – terminological conventions used in scientific methods;
- operationalism – the empirical sense of a notion in science;

[15] K. Ajdukiewicz, *Logika pragmatyczna*, Warszawa 1975, p. 275.
[16] R.M. Olejnik, op. cit., p. 145-147.

- methodological idealization – mental procedure, construction of abstract concepts.

Methodological idealization, which frequently occurs in measurement procedures, is particularly dangerous. In order to grasp the most significant relations between factors, less important factors are ignored. That often takes place as regards the idealization of nature. The exclusion of some measurable aspects of nature results in erroneous assessments, including value measurements. When investigating socioeconomic development, researchers usually focus on technical aspects of measurement such as the choice of econometric models and on the stochastic processing of the measurement results. Processes in natural environment and their impact on humans and economy are ignored although there are numerous empirical investigations of natural scientists which could be applied to expand the models and functions of socioeconomic development by – for example – data concerning the boundaries and barriers of ecosystems.

The differences in opinions on the sources of CO_2 emission can serve as a good example. The causes of the climate change on the Earth are the subject of extensive investigations. Subsequent reports of international organizations such as IPCC, NAS and G8 state that the majority of temperature changes in the last 50 years can be attributed to human activity, i.e. to the anthropogenic effects. Such arguments are indiscriminately used by legislators of ecological regulations, especially in the area of international law on environmental protection, and by people who design remedial measures constituting international commitments for particular countries. However, there are many other investigations and hypotheses that point at natural factors as the main cause of the climate change. According to one hypothesis concerning the greenhouse effect, for example, the direct effect of the absorption of Earth radiation by carbon dioxide is insignificant and only the secondary effects associated with the increased amount of water vapor in the atmosphere – due to the higher temperature of the troposphere – may cause changes in the cloud cover and consequently result in substantial significant climate change[17]. That does not change the fact that the targets of the greenhouse gas reduction in the UE climate and energy policy became obligatory for EU members without the consideration of the above[18].

Author's mesurement model of benefits from ecosystem services[19]

In the measurment theory of K. Ajdukiewicz, which was applied and modified by R.M. Olejnik, the methodology of measurement is composed of the following elements:

[17] T.T. Kaczmarek, *Globalna gospodarka i globalny kryzys*, Warszawa 2009, p. 101-107.

[18] That is proved by teh investigation run for the Ph.D. thesis supervised by the Author and published in: K. Cięciak, *Skuteczność ekologiczna polityki energetycznej Unii Europejskiej w Polsce*, Kraków 2013.

[19] Author's research based on: R.M. Olejnik, op. cit.; J. Famielec, *Straty i korzyści ekologiczne w gospodarce narodowej*, Warszawa-Kraków 1999.

- the selection of value category;
- the selection of value measure for a given value category;
- the determination of the measurement method/s (techniques).

The above elements are given in tables 1, 2 and 3.

The „value" category is most frequently associated with the monetary expression of a given object, phenomenon or process. However, the measurement process is concerned with the determination of preferences, the philosophical significance of value, the significance of work and the attitude to other human being and to the group not only now but also in the future. Ecosystem services may constitute the essence or the condition for the development or preservation of a particular value. The utility value is the most commonly used value category in economics and it can also by applied in reference to the benefits of ecosystem services. Among the benefits from ecosystem services, the heritage value i.e. the sustained ability of ecosystems to bring benefits in the future is gaining in significance. The total economic value is the result of economic operations of a country, including the measurable benefits from ecosystem services – as production (e.g. the value of raw materials used) or quality of life factors (e.g. the quality of housing industry or health care infrastructure – Table 1). Thus, some categories of benefits from ecosystem services are categories of both economic and social values as well as of their basic measures[20].

Value categories can be expressed by different measures (Table 2). *"Economic values are reflected best by prices on the market"*[21]. The benefits from ecosystem services are frequently exploited outside the market and are not subject to competitive operations. There are no market prices for them and, consequently, other measures have to be considered. Most frequently it is the inclination to pay or willingness to accept compensations that can be assessed on mortgage markets. An interesting concept of value measure as such, including the benefits from ecosystem services, is their energy value. Traditional growth factors are expressed in units of energy or the work performed by products/services. However, it is still a challenging research task. In order to measure the benefits from ecosystem services, the following measures can be adapted: producer's surplus, consumer's surplus and economic implications.

The estimation (valuation) of benefits from ecosystem services for selected value categories – with adequately selected measures – can be performed by various methods/techniques. In table 3 they are referred to as valuation methods of

[20] T. Żylicz distinguishes total economic value that includes utility and non-utility values. Non-utility value is often divided into existence and heritage values. The former is attributed to the mere existence of the value,while the latter refers to the value that is passed to next generations; T. Żylicz, *Wycena usług ekosystemów. Przegląd wyników badań światowych*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 33-34. Then, apart from the types of economic values, T. Żylicz discusses valuation techniques. The Author adds an intermediate stage – a selection of the measures of particular value categories of benefits from ecosystem services followed by a selection of calculation techniques.

[21] T. Żylicz, *Wycena usług ekosystemów. Przegląd wyników badań światowych*, „Ekonomia i Środowisko" 2010 no. 1, p. 35.

Table 1
Value categories of ecosystem values and their relation to the measures of socio-economic development

Value category	Measure of socio-economic development
Direct utility value	HDI
Indirect utility value	HDI
Non-utility value	HDI
Existence and heritage value	TNS
Total economic value	GDP

HDI –Human Development Index
TNS – Total Net Savings
GDP – Gross Domestic Product

Source: author's research.

Table 2
Measures of benefits from ecosystem services

Measure category of benefits	Measure of socio-economic development
Willingness to pay	
Willingness to akcept compensation	
Consumer's surplus	TNS, HDI
Producer's surplus	TNS, HDI
Economic implications	GDP
Energy value	

Source: author's research.

Table 3
Valuation methods (techniques) of benefits from ecosystem services

Type of method/technique	Measure of socio-economic development
Cost and benefit analysis	
Cost minimisation	
Valuation of production results	GDP
Valuation of production effort and restitution costs	GDP
Human capital valuation	HDI
Hedonic methods	HDI
Travel costs method	
Declared preferences method	
Household production function	GDP
Value transfer method	

Source: author's research.

benefits from ecosystem services. At that stage, the monetary dimension of value is significant as it can be compared to the value of other benefits from services (e.g. from transport services). Some of such techniques are also applied in the monetary assessment of the effects of socioeconomic development.

The valuation techniques of economic values, including the value of ecosystem services, can be divided in direct and indirect ones[22]. Direct methods, e.g. the assessment of utility and production value, are usually applied by real markets, while indirect methods such as the travel cost method or the declared preferences method, require hypothetical markets.

Conclusions

The search for the benefits from ecosystem services is mainly cognitive in character. Undoubtedly, the services have an impact on production, consumption and investment, i.e. all the aspects that are associated with growth, economic development or prosperity. However, there is no direct connection between those categories. That is because services are natural processes that are not always material, cannot be identified and, which is most important, their influence on production, consumption and – first of all – people's lives is unknown. The benefits from ecosystem services should be assigned some value.

However, there is a danger in the commercial attitude to benefits and their value, just like to the development and prosperity in general. Value systems that should benefit from development must be reconsidered. Excessive economization and financialization of economy and development are the processes that one should be warned of. Basic mistakes are made as regards the measurement of economic growth and prosperity[23].

It is not the objective of the measurement of benefits from ecosystem services to estimate their market price or to find out how much one can earn on them as many of them cannot be the object of market operations and, consequently, they are priceless. The point is in establishing their role in people's lives and economy and in the responsibility for their condition now and in the future. First of all, the responsibility consists in – for example – protecting forests against excessive exploitation that takes place for the sake of current income of states and companies and results in the extinction of several rare ecosystems. The assessment of socioeconomic development only through the GDP growth, the material welfare development or even the improvement of the quality of life results in the loss of numerous significant benefits from ecosystem services. Moreover, the protection and preventive measures as regards ecosystems may remain underestimated.

[22] More in: T. Żylicz, op. cit., p. 35-39.

[23] Which is proved by: J.E. Stiglitz, A. Sen, J.P. Fituossi, *Błąd pomiaru. Dlaczego PKB nie wystarcza?*, Warszawa 2013.

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IS THE ECOSYSTEM SERVICES CONCEPT USEFUL IN POLISH POLICY MAKING? QUALITATIVE ANALYSIS OF EXPERTS PERCEPTION

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CZY USŁUGI EKOSYSTEMOWE SĄ UŻYTECZNE W TWORZENIU POLSKICH POLITYK PUBLICZNYCH? JAKOŚCIOWA ANALIZA PERCEPCJI EKSPERTÓW

STRESZCZENIE: Koncepcja usług ekosystemowych jest coraz szerzej stosowana zarówno w badaniach naukowych, jak i konstruowaniu polityk publicznych, także w Polsce. W niniejszym artykule przedstawiono wyniki indywidualnych pogłębionych wywiadów eksperckich ze specjalistami z zakresu ochrony przyrody. Na podstawie wywiadów zidentyfikowano przyczyny ograniczonej obecności koncepcji usług ekosystemowych w polskich politykach publicznych, został oceniony potencjał tej koncepcji w stosunku do różnych sektorów gospodarki, a także wskazano pozytywne i negatywne konsekwencje mogące wynikać z jej praktycznego stosowania.

SŁOWA KLUCZOWE: usługi ekosystemowe, polityki publiczne, eksperci, wywiady

Introduction

The concept of ecosystem services has been increasingly applied in biodiversity research and policies all over the world[1]. As Norgaard[2] pointed out, the concept of ecosystem services started as a humble metaphor which could help us to think about the relation between people and nature, but eventually it became integral to what we thought about the future of humanity and biological evolution. It enables us to describe and to analyse the relations between people and the environment[3] and involves some novel, incentive-based conservation strategies[4]. The approach presumes that nature provides services which are beneficial for human societies, allows for economic valuation of particular ecosystem services and contributes to the new conservation debate[5]. Within the debate, the traditional nature conservation approach, which disregards the losses to human societies, is challenged. The ecosystem services approach is treated in this debate as a framework offering possibilities for negotiating costs and benefits of conservation[6]. It may offer guidelines for improving conservation and human welfare via win-win solutions[7]. Nevertheless, it is also criticized as it could be misleading in conservation efforts because of its narrow economic orientation towards nature as a stock, which may lead to commodity fetishism[8].

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[1] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 253-260; *The millenium ecosystem assesement, ecosystems and human well-being: a framework for assessment,* www.cices.eu [12-09-2014]; see also: TEEB, *The economics of ecosystems and biodiversity for local and regional policy makers,* www.teebweb.org [12-09-2014]; R. Haines-Young, M. Potschin, Common international classification of ecosystem services (CICES): Consultation on version 4, August-December 2012, www.cices.eu [12-09-2014]; P. Lamarque, F. Quetier, p. Lavorel, *The diversity of the ecosystem services concept and its implications for their assessment and management*, "Comptes Rendus Biologies" 2011 no. 334, p. 441-449.

[2] R. B. Norgaard, *Ecosystem services: From eye-opening metaphor to complexity blinder,* "Ecological Economics" 2010 no. 6(69), p. 1219-1227.

[3] R. S. de Groot, M. A. Wilson, R. M. J. Boumans, *A typology for the classification, description and valuation of ecosystem functions, goods and services*, "Ecological Economics" 2002 no. 41(3), p. 393-408; E. Gómez-Baggethun; D. N. Barton, *Classifying and valuing ecosystem services for urban planning*, "Ecological Economics" 2013 no. 86, p. 235-245.

[4] J. Paavola, K. Hubacek, *Ecosystem services, governance, and stakeholder participation: an introduction*, "Ecology and Society" 2013 no. 18.

[5] B. A. Minteer, T. R. Miller, *The New Conservation Debate: ethical foundations, strategic trade-offs, and policy opportunities*, "Biological Conservation" 2011 no. 144, p. 945-947.

[6] T. O. McShane et al., *Hard choices. Making trade-offs between biodiversity conservation and human well-being*, "Biological Conservation" 2011 no. 144, p. 966-972.

[7] S. C. Farber, R. Costanza, M. A. Wilson, *Economic and ecological concepts for valuing ecosystem services*, "Ecological Economics" 2002 no. 3 (41), p. 375-392.

[8] N. Kosoy, E. Corbera, *Payments for ecosystem services as commodity fetishism,* "Ecological Economics" 2010 no. 6(69), p. 1228-1236.

Although significant progress has been made in the assessment frameworks of ecosystem services, there is still work to be done[9], e.g. development of frameworks that would allow the transition of a scientific concept into a rationale of policy making[10]. De Groot et al.[11] found five groups of challenges and obstacles that need to be addressed in order to fully utilize the concept: (a) Understanding and quantifying how ecosystems provide services; (b) Valuing ecosystem services; (c) Using ecosystem services in a trade-off analysis and decision; (d) Using ecosystem services in planning and management; (e) Financing sustainable use of ecosystem services. The concept is more often perceived as help rather than hindrance as it addresses some current problems of the environmental assessment practice[12]. Yet, some very basic issues, such as a clear and consistent definition to avoid misrepresentations, which could undermine the credibility of the ecosystem services concept, have not been solved. Nevertheless, the implementation of the concept needs to be context specific, used on a case-by-case basis, and take into account both benefits and limitations. It is necessary to put more emphasis on the analysis of ecosystem functionality, structural and functional linkages within ecosystem services and determinants of human well-being, and to integrate ecosystem services into conventional development policies and priorities from their conception to their execution[13].

In Poland, the concept began to be used in scientific research in the 2000s[14]. Yet, in legal and legislative documents, the concept has been barely presented so

[9] G. Yapp, J. Walker, R. Thackway, *Linking vegetation type and condition to ecosystem goods and services,* "Ecological Complexity" 2010 no. 3(7), p. 292-301.

[10] K. Helming, K. Diehl, D. Geneletti, H. Wiggering, *Mainstreaming ecosystem services in european policy impact assessment,* "Environmental Impact Assessment Review" 2013 no. 40, p. 82-87.

[11] R. S. de Groot et al., *Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making,* "Ecological Complexity" 2010 no. 3(7), p. 260-272.

[12] P. Lamarque et al., op. cit.; A. Nahlik, M. E. Kentula, M Siobhan Fennessy, *Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice,* "Ecological Economics" 2012 no. 77, p. 27-35.

[13] G. C. Daily, P. A. Matson, *Ecosystem services: From theory to implementation,* "Proceedings of the National Academy of Sciences" 2008 no. 28(105), p. 9455-9456; see also: D. Ervin, et al., *Growing cities depend on ecosystem services*, "Solutions" 2012 no. 6, p. 74-86; J. Baker, W. R. Sheate, *Ecosystem services in environmental assessment. Help or hindrance?*, "Environmental Impact Assessment Review" 2013 no. 40, p. 3-13; M. Kandziora, B. Burkhard; F. Müller, *Interactions of ecosystem properties, ecosystem integrity and ecosystem service indicators. A theoretical matrix exercise,* "Ecological Indicators" 2013 no. 28, p. 54-78; P. Kumar, S. E. Esen, M. Yashiro, *Linking ecosystem services to strategic environmental assessment in development policies,* "Environmental Impact Assessment Review" 2013 no. 40, p. 75-81.

[14] A. Mizgajski, *Ecosystem services as an emerging field of research and application,* "Ekonomia i Środowisko" 2010 no. 1(37), p. 10-19; T. Żylicz, *Valuation of ecosystem services. An overview of world research*, "Ekonomia i Środowisko" 2010 no. 1(37), p. 31-45; see also: Z. Rosin et al., *Ecosystem services as an efficient tool of nature conservation: a view from the Polish farmland,* "Chrońmy Przyrodę Ojczystą" 2011 no*.* 1(67), p. 3-20; J. Kronenberg, et al., *The importance of White Stork Ciconia ciconia for society: an analysis from the perspective of ecosystem services*, „Chrońmy Przyrodę Ojczystą" 2013 no. 3*(*69), p. 179-203.

far[15]. Our previous study[16] showed that the scope of ecosystem services implementation in the Polish legislation and policy documents is limited. However, the reason for this weak implementation of the concept is still unidentified.

Aim of the research

The study aims to explore the potential for a practical use of the ecosystem services concept, taking into account the scope of its implementation in the legislative and policy documents in Poland. Although the ecosystem services concept is becoming increasingly common in the area of scientific research, it has yet to be widely implemented in practice. Exploring the reasons for this phenomenon contributes to the debate on the utility of the ecosystem services concept because the concept might be useful in nature conservation policies, but at the same time, it might also entail some risks.

The quantitative assessment of the presence of the ES concept in the Polish legal and policy documents[17] aimed at recognizing to what extent the ecosystem services concept is present in Polish legal and policy documents concerning environment protection. The analysis of the documents revealed that the use of the concept is limited. The concept is applied as a certain underlying approach. In particular, ESs are used in a rather descriptive sense (and mostly latently). Within 46 documents that we coded, there were 1315 parts which were relevant to the ecosystem services concept. Moreover, 264 of those parts were found in the Nature Conservation Act (the document with most frequent coding) while the ES concept did not appear in 15 documents at all. Since most of them were decrees (12), we can argue that the ecosystem services concept is hardly present in the lower rank documents. Taking into account the most general level of ES, i.e. the sections concerning provisioning, regulation and maintenance, and cultural services, the most represented category is "Regulation and maintenance" (42% appearances), followed by "Provisioning" (38%), while "Cultural" is the least frequent section. The difference between the two most frequent categories is small (only 4%). A much bigger gap may be observed between both these sections and the "Cultural" section (20% of all appearances), which suggests that the cultural aspect of ecosystems is applied relatively rarely in the legislation in Poland. Moreover, we also found out that the second most frequent ecosystem service is "lifecycle maintenance, habitat and gene pool protection" (142 appearances), while the first most frequent level is the most general one – ecosystem services.

[15] Z. Rosin et al., op cit.
[16] P. Matczak et al., *Catalogue of ecosystem services targeted in protected areas management and spatial planning in Norway and Poland*, Poznań 2014.
[17] Ibidem.

Methodology

In order to investigate the issue of the limited and specific presence of ES in the Polish legislation, we designed and conducted a series of in-depth interviews with experts in the area of environment protection. The guidelines for interviews were prepared on the basis of content analysis to explore broader context of the concept utility in institutions of nature conservation at different level of public management and background (academia, NGOs etc.) as well as particular results of ecosystem services presence in documents. An expert, individual and in-depth interview is a method that has an exploratory value. We used it for analysing the potential of the ES concept in Polish policies. Nine in-depth interviews were conducted with high-level experts in the field of environment protection. Six of them were "face to face" in the offices of experts, two of them were phone interviews and in one case we got answers via e-mail. The interviews were realized from May of 2014 until July of 2014 and lasted between 20 and 40 min. The selection of experts was made on the basis of snowball sampling supported with a literature review and a media reconnaissance. Four categories of experts were interviewed: 1) Representatives of the administration: a specialist from the Department of Environment Protection in the Ministry of the Environment; a director in the National Forest Holding; a director at the National Fund for Environmental Protection and Water Management; an expert from the Ministry of the Environment working on ecological education; a former Vice-Minister of the Environment; 2) Researchers: a leader of a research center; a professor at a university of life sciences specialising in nature conservation; a scientist working at a university and for a nature protection foundation specialising in ecosystem services; 3) NGOs: a president of one of the leading associations for nature protection; 4) Politicians: a member of the Senate working on the environment protection. The analysis of nine interviews helped to identify the diversity of opinions of ecosystem services utility, limitations and potential among experts with various background.

Results

The analysis is divided into three sections: 1) The scope and potential of the ecosystem services concept implementation; 2) Positive consequences of ecosystem services implementation; 3) Negative consequences of ecosystem services implementation.

The scope and potential of the ecosystem services concept implementation

Supporting the results of the earlier quantitative analysis, the experts claim that the ecosystem services concept is not commonly present in the Polish public administration, which is responsible for the environment protection. Moreover,

they argue that even if the concept is used, its application is usually inappropriate – not corresponding to the scientific knowledge on ecosystem services. Apart from the uses in scientific research that has some relevance when the development of policies is concerned, the concept is applied by NGOs as a tool for promoting biodiversity protection.

According to the experts, the ecosystem services concept is hardly implemented in the regulations because the term is unclear and imprecise. It is a barrier in day-to-day decision making. Moreover, the concept can rather be used on the highest level of public administration (by central governmental administration) than on the lower ones. There are two reasons for that. Firstly, among the highest level of government officials there is more knowledge of "trendy" new ideas. Secondly, the concept is applied in acts and in national strategies at a high degree of generality, as a mere notion. The application on the level of decrees or the local level of day-to-day decision making processes would possibly require translation into more concrete parameters, concerning specific actions and money flow. However, the concept is lacking such parameters.

It was also identified that, on the one hand, the EU regulations on ecosystem services are still not very precise, but on the other hand, the use of ecosystem services concept is likely to expand in the future due to the new European legislation. According to experts, there is a tendency to focus on ecosystem services in the EU environmental laws and strategies. Poland as a member state has to transpose European regulations (e.g. assessments of ecosystem services in national accounts[18]) into the national law.

Although some experts did not have an opinion on the ecosystem services concept utility in particular economy sectors (they only knew the facts connected to their institutions), the others noticed that various sectors differ a lot in terms of the implementation potential of the ecosystem services concept.

According to them, the ecosystem services concept is useful in such sectors as tourism and forestry because these yield direct profits from nature. Some experts pointed out that although agriculture is also a sector which reaps direct profits from nature, the concept is not used in this sector because agricultural ecosystems are very intensively exploited, with a much smaller emphasis on their protection.

Regarding the significant disproportion between particular ecosystem services applications in the Polish legislation, experts pointed out that cultural ecosystem services were less represented than provisioning and regulating services for at least two reasons. Firstly, this could be connected with the general regularities which were described in the Maslow's hierarchy of needs – cultural services were on a higher level of this hierarchy and first required the fulfilment of more basic needs, like provisioning, regulating and maintenance services. Secondly, this could be attributed to the educational background of the governmental officials who are engaged in the environmental policies construction process.

[18] The Europe Union 2020 Biodiversity Strategy.

According to the experts, such officials are mainly naturalists, and they focus on habitats and biological processes and are less interested in cultural services.

Furthermore, even if some experts were not sure why there was a relatively large presence of lifecycle maintenance, habitat and gene pool protection ecosystem services, they agreed that this might be caused by a traditional understanding of environment protection as a protection of species and a protection of valuable areas. Moreover, they argue that many analysed documents were written by biologists who are aware of such environmental processes as lifecycle maintenance or gene pool protection.

Another reason could be the Europeanization of the Polish national law – the transposition of the EU directives into the national legislation. For instance, there are some significant uses of ecosystem services concept in the documents on water management as a consequence of the Water Framework Directive[19] or in the implementation of Natura 2000: "The aim of the network is to assure a long-term survival of Europe's most valuable and threatened species and habitats"[20].

Positive consequences and negative of ecosystem services implementation

Experts emphasize that the concept is very useful as a social communication tool in discussing environmental issues. It can minimize conflicts concerning e.g. implementation and management of Natura 2000 by helping to compromise or to work out better solutions during the decision-making process and it can educate people on environmental protection in a more intuitive way (explaining what people get from ecosystems and how much it may cost). Moreover, a wider use of the concept creates the need for more research and more expertise in the area of ecological economics. Thus, it builds a market for environmental experts.

According to some experts, the concept as a neutral idea and the method does not have negatives aspects. However, for most experts, there is a risk stemming from the fact that the concept frames the environment not in terms of its intrinsic values, but in terms of its monetary value. It presumes that we can protect only those elements which we can calculate. Thus, the ES concept entails a danger of commodification of nature, which is fundamentally wrong and poses a threat for the environment in the long run.

[19] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

[20] *MEMO on Commission strategy to protect Europe's most important wildlife areas – frequently asked questions about NATURA 2000,* www.ec.europa.eu [20-09-2014].

Conclusions

The ecosystem services concept is seldom applied in the Polish legal and policy documents. The interviewed experts confirm the hypothesis that is based on the experiences from other countries[21] (however the identification of precise distribution of opinions requires further research).

The hypothesis states that the idea has a high potential and that it is a promising tool for policy and decision making. The research also confirms that some of de Groot's groups of obstacles[22] have not been overcome yet, especially those connected with day-to-day policy and management. Previous studies emphasized the necessity to integrate ecosystem services into conventional development policies in every phase of their development and execution[23]. Yet, the ambiguity and inconsistency of the concept pose constraints into the concept application. Moreover, due to a fragmented knowledge of the interested parties, the concept is used in the regulatory framework mainly as a general, guiding idea, not as a practically oriented method used operationally in the decision-making process. The concept is intellectually attractive but entails difficulties in its application in policies. Actually, it seems to be more useful in argumentation and communication than in measurement. Furthermore, experts attribute reasons for the limited progress of the application of the ES approach mainly to human factors: specific education of the administrators and decisions makers, reluctance to apply new concepts, and also limited and fragmented knowledge.

The concept might be perceived as ambivalent because the ecosystem services approach can be framed both as helpful in nature conservation and as dangerous to nature conservation. It may be helpful in the decision making process, but it may also entail risks as it promotes perceiving the environment mainly through the prism of monetary values, which may lead to commodity fetishism[24] in Poland and in other countries. To summarise, the ecosystem services concept has a policy potential, but in order to be applied, it requires more clarified definitions adjusted to policy making. Perhaps, application in some policy areas, such as forestry or water management, would be a step forward offering some experience useful in other domains.

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[21] E.g. T. O. McSheane et al., op. cit.; P. Lamarque et al., op. cit.; A. Nahlik et al., op. cit.
[22] R. S. de Groot et al., op. cit.
[23] P. Kumar et al., op. cit.
[24] N. Kosoy, E. Corbera, op. cit.

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VALUE OF FOREST RECREATION. META-ANALYSES OF THE EUROPEAN VALUATION STUDIES

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WARTOŚĆ REKREACJI LEŚNEJ. META-ANALIZA WYCEN, PRZEPROWADZONYCH W EUROPIE

STRESZCZENIE: Celem badania było oszacowanie zmiennych wpływających na korzyści rekreacyjne generowane przez ekosystemy leśne Europy. W tym celu zgromadzono badania rekreacyjne przeprowadzone w krajach europejskich w latach 1970-2012. Zgromadzona baza danych zawiera zarówno badania preferencji ujawnionych, jak i preferencji deklarowanych. Łącznie zgromadzono 53 badania, z ośmiu krajów, które zawierają 252 indywidualnych oszacowań. Badania zostały przeprowadzone na terenie 73 różnych kompleksów leśnych na łącznej próbie ponad 40 000 osób. Dokonano tak zwanej metaanalizy, w której zmienną zależną jest gotowość do płacenia (WTP) lub nadwyżka konsumenta na osobę (CS). W badaniu podjęto próbę wyjaśnienia zmienności w WTP (CS) za pomocą zmiennych metodologicznych charakteryzujących badanie oraz charakterystyk badanych obiektów – w tym przypadku charakterystyk odwiedzanych lasów. Przeprowadzona analiza wskazuje, że ceteris paribus lasy, położone na terenie parków narodowych, dostarczają wyższych korzyści rekreacyjnych, a badania przeprowadzone w późniejszym latach związane są z wyższym poziomem nadwyżki konsumenta. Wynik ten może wskazywać, że preferencje konsumentów zmieniają się w czasie i ludzie osiągają coraz to wyższe (w ujęciu realnym) korzyści rekreacyjne z tytułu wizyt w lesie.

SŁOWA KLUCZOWE: rekreacja leśna, metaanaliza, gotowość do płacenia, nadwyżka konsumenta, obszary chronione

Introduction

The overwhelming majority of the primary valuation studies of ecosystem services conducted in the world recently were site-specific case studies, which means that their results are highly dependent on the particular site characteristics. However, generalisation of natural values and detection of tendencies in their shaping remain considerable challenges because of high heterogeneity of sites' natural characteristics. The meta-analytic approach in valuation allows for both syntheses of the values retrieved by the primary studies under consideration, and revealing the pattern in valuation methodology analysed. Meta-analyses approach allows basing study findings upon the considerable data since the number of primary studies, which it relies on, is multiplied by the number of individual observations they contain. Meta-analytic approach implies estimation of the regression model, where the target dependant variable is explained through the set of variables which account for both 'real life' characteristics (e.g. site-specific natural and socioeconomic features) as well as the strictly methodological factors, and performs estimation of their effects. As compared with the primary valuation exercises, meta-analytic studies are considerably less expensive since they do not require direct fieldwork. Besides, meta-analyses is often used as an approach which allows for the relatively more correct transfer[1] of environmental benefits estimated through the direct valuation studies into different context (benefit transfer aspect of meta-analyses is not addressed in this paper).

Therefore a considerable meta-analytical literature has emerged within the domain of ecosystem services valuation. Thus, meta-analytical valuation studies have recently been conducted for the recreational fishing resources (Johnston i in., 2006)[2]; various forest ecosystem services, assessed through contingent valuation (CVM) studies[3]; wetlands (Brander et al., 2006[4]; Kuik et al., 2009); coral reefs (Brander et al., 2007)[5].

However, in accordance with our best knowledge, only one meta-analysis of forest recreation values in Europe has been performed so far. Zandersen & Tol[3] carried out a meta-analysis based on studies that have applied the travel cost method (TCM): twenty six primary studies in total, conducted in nine European countries; they managed to include 251 independent entries into the modelling. In their analysis most of the variables describing methods used in the primary studies turned out not to be statistically significant. Besides, no natural charac-

[1] O. Kuik et al., *The value of wetland ecosystem services in Europe. An application of GIS and Meta-Analysis for value transfer*, in: 17th Annual Conference of the European Association of Environmental and Resource Economists (EAERE), 24-26.06.2009, Amsterdam.
[2] R. Johnston, M. Ranson, E. Besedin, E. Helm, *What determines willingness to pay per fish? A Meta-Analysis of recreational fishing values*, "Marine Resource Economics" 2006 no. 21, p. 1-32.
[3] M. Zandersen, R.S.J. Tol, *A meta-analysis of forest recreation values in Europe*, "Journal of Forest Economics" 2009 no. 15, p. 109-130.

teristics of the primarily valued sites (except the sites' size) proved to have significant impact on the monetary value, the result which makes the model somewhat problematic for the practical use, for instance for the benefit transfer purposes.

Shrestha & Loomis[4] performed the meta-analyses of the international outdoor recreation in the Unites States. Unlike Zandersen & Tol (2009) who concentrated on TCM primary studies only, Shrestha & Loomis (2003) included both primary studies based on revealed preferences (TCM) and stated preferences (CVM). However, since they did not restrict their study to the *forest* recreation, the two studies' results are not directly comparable. The idea of the current study was to combine the approaches of the two studies mentioned, in order to detect the impact of natural sites' characteristics on the estimated value of their recreational services.

Methodology

In our study a meta-regression technique with normalised dependant variable – a log of annual willingness-to-pay per hectare in case of CVM and annual consumer surplus per hectare in case of TCM (WTP/ha/year or CS/ha/year) has been applied. Only studies reporting CS or WTP per person per visit[5] have been used. Normalised welfare measures were obtained by multiplying WTP or CS per person per visit by total annual number of visitors and divided by area of a given site.

Since the main purpose of this meta-regression was to evaluate the impact of the site characteristics on value of the forest recreation, increasing the number of sites by pooling observations from revealed preference (RP) and stated preference (SP) studies has been expected to increase the robustness of the estimates of forest site characteristics[6]. Whilst the RP studies rely on information characterising real transactions performed by economic agents on the existing markets, SP studies derive information from purely hypothetical markets' modelling. Using estimates from SP and RP studies in one meta-regression raises concern about inconsistencies between Marshallian and Hicksian welfare measures[7]. This is because WTP estimates are derived from a Hicksian demand function, while the CS estimates are derived from a Marshallian demand function. These conceptual differences between WTP and CS are accounted for by including a method dummy variable into the regression. Some authors have applied this approach in previous studies (e.g. Shrestha & Loomis 2003).

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[4] R.K. Shrestha, J.B. Loomis, *Meta-analytic benefit transfer of outdoor recreation economic values. Testing out-of-sample convergent validity*, "Environmental&Resource Economics" 2003 no. 25, p. 79-100.

[5] If CS or WTP per group was calculated, this observation was included only if information on average group size was reported.

[6] Pooling SP and RP studies provided information on 82 different forests sites.

[7] W.M. Hanemann, *Willingness to pay and willingness to accept. How much can they differ*, "The American Economic Review" 1991 no. 81(3), p. 635-647.

Valuation studies often test several model specifications and report more than just one result of interest for the meta-analysis. In most cases multiple observations from one study were included in the meta-regression by adding methodological variables that enabled differentiation between them. However, even when all differences in specifications are accounted for, the observations within the same study are likely to share some non-observable factors what in turn may result in correlated errors and biased parameters estimations.

To account for this possibility the following specification of the meta-regression model has been assumed:

$$\text{Ln}\,[\text{WTP(CS)}_{\text{ha/year}}(EUR'2005)] = \alpha + \beta x_i + \mu_i + e_{it} \quad (1)$$

Where: $\text{WTP(CS)}_{\text{ha/year}}$[8] is vector of standardized values (in 2005 EUR) from study i, x_i is a set of explanatory variables including study methodological descriptors and site characteristics. Error term is decomposed into two parts: error at the study level μ_i and e_{it} as an error at the estimation level. Both are assumed to be normally distributed with zero mean and variances respectively: σ_μ and σ_e.

A random or fixed effect specification can be used to address the issue of common μ_i across multiple observations in the same study. In case of this dataset, testing allowed us to reject random effects in favour of a fixed effect specification, which in turn was rejected in favour of equal effects specification. As a result, a classical ordinary least square (OLS) technique was employed to estimate meta-regression model.

Variables, used in the modelling qualify to one of the three following groups:

- method variables which describe the techniques used in the primary study;
- site variables which address natural sites' characteristics;
- other variables (e.g. year of data collection).

The main source of the data was a database prepared within the framework of the EXIOPOL research project. Data on GDP and population density were obtained from EUROSTAT. Variables included in the final meta-regression are listed in Table 1.

Final dataset consisted of fifty-three primary valuation studies of forest recreation conducted in between 1970 and 2012 in eight countries plus Northern Ireland, which gave 253 entries into the model; seventy-three forest sites have been included into the modelling. Primary studies included into dataset contain the records of over 40 000 of individual observations. For the full bibliography of the primary studies included into dataset, please see Giergiczny, Mavsar and Zhou[9].

[8] Henceforth WTP will be used in the text, however whenever it is used it may denote also CS.

[9] M. Giergiczny, R. Mavsar, W. Zhou, *Report documenting the results of the meta-data analysis linking the monetary values with the physical characteristics of forests,* EXIOPOL Report Series, Milano 2008; www.feem-project.net [20-09-2014].

Table 1
Variables included in the meta-regression model

SYMBOL	VARIABLE
	METHOD VARIABLES
RP	1 – if Revealed Preference method (Marshallian measure) 0 – if Stated Preference method (Hicksian measure)
DC	1 – if dichotomous choice elicitation format in SP 0 – otherwise.
OE	1 – if Open ended elicitation format in SP 0 – otherwise.
OValue	1 – if option value included, 0-otherwise
Ttime	1 – if value of time is accounted for, 0-otherwise.
ML	1 – if ML estimator was used in RP method, 0-otherwise.
	SITE VARIABLES
	Nine country dummies (8 countries plus Northern Ireland) with Great Britain as reference level
Ln_Inc	Log of Income on country level (EUR '2000)
Alt	Elevation of the highest point in the forest area (in hundreds of meters)
Ln_Size	Log of study site forest area (ha)
Protected	Protection status 1 – if protected in the form of national park, reserve or natural park, 0 – otherwise
Ln_Density	Log of Population density (NUTS 3 level) (people/km^2)
	OTHER VARIABLES
Year	Year of data collection

Source: own elaboration.

Results and discussion

The meta-regression results are presented in Table 2. Since a part of variables enter a model in linear whilst the others in log-linear way, direct comparison of their impact is rather difficult, however they still allow for economic interpretation.

The signs and significance of the variables are in most cases consistent with a priori expectations and past recreation valuation studies. One serious exception is GDP per capita, a variable used as a proxy of income level. Basically, income is expected to have positive effect on WTP, however in this study coefficient by logarithm of income GDP per capita (PPP) has been found to be negative and not significant. A similar result was found in Zandersen & Tol (2009).

Dummy variable 'RP' is positive and highly significant, indicating that contingent valuation method (CVM) studies produce lower estimates of WTP than do

Table 2
Regression results

SYMBOL	Coefficient	Standard errors
METHOD VARIABLES		
RP	1.959***	.425
DC	1.837***	.462
OE	1.306***	.459
OValue	0.643	.430
Ttime	0.435*	.261
ML	-0.421	.456
SITE VARIABLES		
Ln_Alt	0.131*	.079
Ln_Size	-0.451***	.069
Protected	1.06***	.2205
Ln_Density	0.686***	.104
Ln_GDPPPP	-0.054	.716
Year	0 .0531*	.0284
COUNTRY DUMMIES		
Austria	2.701***	.766
Germany	2.215***	.592
Ireland	2.483***	.632
Italy	0.435	.366
Northern Ireland	1.062*	.599
Poland	1.701	1.102
Spain	1.887***	.527
R^2=0,61; N obs.=253, Indicates statistical significance at: *** 0.01 level, * 0.1 level		

Source: own elaboration.

travel cost method studies (TCM), a result consistent with Carson et al.[10], Walsh et al.[11] and Shrestha & Loomis (2003).

Unlike in Zandersen & Tol (2009) the following site characteristics: altitude, forest area, protected area, density of population proved to be statistically signif-

[10] R.T. Carson, N.E. Flores, K.M. Martin, J.L.Wright, *Contingent valuation and revealed preference methodologies. Comparing the estimates for quasi-public goods*, "Land Economics" 1996 no. 1(72), p. 80-99.

[11] R.G. Walsh, D.M. Johnson, J.R. McKean, *Issues in nonmarket valuation and policy application. A retrospective glance*, "Western Journal of Agricultural Economics" 1989 no. 14, p. 78-188; R.G. Walsh, D.M. Johnson, J.R. McKean, *Benefit transfer of outdoor recreation demand studies: 1968-1988*, "Water Resources Research" 1992 no. 28, p. 707-713.

icant. Since dependant variable was log of WTP/ha/year the coefficients by variables that are logarithmically transformed are estimates of the elasticities.

While the model, presented in the Table 2 exhibits the best fit, different specifications of meta-regression function were also tested. For example when altitude was employed into the regression in a linear form, its coefficient was highly significant at 0,01 level. Estimated coefficient 0,073 indicated that an increase in elevation by 100 meters raised WTP/ha/year by 7,3%[12]. The question however arises: do people prefer to visit forests that are situated in highlands or mountains or they just like highlands or mountains and detected positive impact on their WTP has nothing to do with presence of forest? Given the current dataset this question is rather difficult to answer, however there are reasons to believe that people indeed may derive bigger recreational benefits from forests situated in the highlands or mountains comparing to forests in lowland areas[13]. Therefore this variable could have also been employed into a value transfer function.

Another interesting result is coefficient by variable 'Protected', which indicates that if forest is legally protected then WTP/ha/year is higher by 106% as compared with the forests which are not. Assuming that protection status is an indicator of relative uniqueness of a given ecosystem, obtained results indicate that standardised recreational benefits are higher for forests in which the natural processes are relatively better preserved.

Positive and highly significant coefficient at country dummies for Austria, Germany, Spain or Ireland would have indicated higher conservational values of continental and Irish forests as compared with the same of British ones. However, this difference can be more realistically explained by the relatively more numerous valuation studies, conducted in the Great Britain as compared with the other countries and territories under consideration. There studies cover the majority of country's woodland whilst less numerous valuation studies conducted in other countries may focus on the most valuable sites in the first turn. Similarly, not significant coefficient in case of Poland may be interpreted as a result of relatively not numerous primary valuation studies conducted in the country.

Conclusions

Method variables effects are consistent with the literature (e.g. Carson *et al.* (1996), Shrestha&Loomis (2003): *ceteris paribus* SP studies provide lower estimates then RP ones.

The following site characteristics have produced significant results in terms of the effect on the normalised WTP per year per ha for the forest recreation: sites' altitude, forest area, protected area status, density of population have

[12] In fact what people may care more about is the difference in level between the highest and lowest part. However data on highest point are much easier to encounter and these variables are likely to be highly correlated.

[13] Mostly landscape amenities but also some recreational activities like: hiking, mountain biking.

proved to be statistically significant (interpreted as elasticity because of logarithm in the left-hand side of the model) – unlike in Zandersen & Tol (2009) except the size – however some of them are missing undivided interpretation (e.g. altitude). Income – GDP per capita (PPP) – turned out to be not significant (the same found by Zandersen & Tol (2009).

Possibly, the most important finding of the study, is that the protected area status turned out to be positive and highly significant. Assuming that protection is an indicator of relative uniqueness of a given ecosystem, obtained results indicate that standardised recreational benefits are higher for forests in which the natural processes are relatively better preserved. This finding can be considered the study's added value, since the past studies failed to produce similar result, the one which may have considerable political importance.

Ceteris paribus the more recent valuation studies retrieve the higher level of consumer surplus (either Marshallian or Hicksian). Consumers' preferences might have changed in time yielding ever higher recreational benefits, derived out of forest recreation.

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ECOSYSTEM SERVICES IN TOURISM AND RECREATION. REVISITING THE CLASSIFICATION PROBLEM

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ŚWIADCZENIA EKOSYSTEMOWE NA POTRZEBY TURYSTYKI I REKREACJI. JESZCZE RAZ O PROBLEMIE KLASYFIKACJI

STRESZCZENIE: Na całym świecie obserwuje się rosnące zainteresowanie kulturowymi świadczeniami ekosystemów. Jakkolwiek znaczenie tej grupy świadczeń dla jakości życia ludzkiego jest niepodważalne, ten zakres badań pozostaje słabo rozwinięty tak pod względem metodycznym jak i teoretycznym.
Turystyka i rekreacja są zazwyczaj włączane do grupy świadczeń kulturowych. Jednakże nie bazują one wyłącznie na potrzebach duchowych; obejmują również konsumpcję różnego typu zasobów przyrodniczych. Celem artykułu jest analiza relacji między turystyką i rekreacją a różnymi kategoriami świadczeń ekosystemowych. Dla określenia wagi ośmiu wydzieleń drugiego poziomu klasyfikacji CICES dla turystyki i rekreacji posłużono się metodą analizy hierarchicznej. Analiza została przeprowadzona przez ekspertów reprezentujących geografię fizyczną oraz geografię turyzmu. Badanie potwierdziło, że turystyka i rekreacja bazują na zróżnicowanym spektrum świadczeń ekosystemowych, nie powinny być zatem traktowane jako świadczenie *per se*.

SŁOWA KLUCZOWE: turystyka i rekreacja, świadczenia ekosystemowe, klasyfikacja

Introduction

Tourism and recreation are the important element of human well-being. Natural values are concerned to be crucial for the most of leisure activities. Their identification and assessment can be conducted using ecosystem services concept which has gained its global popularity in the last 15 years. This paper does not aim at its characteristics, however three principal advantages of using ecosystem services concept should be mentioned. First, it allows to recognize relations between economic and ecological aspects of use of natural resources. Second, it makes possible to identify consequences of different scenarios of spatial development. Third, it has high potential as and information and educational tool.

Tourism and recreation find its place within the discussed concept and are typically listed as one of the cultural ecosystem services. However, their position remain unclear, as they are positioned at different levels and in various relations to other services (see table 1). One of the ambiguities is if recreational ecosystem services are of material of nonmaterial character. The popular Millenium Ecosystem Assessment (MEA)[1] classification recognizes tourism and recreation as one of the cultural services, thus promotes their nonmaterial character. In Common International Classification of Ecosystem Services (CICES 4.3)[2] classification recreation is also considered as a cultural service, and it is described even in a more narrow way, as physical and intellectual interaction with the environment. As tourism and recreation are a very diversified phenomenon, the existing classifications are supposed to be too limited. The one way to resolve this problem is to create new, more suitable typologies[3]. However, the use of common and well established frameworks would allow to easily combine research on tourism and recreation with those concerning other types of human activities. The implementation of common classification of ecosystem services is thus significant from scientific as well as from practical point of view. In our opinion ecosystem services for tourism and recreation cannot be limited to just one category. This paper attempts to identify the weight of different ecosystem services to tourism and recreation phenomenon.

CICES classification has been explored in order to describe the importance of different ecosystem services to tourism and recreation. The classification which was developed on the basis of environmental accounting undertaken by the European Environment Agency (EEA) is based on the requirement that any new

[1] *Millenium ecosystem assessment. Ecosystems and human well-being. Synthesis*, Washington D.C. 2005.

[2] Common International Classification of the Ecosystem Services v. 4.3, www.cices.eu [27-09-2014].

[3] R. Costanza, *Ecosystem services: multiple classification systems are needed*, "Biological Conservation" 2008 no. 2(141), p. 350-352.

Table 1
Position of tourism and recreation in different classifications of ecosystem services

Classification	Level	Position of tourism and recreation	Recognition of material aspects	Recognition of nonmaterial aspects
Costanza et al. 1997[a]	first	One of 17 main categories	yes	no
De Groot et al. 2002[b]	first	One of 23 ecosystem functions	yes	yes
MEA 2005[c]	second	One of 4 subgroups of cultural ecosystem services	no	yes
Wallace 2007[d]	second	One of 6 subgroups of category socio-cultural fulfillment	no	yes
Boyd & Banzhaf 2007[e]	first	One of 6 benefits	yes	no
CICES 2013[f]	third	One of 20 service groups, belong to cultural section	yes	no

[a] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 254.
[b] R.S. De Groot, M.A. Wilson, R.M.J., Boumans, *A typology for the classification, description and valuation of ecosystem functions, goods and services*, "Ecological Economics" 2002 no. 41, p. 396.
[c] *The Millenium Ecosystem Assessment*, op. cit., p. 120.
[d] K.J. Wallace, *Classification of ecosystem services: Problems and solutions*, "Biological Conservation" 2007 no. 139, p. 241.
[e] J. Boyd, p. Banzhaf, *What are ecosystem services? The need for standardized environmental accounting units*, "Ecological Economics" 2007 no. 63, p. 616-626.
[f] *Common International Classification of the Ecosystem Services v.4.3*, op. cit.

Source: after: M. Kowalczyk, S. Kulczyk, *Ecosystem services in tourism research. Case study of aquatic recreation*, "Ekonomia i Środowisko" 2012 no. 2(42), p. 203, changed.

classification has to be consistent with previously accepted typologies[4]. Widely used in Europe and in other countries, it has three hierarchical levels and can be modified depending on scale and approach of undertaken research. CICES has gone through a number of evolutionary stages since it was first proposed in 2009. The most recent version (4.3) has been used as the basis of this work.

Method

The Analytic Hierarchy Process (AHP) has been implemented to identify which of CICES categories are supposed to be the most important for tourism and recreation. Developed by Saaty[5] in the 1970s, this multiple choice method is widely used both for management and scientific purposes. It has been also imple-

[4] R. Haines-Young et al., *Towards a common international classification of ecosystem services (CICES) for integrated environmental and economic accounting (Draft V1)*, Report to the European Environment Agency for Contract No. EEA/BSS/07/007, Nottingham 2009.
[5] T.L. Saaty, *The analytic hierarchy process*, New York 1980.

mented in tourism research[6]. The method allows to incorporate both qualitative and quantitative elements of a problem within a single study and to arrange them in a hierarchical form. The AHP approach involves three basic steps: (1) decomposition – creation of the hierarchy (2) pairwise comparison of elements of the hierarchical structure; (3) synthesis of priorities. The values of the pairwise comparisons are determined according to the nine point scale, where 1 means that two activities contribute equally to objective and 9 that the importance of one over another is affirmed on the highest possible order. After the pairwise comparison a matrix is constructed, a vector of priorities is calculated and is then normalized to sum to 1.0. Finally, the reliability of the experts' judgments is checked using the consistency ratio (CR) metric. Inconsistency unveils exaggerated or careless judgments. Originally, T.L. Saaty considered CR = 0.1 as the acceptable upper limit, but depending on a character of an analysis and on a number of compared elements values up to 0.3 could also be accepted[7].

Due to limited human capacity for proceeding information the number of elements taken into account in AHP analysis should not exceed 9[8]. Accordingly, the second level of CICES classification has been assessed. These are 8 elements: nutrition; materials; energy; mediation of wastes, toxics and other nuisances; mediation of flows; maintenance of physical, chemical and biological conditions; physical and intellectual interactions with ecosystems and land-/seascapes, spiritual, symbolic and other interaction with ecosystems and land-/seascapes. The table 2 shows the position of analyzed elements within CICES classification. As it has been mentioned above, tourism and recreation activities themselves taken into account by CICES as a sublevel of "physical and intellectual interactions (…)".

Ten experts were asked to make comparisons of the elements presented above. Five of them were landscape ecologists and five were tourism geographers. For every set of judgments the individual AHP matrix were constructed. Results were finally synthetized to one final AHP matrix. The analysis was conducted with the use of free AHP Excel template elaborated by K.Goepel.

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[6] C.F. Lee, H.I. Huang, H.R. Yeh, *Developing an evaluation model for destination attractiveness: Sustainable forest recreation tourism in Taiwan*, "Journal of Sustainable Tourism" 2010 no. 18(6), p. 811-828; L. Nahuelhual, A. Carmona, P. Lozada, A. Jaramillo, M. Aguayo, *Mapping recreation and ecotourism as a cultural ecosystem service. An application at the local level in Southern Chile*, "Applied Geography" 2013 no. 40, p. 71-82; T. Adamczyk, M. Nowacki, *Ocena atrakcyjności krajoznawczej destynacji żeglarskich z wykorzystaniem metody AHP*, „Turystyka Kulturowa" 2014 no. 8, p. 51-68.

[7] K. D. Goepel, *Implementing the analytic hierarchy process as a standard method for multi-criteria decision making in corporate enterprises–a new AHP excel template with multiple inputs, Proceedings of the international symposium on the analytic hierarchy process*, Kuala Lumpur 2013, p. 4.

[8] T.L. Saaty, M.S. Ozdemir, *Why the magic number seven plus or minus two*, "Mathematical and Computer Modelling" 2003 no. 3 (38), p. 233-244.

Table 2
CICES classification – 1st and 2nd level

Section	Division
Provisioning	Nutrition
	Materials
	Energy
Regulation & Maintenance	Mediation of waste, toxics and other nuisances
	Mediation of flows
	Maintenance of physical, chemical, biological conditions
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes

Source: *Common international classification* . . ., op. cit.

Results

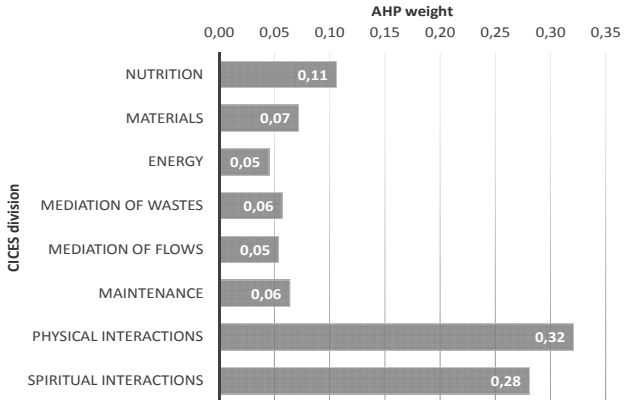
Figure 1 presents the results of the conducted analysis. Both included types of cultural services have occurred to be the most important for tourism and recreation, with physical and intellectual interactions with ecosystems and land-/seascapes at the first position. Provisioning services, especially nutrition, are also significant. The importance of regulation and maintenance remains unclear. The elements of this group have been weighted as less significant.

However the final matrix has high level of consistency (CR = 0.018), the judgments of the individual experts are less consistent. Only four experts reached the level of consistency suggested by T.L. Saaty (CR <= 0.1). CR for another six sets of judgments varied between 0.1 and 0.3.

The experts' academic background seems to have no influence on their judgments. As well those of physical geographers and specialists in tourism remain highly diversified (see Figure 2). In posterior personal communication experts admitted that the task appeared difficult for them. The main problems which they perceived were:

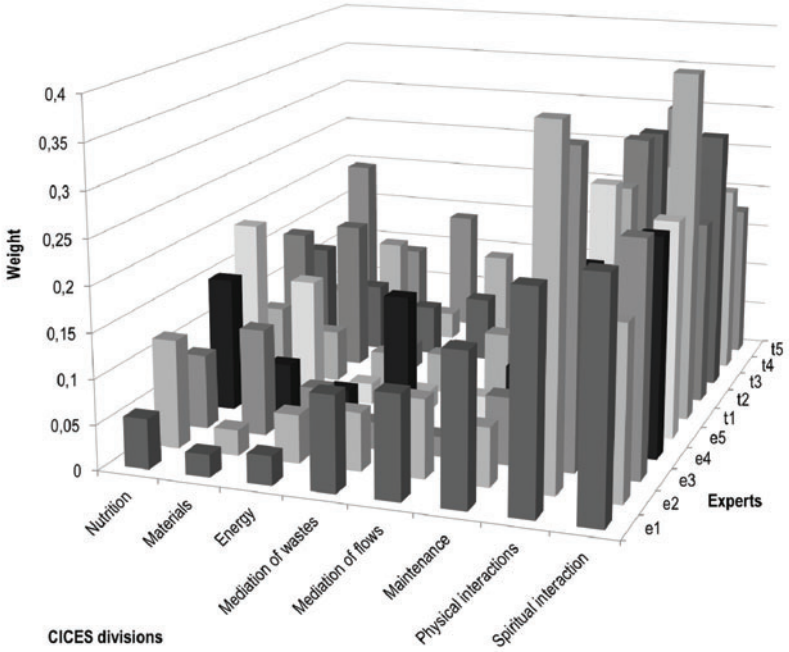
- broad and unclear categories, although some examples were given to make them clearer;
- a lack of knowledge of the assessed phenomena; especially regulating and maintenance categories were seen as problematic;
- the need to treat tourism and recreation in general; in reality it remains very diversified.

Figure 1
The results of AHP analysis



e 1...e5 – landscape ecologists, t1...t5 – tourism geographers.

Figure 2
The results of AHP analysis – the individual judgments



e 1...e5 – landscape ecologists, t1...t5 – tourism geographers.

Source: own elaboration.

Discussion

The division into provisioning, regulating & supporting and cultural services originates from the MEA and is implemented also in CICES classification. This division is one the most used. Understandably, it could not fit all purposes. It has been criticized in context of environmental accounting[9] and poverty alleviation[10]. However considering ecosystem services complexity an idea of a single classification system should be approached with caution[11] common classifications such as MEA or CICES, allows for easy communication and comparisons within different contexts.

The CICES classification defines tourism and recreation as one of cultural services. The discussed phenomenon is included into the category of physical and intellectual interactions with ecosystems/landscapes. The conducted analysis shows clearly that tourism and recreation is too broad and complicated phenomenon to be treated as a single ecosystem service itself. However, cultural ecosystem services are definitely the most important for tourism and recreation (0,32). Physical and intellectual interactions with ecosystems of land/seascapes are followed closely by spiritual and symbolic interactions (0,28). Nutrition should be also considered as an important service (0,11). Its significance seems to respond to the growing popularity of regional food, that is in many cases an important driver of tourism activity.

The regulating and maintenance services occurred to be the most problematic ones. On the one hand, the expert were conscious that tourism and recreation influenced ecological functions, but they seemed not to have the detailed knowledge of the problem. In fact, the relations between different leisure activities and various types of ecosystems still remain unknown. Additionally, the enormous diversity of relations that should be included makes their evaluation very difficult if possible at all.

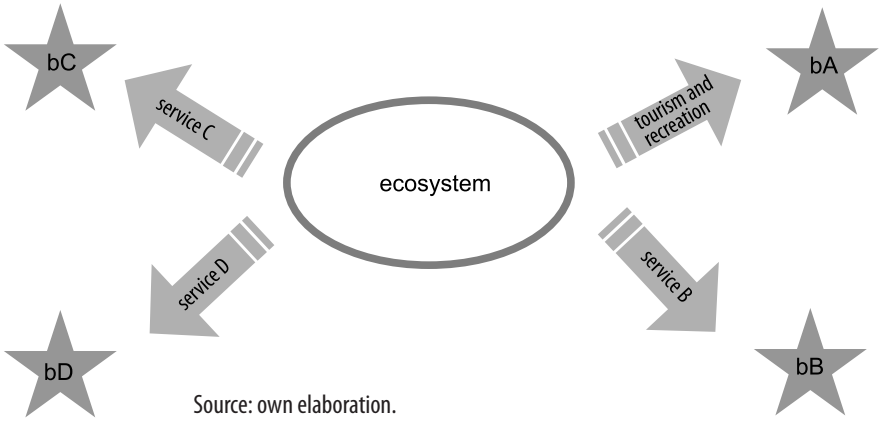
It has to be noticed, that the notion of tourism and/or recreation is very broad and its limit remain unclear. Therefore, it is difficult to identify any ecosystem – human relations as connected or separate to tourism. It is not just the case of regulating and maintenance services mentioned above, but also of the ecosystem services, that are easier to be identified and to quantified. For example nutrition service supports tourist interests as well as everyday human needs. Delivery of regional products is just a small fraction of the phenomenon and does not nec-

[9] J. Boyd, S. Banzhaf, *What are ecosystem services? The need for standardized environmental accounting units*, "Ecological Economics" 2007 no. 2-3(63), p. 616-626; K.J. Wallace, *Classification of ecosystem services: problems and solutions*, "Biological Conservation" 2007 no. 3-4(139), p. 235-246; B. Fisher, R.K. Turner, *Ecosystem services: classification for valuation*, "Biological Conservation" 2008 no. 141, p. 1167-1169.

[10] T. Daw, K. Brown, S. Rosando, R. Pomeroy, *Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being*, "Environmental Conservation" 38 (4), p. 370-379.

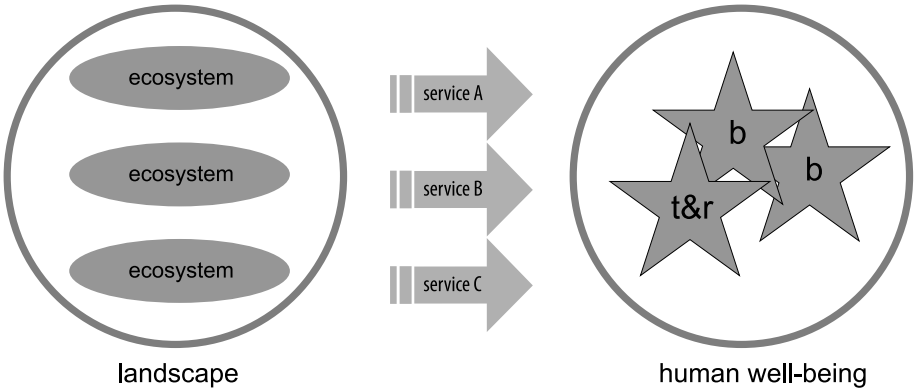
[11] R. Costanza, *Ecosystem services multiple classification systems are needed*, "Biological Conservation" 2008, 2(141), p. 350-352.

Figure 3
Ecosystem services concept – ecological approach. b = benefit



Source: own elaboration.

Figure 4
Ecosystem services concept – social approach. T&R = tourism and recreation b = other benefits



Source: own elaboration.

essarily concern only tourists. The mentioned products can be also consumed by locals. Also, if sold far from the place of their origin, they would lose their importance to tourism.

Originally, the concept of ecosystem services has been used as a tool for nature management and biodiversity conservation. Growing interest in the nature-human relations resulted in transformation of the original concept into the planning tool, where nature's services are used in a holistic approach centered around human well-being concept[12]. The followers of the second approach often

[12] P. Lamarque, F. Quétier, S. Lavorel, *The diversity of the ecosystem services concept and its implications for their assessment and management*, "Comptes Rendus Biologies" 2011 no. 5 (334), p. 441-449.

refer not to ecosystem but rather to landscape services, as landscape is more complex term that include human activity[13].

The approach results in different position of tourism and recreation (Figure 3 and 4). If the research is socially focused, limiting tourism and recreation to one synthetic category could result in omitting some elements that are important to human-nature relation. However, the adopted level of detail should reflect spatial, social and time scale of the research.

Conclusions

The ecosystem services concept has been widely discussed in the scientific literature for the past 15 years. It can be very useful also in tourism studies, as an enormous part of tourism and recreation activities are undertaken in nature. In the existing classifications of ecosystem services, however, tourism and recreation are considered just as a single service. This paper proved that such an approach is too limited and it does not take into account the complexity of the studied phenomenon.

Natural ecosystems have an important value as a place where people can come for rest, relaxation, refreshment and recreation[14]. However, in order to use them as places for tourism and leisure, other ecosystem functions should also be considered. This paper aimed at discussing the position of tourism and recreation in classifications of ecosystem services. It showed, that they should be treated as a complex phenomenon and not just as a separate service. This approach should be continued and expanded.

The research was funded by the National Science Centre on the basis of a decision DEC-2012/07/B/HS4/00306.

[13] J.W. Termorshuizen, P. Opdam, *Landscape Services as a bridge between landscape ecology and sustainable development*, "Landscape Ecology" 2009 no. 24, s.1037-1052; A. Tengberg et al., *Cultural ecosystem services provided by landscapes. Assessment of heritage values and identity*, "Ecosystem Services" 2012 no. 2, p. 14-26; M. Vallés-Planells, F. Galiana, V. Van Eetvelde, *A classification of landscape services to support local landscape planning*, "Ecology and Society" 2014 no. 1(19), p. 44, www.dx.doi.org [20-08-2014].

[14] R.S. de Groot, M.A. Wilson, R.M.J., Boumans, *A typology for the classification, description and valuation of ecosystem functions, goods and services*, "Ecological Economics" 2002 no. 41, p. 402.

STUDIES AND MATERIALS

STUDIA I MATERIAŁY

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THE USE OF INTEGRATED ENVIRONMENTAL PROGRAMME FOR ECOSYSTEM SERVICES ASSESSMENT

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WYKORZYSTANIE PROGRAMU ZINTEGROWANEGO MONITORINGU ŚRODOWISKA PRZYRODNICZEGO DO OCENY USŁUG GEOEKOSYSTEMOWYCH

STRESZCZENIE: W artykule przedstawiono koncepcję zastosowania Zintegrowanego Monitoringu Środowiska Przyrodniczego (ZMŚP) do realizacji zadań w zakresie usług geoekosystemów. Program ZMŚP stwarza możliwości oparcia ocen usług regulacyjnych na danych pomiarowych realizowanych w różnych typach krajobrazów Polski, reprezentatywnych dla struktury krajobrazowej kraju. Pomiary realizowane przez Stacje Bazowe ZMŚP pozwalają ocenić na przykład usługi regulacyjne lasów w zakresie remediacji toksyn i innych uciążliwości, regulacji procesów glebotwórczych i jakości gleby, regulacji klimatu przez sekwestrację węgla, a także usługi ekosystemów wodnych związane z regulacją cyklu hydrologicznego, regulacją jakości wody oraz regulacją transportu materii. Realizacja programu badawczo-pomiarowego ZMŚP poszerzona jest o programy specjalistyczne, specyficzne dla poszczególnych Stacji Bazowych. Stwarza to możliwość oceny usług geoekosystemów z uwzględnieniem specyfiki środowiska przyrodniczego zlewni badawczych oraz specjalizacji zespołów badawczych.

SŁOWA KLUCZOWE: Zintegrowany Monitoring Środowiska Przyrodniczego, usługi regulacyjne, wzmacnianie lub konkurowanie, beneficjenci

Introduction

Scientists and practitioners have a lot of experience in the assessment of the majority provisioning and cultural services like timber, food and recreation services[1], however regulating services are more difficult to estimate and thus still pose serious challenges.[2] Much of the conceptualisation around regulation ecosystem services is not supported by observation data and the links to ecological processes are poorly defined. Applications to new situations are often largely qualitative, based on expert judgement or assumptions,[3] and lack supporting evidence from field measurements. In this context, long-term monitoring data relating to complex functioning of ecosystems seem to be very useful. Taking this into account, the article presents a concept of the use of the Integrated Environmental Monitoring Programme (IEMP) for the identification and assessment of services for various types of Poland's landscapes.

The Integrated Environmental Monitoring Programme (IEMP) functions within the State Environmental Monitoring Programme since 1994. Its task, as opposed to specialist monitoring, involves long-term research, both abiotic and biotic of elements of the natural environment, based on planned and organized stationary tests.

The aim of the IEMP is to provide data for defining the current environmental status and, based on multi-year observation cycles, to present short- and long-term environmental changes in the conditions of climate changes and growing human impact on the environment. The results obtained from the conducted observations are the basis for preparing short- and long-term forecasts of the development of the natural environment and presenting the directions for threats and methods for preventing them. The Integrated Environmental Monitoring Programme, as opposed to sector-related monitoring provides comprehensive information, not only within selected measurement programmes, but mostly about cause and effect relationships and results of their impact on the geographical environment.

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[1] M. Hernández-Morcillo, T. Plieninger, C. Bieling, *An empirical review of cultural ecosystem service indicators*, "Ecological Indicators" 2013 no. 29, p. 434-444; M. Kandziora, B. Burkhard, F. Müller, *Mapping provisioning ecosystem services at the local scale using data of varying spatial and temporal resolution*, "Ecosystem Services" 2013 no. 4, p. 47-59; A.I. Milcu, J. Hanspach, D. Abson, J. Fischer, *Cultural ecosystem services. A literature review and prospects for future research*, "Ecology and Society" 2013 no. 18, v. 3, p. 47-59; M. Pérez-Soba et al., *Study on the role of agriculture as provisioning ecosystem service*, Interim report to the Institute for Environment and Sustainability (JRC/IES), Alterra Wageningen UR, Copenhagen 2012.

[2] P. Kumar, M. Verma, M.D. Wood, D. Negandhi, *Guidance manual for the valuation of regulating services*, Nairobi 2010.

[3] L. Jones et al., *A review and application of the evidence for nitrogen impacts on ecosystem services*, "Ecosystem Services" 2014 no. 4, p. 76-88.

The IEMP is a scientific and research programme and it is used for recognizing the functioning of geoecosystems, their protection and preservation of Poland's landscape structure. In terms of the methodology, the IEMP is based on the concept of system functioning[4], implements the assumptions of preserving geodiversity and biodiversity of the whole country. The basic object of IEMP research is the river or lake catchment area within which test research areas are located which are representative for the landscape under analysis.

A broad range of complementary stationary research is conducted according to standardised methods at 11 IEMP Base Stations in the entire country and at the Polar Base Station in Spitsbergen as a reference station for the assessment of the condition of the natural environment in Poland. The location of IEMP Base Station in Poland takes into account the diversity of landscapes-ecological zones[5] and mesoregions by dominant forms of land cover[6] (Figure 1, Table 1).

Figure 1
The location of Integrated Environmental Monitoring Programme Base Stations in landscape-ecological zones

Source: own study based on the Land Cover Structure according to landscape-ecological zones; M. Stępniewska, A. Mizgajski, op. cit.

[4] A. Kostrzewski, *Geoekosystem obszarów nizinnych. Koncepcja metodologiczna,* „Zeszyty Naukowe Polskiej Akademii Nauk, Człowiek i Środowisko Komitet Naukowy przy Prezydium PAN" 1993 no. 6, p. 11-17.

[5] A. Mizgajski, M. Stępniewska*, Ecosystem services assessment for Poland – challenges and possible solutions*, "Ekonomia i Środowisko" 2012 no. 2(42), p. 54-73.

[6] D. Łowicki, A. Mizgajski, *Typology of physical-geographical regions in Poland in line with land-cover structure and its changes in the years 1990-2006*, "Geographia Polonica" 2013 no. 86(3), p. 255-266.

Table 1
Physicogeographical characteristics of representative catchment areas of the Integrated Environmental Monitoring Programme

IEMP Base Station	Catchment research	Area [km^2]	Landscape-ecological zone4	Catchment/ Basin	Physical-geographic macro-region[8]	Dominant forms of land cover in mesoregion[9]
Wolin	Gardno Lake	2,6	Baltic Sea	Baltic Sea	Szczecin Coastland	Distinctly forested and averagely artificial
Storkowo	Parsęta	74,0	Lakelands	Parsęta	Westpomeranian Lakeland	Diversified
Puszcza Borecka	Łękuk Lake	13,3	Lakelands	Węgorapa/ Pregoła	Masurian Lakeland	Diversified
Wigry	Czarna Hańcza	7,4	Lakelands	Niemen	Lithuanian Lakeland	Distinctly agricultural
Koniczynka	Struga Toruńska	35,2	Lakelands	Wisła	Chelmno-Dobrzyn Lakeland	Distinctly agricultural
Różany Strumień	Różany Stream	10,1	Lakelands	Warta/ Odra	Poznań Lakeland	Diversified
Kampinos	Olszowiecki Channel	20,2	Lowlands	Łasica/ Wisła	Central Mazovia Lowland	Distinctly artificial and averagely forested
Święty Krzyż	I rank catchment	1,3	Uplands	Kamienna/ Wisła	Kielce-Sandomierz Upland	Distinctly agricultural and averagely artificial
Roztocze	Świerszcz	46,5	Uplands	Wieprz/ Wisła	Roztocze	Distinctly forested
Szymbark	Bystrzanka	13,0	Medium-high Mountains	Ropa/ Wisła	Central Beskydy Mountains/Central Beskydy Foothills	Distinctly agricultural and averagely artificial
Karkonosze	Wrzosówka	93,2	Medium-high Mountains	Kamienna/ Odra	Giant Mountains	Distinctly forested

Source: own study based on the Integrated Environmental Monitoring Programme.

As regards the organization of the measurement system, research methods and substantive studies, the IEMP refers to the European Integrated Monitoring Programme[9]. The research and measurement scope of the IEMP includes the fol-

[7] A. Kondracki, *Geografia regionalna Polski*, Warszawa 2000, p. 441.
[8] D. Łowicki, A. Mizgajski, op. cit.
[9] A. Kostrzewski, J. Tylkowski, *Conditions of geo-ecosystems of Poland in 2012 – Implementation of the Integrated Environmental Monitoring Programme;* S. Kleemola, M. Forsius (eds.), *23rd Annual Report Convention on Long-range Transboundary Air Pollution International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems*, Finnish Environment Institute 2014, p. 45-51.

lowing programmes: meteorology, air pollution, chemistry of precipitation, chemistry of throughfall and stemflow, chemistry of soil solutions, groundwater, surface water, soils, structure and dynamics of the vegetation and invasive alien species, damage to trees and stands of trees, epiphytes, heavy metals and sulphur in lichens, land cover and the use of land, hydrobiology of rivers – macrophytes and hydromorphological assessment of river beds, ecosystem services.

The use of the Integrated Environmental Monitoring Programme for valuation of ecosystem services

Table 2 presents parameters from the measurement programme implemented by IEMP Base Stations which may support the quantification of selected regulating services listed in the CICES classification[10]. The measurement of the load of pollutants reaching the ground with the throughflow and stemflow as compared to loads of these pollutants brought to the ground with precipitation in an open area informs about regulating services in forests in the area of remediation of toxics and other nuisances. Forest services pertaining to the regulation of soil-forming processes and soil quality may be characterised owing to the measurement of the organic matter reaching the forest floor and the biogenic loads it contains. The carbon content in the organic precipitation, on the other hand, is an indicator of services related to global climate regulation by carbon sequestration.

The degree of defoliation is an indicator of the forest condition useful for the end user for the determination of the representativeness of results obtained at IEMP Base Stations as compared to the level of environmental pollution. This parameter is measured on monitored surfaces in the basic IEMP programme and its value can be compared by the end user with the degree of defoliation in the area under analysis owing to data from the state forest monitoring.

Further measurement parameters allow for characterising regulating services of river ecosystems related to the regulation of sediment transport. The IEMP programme also includes the measurement of a range of parameters used to define the quantitative and qualitative status of aquatic ecosystems. These include physicochemical properties of waters, characteristic flows in rivers, the status of groundwater, indices of changes in retention in a hydrological year in relation to the energy of the lay-of-the-land and the structure of the land use. Transformation of these parameters into useful indices of services in the area of regulation of the hydrological cycle and regulation of water quality requires the assessment of their influence on the degree of meeting the needs of aquatic habitats and water-dependent habitats. The seasonal water regime and water quality determine the possibility of the fulfilment of various functions of these habitats and, as a result, of providing ecosystem services, e.g. maintaining habitats plant and animal

[10] *Common international classification of ecosystem services (CICES) v. 4.3 (update January 2013)*, www.cices.eu [24-07-2014].

Table 2

Parameters of the IEMP measurement programme useful for the assessment of ecosystem services

CICES Division	CICES Group	CICES Class	Indicators of ecosystem services
Mediation of toxics and other nuisances	Mediation by ecosystems	Filtration/ sequestration/ storage/ accumulation by ecosystems	• **Remediation of pollutants reaching the forest floor with throughfall and stemfall**: Pollutant loads reaching the ground with throughfall and stemfall, mg/m2: Basic programme: S-SO4, SO4, N-NO3, NO3, NH4, N-NH4, Cl, Na, K, Mg, Ca; Extended programme: Cd, Cu, Pb, Mn, Fe, Zn, Ni, As, Cr, Al. • **Remediation of pollutants reaching the forest floor with organic precipitation:** Loads of elements reaching the forest floor with organic precipitation, kg of dry matter/ha/year Extended programme: total S, Ca, Mg, Na, K, Mn, Zn, B, Cu, Mo, Pb, Cd. • **Background: pollutant loads reaching the ground with precipitation in an open area** Loads of pollutants brought to the ground with precipitation, kg/km2: Basic programme: S-SO4, SO4, N-NO3, NO3, N-NH4, NH4, Cl, Na, K, Mg, Ca; Extended programme: Cd, Cu, Pb, Mn, Fe, Zn, Ni, As, Cr, Al.
Maintenance of physical, chemical, biological conditions	Soil formation and composition	Decomposition and fixing processes	• **Maintenance of biogeochemical conditions of soils by decomposition of dead organic material, nitrification, denitrification and other biogeochemical processes:** – Organic matter reaching the forest floor, g/m2 – Basic programme – Loads of elements reaching the forest floor with organic precipitation, kg of dry matter/ha/year Extended programme: organic C, total N, total P
	Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	• **Global climate regulation by carbon sequestration:** – Organic C load reaching the forest floor with organic precipitation, kg of dry matter/ha/year – Extended programme
Mediation of flows	Mass flows	Buffering and attenuation of mass flows	• **Transport of sediment by rivers:** Load of dissolved substances carried with river runoff, kg/ha/year: Basic programme: S-SO4, N-NO3, HCO3, total P, total Al, N-NH4, Cl, Na, K, Mg, Ca; Extended programme: Cd, Cu, Pb, Mn, Zn, Ni, As, Fe, Cr.

Source: own study based on the: A. Kostrzewski, R. Kruszyk, R. Kolander, *Zintegrowany monitoring środowiska przyrodniczego. Zasady organizacji, system pomiarowy, wybrane metody badań 2006*, www.staff.amu.edu.pl [23-07-2014].

nursery and reproduction, flood and drought protection, maintaining baseline flows for water supply[11].

The implementation of the IEMP measurement programme is extended by specialist programmes specific for individual stations. It makes it possible to assess ecosystem services taking into account the specificity of the natural environment of the investigated catchment areas and specialization of research teams (e.g. research of lateral erosion in river beds, research of soil erosion, landslides, drainage catchment areas, cliff abrasion).

The assessment of trade-offs and synergies between the ecosystem services is a promising research area. This type of analyses should provide grounds for answering a question of practical relevance: in which landscape structures of Poland can the bundle of ecosystem services be increased? [12]

IEMP Base Stations situated in areas of high natural value are attractive for analysing trade-offs and synergies between regulating and cultural services. A broad range of regulating services are accompanied by a low degree of anthropogenic transformation there. At the same time, the aforementioned areas are attractive places of rest and relaxation providing a range of cultural services, e.g. entertainment, heritage or educational values. The intensity of use of cultural benefits influences the structure and level of regulating services. In addition, these areas are the place of residence for the local community which obtains food and materials for their own needs there (provisioning services)[13].

IEMP base stations with research catchment areas transformed by human activity connected with agriculture are promising areas for research on trade-offs and synergies between provisioning, regulating and cultural services. In addition to food, fuel and fiber, agricultural areas can provide another ecosystem services, e.g. regulation of water quality, biocontrol services, climate stabilization, providing natural habitats for conservation and recreation, aesthetic and cultural amenities such as beautiful farmscapes. Various agricultural management practices have differing effects, sometimes in opposition and at other times synergistic for providing these regulating and cultural services[14].

The IEMP potential for the assessment of ecosystem services is also connected with the identification of spatial *distribution* of *ecosystem service beneficiaries (ESBs).* Different stakeholders often attach a different value to ecosystem services, depending on their cultural background and the impact of the service on their well-being. *Depending on the* ecosystem service under analysis*, ESBs* can occur at a local, regional, national and even global level. For example the value of the supply of tourism and recreational activities at a given location does not

[11] E. Maltby et al., *Freshwaters – Openwaters, Wetlands and Floodplains*, in: *The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment,* Cambridge 2011.
[12] A. Ruijs et al., *Trade-off analysis of ecosystem services in Eastern Europe*, "Ecosystem services" 2013 no. 4, p. 82-94.
[13] I. Palomo et al., *National Parks, buffer zones and surrounding lands: Mapping ecosystem service flows*, "Ecosystem Services" 2013 no. 4, p. 104-116.
[14] G.P. Robertson et al., *Farming for ecosystem services. An ecological approach to production agriculture*, "BioScience" 2014.

necessarily accrue only to the local community. It is a frequent situation that external visitors are the main beneficiaries of such services. On the other hand, the benefits from clean water supply, waste treatment or moderation of extreme events (e.g. flood) generally directly accrue to the welfare of local communities[15]. Consideration of *beneficiaries* for various types of Polish landscape enhances the applicability of ecosystem services assessment to support decision making, as different stakeholders' interests often result in different visions on the management of the area. The formulation of management plans that are acceptable to all stakeholders requires the balancing of these different interests[16].

Conclusions

The Integrated Environmental Monitoring Programme implemented for 20 years is a good source of quantitative data pertaining to the functioning of the natural environment of catchment areas under investigation which are representative for landscape-ecological zones in Poland.

The verified IEMP database containing 1 million records is a reliable basis for identifying and valuating ecosystem services, especially as regards the assessment of regulating services. Within the framework of the IEMP, a specialist ecosystem services programme will be implemented in the years 2015-2017, which is aimed, amongst other things, at developing methodological and application principles of the assessment of ecosystem services in Poland.

However, parameters of the measurement programme implemented by IEMP Base Stations will be useful indicators of ecosystem services only if they are adapted to the indices of benefits supplied to human societies. Operationalization of measurement parameters as proposed by the European Environment Agency[17], would be a good platform that would make it possible to standardize the methodology for the whole country and to ensure comparability of results with other countries.

[15] R. S. de Groot et al., *Global estimates of the value of ecosystems and their services in monetary units*, "Ecosystem Services" 2012 no. 1, p. 50-61.
[16] L. Hein, K. van Koppen, R. S. de Groot, E.C. van Ierland, *Spatial scales, stakeholders and the valuation of ecosystem services*, "Ecological Economics" 2006 no. 57, p. 209-228.
[17] European Environment Agency, op. cit.

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RESOURCES OF THE POLISH OFFICIAL STATISTICS FOR VALUATION OF PROVISIONING ECOSYSTEM SERVICES

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ZASOBY POLSKIEJ STATYSTYKI PUBLICZNEJ DO OCENY I WYCENY ZAOPATRUJĄCYCH USŁUG EKOSYSTEMOWYCH

STRESZCZENIE: Jedną z głównych przeszkód w ocenie usług ekosystemowych jest brak odpowiednich danych do ilościowego ujęcia popytu i podaży na poszczególne usługi. Przedmiotem artykułu jest ocena potencjału statystyki publicznej do wsparcia ocen i wycen zaopatrujących usług ekosystemowych w Polsce. Analizę dostępności danych źródłowych przeprowadzono w trzech wymiarach: dla klas Wspólnej Międzynarodowej Klasyfikacji Usług Ekosystemowych (CICES), jednostek podziału administracyjnego Polski oraz głównych typów ekosystemów. Oceniono także dostępność czasową danych i związaną z nią możliwość określania wieloletnich trendów zmian w poziomie usług.

Dokonany przegląd zasobów statystycznych pozwala oceniać, iż dostarczają one rozległego materiału do ocen i wycen zaopatrujących usług ekosystemowych, niemniej występują trudności przy korzystaniu z istniejących danych. Należą do nich szczególnie: zróżnicowana dostępność danych statystycznych na różnych poziomach przestrzennych, brak informacji o niektórych usługach, a także rozproszenie danych związane z faktem, że usługi ekosystemowe nie stanowią kryterium organizującego w zbieraniu i prezentowaniu danych.

SŁOWA KLUCZOWE: usługi ekosystemowe, ocena, wycena, raportowanie, dane statystyczne, źródła danych

Introduction

The interest in ecosystem services (ES) in both the research and policy communities has grown substantially[1]. The main obstacles in the valuation of ES include the lack of appropriate data for the quantification of the supply and demand for individual services.[2] The analysis of available data is considered to be a necessary first step towards the development of a reliable and feasible indicator for ES mapping and assessment[3]. Data sources that may be used for the quantification of ES may include both maps and statistical data[4]. The latter are perceived as particularly useful in the quantification of provisioning ES. Many of these services are market-related;[5] therefore, the input data for their analyses may be obtained from statistical reports for individual economic sectors.

The aim of this paper is to assess the potential of public statistics for the support of valuations of provisioning ES and the reporting concerning the value of these services in Poland. The aims of the studies include the identification and assessment of the available source data for the quantification of provisioning services in physical and monetary units. The practical aim involves the assessment of the usefulness of the public statistics database for the implementation of target 2, action 5 of the European Union Biodiversity Strategy. This action involves mapping and assessment of the state of ecosystems and their services in member states by 2014 and the assessment of the economic value of such services and promoting the integration of these values into accounting and reporting systems by 2020[6].

Methodology

The analysis of the source data availability for the valuations of provisioning services was carried out in three dimensions: for classes covered by the Common International Classification of Ecosystem Services (CICES version 4.3), Polish

[1] L.M. Cox, A.L. Almeter, K.A. Saterson, *Protecting our life support systems. An inventory of U.S. federal research on ecosystem services*, "Ecosystem Services" 2013 no. 5, p. 163-169; L. Braat, R. de Groot, *The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy*, "Ecosystem Services" 2012 nr 1, p. 4-15; R. Seppelt, et al., *A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead*, "Journal of Applied Ecology" 2011, p. 630-636.

[2] B. Burkhard, F. Kroll, p. Nedkov, F. Müller, *Mapping ecosystem service supply, demand and budgets*, "Ecological Indicators" 2012 no. 21, p. 17-29.

[3] *Available data for mapping and assessing ecosystems in Europe*, 2013 Final Report – task 5.2.5, www.projects.eionet.europa.eu [04-07-2014]; *Indicators for mapping ecosystem services: a review,* 2012 Report EUR 25456 EN, www.publications.jrc.ec.europa.eu [03-07-2014]. *Mapping of ecosystems and their services in the EU and its member states (MESEU). Final report, part 5: task 4 – Recommendations on mapping approaches*, Alterra Wageningen 2013.

[4] Ibidem.

[5] *Study on the role of agriculture as provisioning ecosystem service*, 2012 Final report, www.ecologic.eu [03-07-2014].

[6] *Our life insurance, our natural capital: an EU biodiversity strategy to 2020* [COM(2011) 244].

administrative units and the main ecosystem types. The assessment covered also the temporal availability of data and the associated possibility of defining multi-annual change trends.

The studies were based on the following data of the Central Statistical Office (CSO):

- Local Data Bank[7];
- Environment – statistical yearbooks of 2005-2013[8];
- Municipal infrastructure – statistical yearbooks of 2003-2012[9];
- Forestry – statistical yearbooks of 2005-2013[10];
- Agriculture – statistical yearbooks of 2007-2012[11];
- Agricultural and horticultural crops production – publications of 2003-2012[12];
- Farm animals – publications of 2002-2012[13];
- Physical dimensions of livestock production – publications of 2006-2012[14];
- Horticultural crops – publications from the National Agricultural Censuses 2002 and 2010[15];
- Agricultural crops and selected elements of crop production methods – a publication from the National Agricultural Census 2010[16];
- Arable soil use and quality – a publication from the National Agricultural Census 2002[17];
- Maritime Economy – statistical yearbooks of 2007-2013[18];
- Energy from renewable sources – publications of 2011-2012[19];
- Energy Statistics – publications of 2007-2012[20];
- Energy consumption in households in 2009[21].

In this analysis the term *ecosystem services indicator* is used to refer to the number expressing the level of the service, presented in an absolute or relative form[22]. Source data for the quantification of provisioning services were analysed in two groups: indicators expressed in physical units (such as tons, square kilometres, cubic meters) and monetary indicators (in PLN). The former

[7] *Bank Danych Lokalnych*, www.stat.gov.pl [20-0-2014].
[8] *Ochrona środowiska 2005-2013*, www.old.stat.gov.pl [16-06-2014].
[9] *Infrastruktura komunalna 2003-2012,* www.stat.gov.pl [16-06-2014].
[10] *Leśnictwo 2005-2013*, www.old.stat.gov.pl [16-06-2014].
[11] *Rocznik Statystyczny Rolnictwa 2007- 2012,* www.stat.gov.pl [16-06-2014].
[12] *Produkcja upraw rolnych i ogrodniczych 2003- 2012,* www.stat.gov.pl [16-06-2014].
[13] *Zwierzęta gospodarskie 2002- 2012,* www.old.stat.gov.pl [16-06-2014].
[14] *Fizyczne rozmiary produkcji zwierzęcej 2006-2012*, www.stat.gov.pl [16-06-2014].
[15] *Uprawy ogrodnicze. Powszechny Spis Rolny 2010,* www.stat.gov.pl [16-06-2014].
[16] *Uprawy rolne i wybrane elementy metod produkcji roślinnej. Powszechny spis rolny 2010,* www.stat.gov.pl [16-06-2014].
[17] *Użytkowanie gruntów i ich jakość. Powszechny Spis Rolny 2002*, www.stat.gov.pl [16-06-2014].
[18] *Rocznik statystyczny gospodarki morskiej 2007-2013,* www.stat.gov.pl [16-06-2014].
[19] *Energia ze źródeł odnawialnych w 2011 r, w 2012 r.,* www.stat.gov.pl [16-06-2014].
[20] *Gospodarka paliwowo-energetyczna w latach 2007-2008, w latach 2011-2012,* www.stat.gov.pl [16-06-2014].
[21] *Zużycie energii w gospodarstwach domowych w 2009 r.,* www.stat.gov.pl [16-06-2014].
[22] Joint Research Centre, op. cit.

provide a source material for the biophysical valuation of provisioning services, whereas the latter – for economic valuation.

Results

Inventory of data at different spatial scales

In the analysed resources of the national public statistics, 588 provisioning services indicators in physical units and 164 monetary indicators have been identified altogether (Table 1). These indicators enable the quantification of the services at different administrative levels. In the course of the studies, indicators for the valuations of provisioning services at the national, provincial and commune levels were identified. The analysis did not cover districts, as – apart from the Local Data Bank – in CSO's publications used as a source material, no reporting on this administrative level was found.

As regards indicators for the biophysical valuations of provisioning services, 58% of them were identified at the provincial level, 38% at the national level and 4% at the commune level. Most of the monetary indicators were identified at the national level (94%). Monetary indicators at the provincial level represent only 6% of the total number, while no such indicators were identified at the commune level.

At the national level, a considerable share (50%) of the indicators for the biophysical valuation of provisioning services is represented by the indicators for the services from the CICES class concerning plant-based resources. They include the statistics of production and energy consumption from plant-based resources. The indicators for the class of genetic materials from all biota are also widely represented (24% of all indicators in physical units). They are mainly characterised by forest genetic resources, including parents of family as well as seed tree stands and seed orchards. Monetary indicators describing the level of provisioning services at the national level are mainly related to the classes of cultivated crops (40% of all indicators), reared animals and their outputs (33%) as well as fibres and other materials from plants, algae and animals for direct use or processing (16%). The indicators related to the above-mentioned classes reflect the

Table 1

The number of identified indicators for provisioning services at different administrative units

Type of valuation	Communes	Provinces *	Country *	Total
Biophysical valuation	22	342	224	588
Economic valuation	0	10	154	164

* source data that do not occur in the reporting for lower-level administrative units

Source: own study.

value of the crop and animal agricultural production in total and divided by products, as well as the value of the wood sales of the National Forest Holding, according to product assortments.

The indicators, that are useful for the biophysical valuation of provisioning services at the provincial level, are most widely represented by the classes of cultivated crops (44% of all indicators) and materials from plants, algae and animals for agricultural use (17%). As regards the first of the above-mentioned classes, the analysed indicators are characterized by the size of the production of consumer crops, whereas the second one – by the size of fodder crops. Monetary indicators at this administrative level cover the value of the purchase of agricultural produce, fruit and forest mushrooms as well as game.

At the commune level, as far as indicators expressed in physical units are concerned, the classes of cultivated crops (36% of all indicators) and reared animals and their output (27%) are the most widely represented. They are related to the sowing area of selected farmlands and orchards as well as the headage of farm animals. At the commune level, no indicators reporting the level of provisioning services in monetary units were identified.

CICES classification coverage by data on provisioning services

The analysis covered the completeness of source data related to the classes of provisioning services specified in CICES version 4.3. The number of indicators for individual classes is presented in table 2. As regards indicators in physical units at the national level, at least one indicator for 7 out of 16 CICES classes was identified, at the provincial level – for 12 classes, whereas at the commune level – for 6 classes. The analysed indicators were not identified for four CICES classes altogether. As regards monetary indicators at the national level, at least one indicator for 5 out of 16 CICES classes was identified, whereas at the provincial level – for 4 classes. No monetary indicators were identified at the commune level. Monetary indicators were not identified for nine CICES classes altogether.

Availability of statistical data for the main ecosystem types

In the next phase of the works, the coverage of the main ecosystem types with provisioning ES indicators was identified. The analysis results are included in Table 3. Indicators in both physical and monetary units are dominated by the ones describing provisioning services of agricultural areas and forests. For many indicators concerning the class of plant-based resources, it was impossible to explicitly match them to ecosystem types. These were indicators that covered the total use of various forest, agricultural and peat biomass types for power-related purposes, without taking into account their origin.

Temporal availability was determined for all identified indicators. When services are only assessed on the one-year basis, the drawback is the omission of temporal changes of ES supply and demand. Provisioning services vary over the

Table 2
The number of indicators for provisioning services available in the resources of the national public statistics according to CICES classes

CICES classes	Number of indicators for the administrative level *							
	Communes		Provinces		Country		Total	
	P	M	P	M	P	M	P	M
Cultivated crops	8	0	148	2	2	62	158	64
Reared animals and their outputs	6	0	21	2	22	51	49	53
Wild plants, algae and their outputs	0	0	2	2	0	0	2	2
Wild animals and their outputs	0	0	25	4	10	0	35	4
Plants and algae from in-situ aquaculture	0	0	0	0	0	0	0	0
Animals from in-situ aquaculture	0	0	0	0	0	0	0	0
Surface water for drinking	0	0	1	0	0	0	1	0
Ground water for drinking	0	0	1	0	0	0	1	0
Fibres and other materials from plants, algae and animals for direct use or processing	3	0	30	0	6	24	39	24
Materials from plants, algae and animals for agricultural use	2	0	57	0	18	4	77	4
Genetic materials from all biota	0	0	17	0	53	0	70	0
Surface water for non-drinking purposes	2	0	10	0	0	0	12	0
Ground water for non-drinking purposes	1	0	8	0	0	0	9	0
Plant-based resources	0	0	22	0	113	13	135	13
Animal-based resources	0	0	0	0	0	0	0	0
Animal-based energy	0	0	0	0	0	0	0	0

P – indicators in physical units, M – monetary indicators
* A class with at least 1 indicator [grey color]

Source: own study.

years based on growing seasons or regulations, e.g. concerning the agriculture, fishing or hunting. Such information has to be taken into account when communicating ES supply and demand to stakeholders. It was determined that 85% of the indicators in physical units cover the period of at least 10 years, whereas 15% of them are based on one-year data. As regards monetary indicators, these shares are 95% and 5% respectively. The predominance of indicators covering the period of 10 years and longer provides a good possibility of defining multi-annual change trends at the level of provisioning services.

Table 3
The number of identified provisioning services indicators for the main ecosystem types

The main ecosystem types	CICES classes	Number of indicators			
		For CICES classes		Total	
		P	M	P	M
Agriculture areas	Cultivated crops	158	64	315	121
	Reared animals and their outputs	49	53		
	Fibres and other materials from plants, algae and animals for direct use or processing	12	0		
	Materials from plants, algae and animals for agricultural use	77	4		
	Plant-based resources	19	0		
Forests	Genetic materials from all biota	25	4	180	30
	Fibres and other materials from plants, algae and animals for direct use or processing	2	2		
	Wild animals and their outputs	27	24		
	Wild plants, algae and their outputs	70	0		
	Plant-based resources	56	0		
Freshwater	Ground water for drinking	1	0	24	0
	Surface water for drinking	1	0		
	Ground water for non-drinking purposes	1	0		
	Surface water for non-drinking purposes	12	0		
	Wild animals and their outputs	9	0		
Baltic Sea	Wild animals and their outputs	9	0	9	0
Forests/Agriculture areas	Plant-based resources	58	13	58	13
Forests/Grasslands	Plant-based resources	2	0	2	0

P – indicators in physical units, M – monetary indicators

Source: own study.

Discussion

The identified indicators of the provisioning ES are included in the list of preferred indicators provided by Joint Research Centre (JRC)[23]. In the JRC's work, almost a half (46%) of the proposed indicators is characterised by food provision, 30% by water provision, while the remaining ones are medicinal resources (4%) and genetic resources (3%). Indicators found in the resources of the Polish public statistics are also consistent with the indicators of ES proposed by the

[23] Ibidem.

European Commission Working Group: "Mapping of Ecosystems and Their Services in the EU and its Member States" (MAES).[24] Examples of indicators for agricultural areas recommended by MAES available in the Polish official statistics include the yields of food and feed crops, food and feed crop area, livestock data, meat production and consumption. As regards forests, the examples of such indicators include the data on forest harvesting, and as far as freshwater is concerned – on domestic water consumption and water use for sectors of economy.

As pointed out by the authors of PEER[25], indicators referring to ES need to reflect (the actual distance from) the sustainable production rates to ensure that the long-term benefit flow of services is represented. High values may arise from over-exploitation of ecosystems and lead to wrong conclusions concerning the most advantageous strategies of the use and protection of ecosystems. Currently, there is no clear definition concerning the meaning of sustainability with regard to individual ES. However, in the Polish statistical data, no indicators characterising the level of provisioning services covering the aspects of sustainability of production were identified.

It should also be noted that provisioning ES provided by agriculture are not "pure" ES, but they originate from deeply modified habitats. The values of those services depend not only on the natural capital (e.g. the soil as a natural resource for plant production), but also on the contribution of man-made input into the system (i.e. labour, machinery, fertilisers, irrigation).[26] The availability of indicators characterising both elements should enhance the usefulness of valuations of provisioning services for the support of decision-making processes.

The presented indicators focus mainly on ES-supply assessment. ES-supply indicators show the capacities of different ecosystems to provide ecosystem services, but the locations of respective demands for these services cannot be determined on their basis. ES-demand indicators represent ⅓ of all identified indicators. This type of indicators makes it possible to determine the amount of ES consumed or used in a particular area, and thus to assess where ES are actually provided. In order to analyse the source and sink dynamics and to identify service flow, the information about the ES supply and demand needs to be merged.[27] The indicators identified during the presented studies enable the creation of budgets of ecosystem service supply and demand only for 5 out of 16 classes of provisioning services: surface and ground water for drinking purposes, surface and ground water for non-drinking purposes and plant-based resources.

[24] MAES, *Mapping and assessment of ecosystems and their services. Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020*, 2014 Technical Report – 2014 – 080, www.ec.europa.eu [03-07-2014].

[25] *A spatial assessment of ecosystem services in Europe: Methods, case studies and policy analysis – phase 1*, 2011 PEER Report No 3, www.peer.eu [03-07-2014].

[26] FRAGARIA consortium, op. cit.

[27] B. Burkhard, F. Kroll, S. Nedkov, F. Müller, op. cit.

Conclusions

The analysis of the existing statistical data makes it possible to conclude that they provide a great deal of useful material for the valuations of provisioning ES; there are yet still several challenges to be dealt with.

In particular, data are plentiful, but their availability is different at individual spatial scales. On the national level, data availability is not so much the problem, as many statistics are readily available, or national aggregations can be done from regional and local data. At the local level, on the other hand, provisioning ES remain poorly characterised by data; therefore, a comprehensive valuation of services cannot be carried out on their basis. It is possible to use data from higher administrative units (e.g. yields on regional level) in order to carry out ES valuation on the local scale. However, this may result in over-simplification and coarse assessment, since the crucial local specificity remains hidden due to the high level of aggregation of data coming from national and regional scales.[28] Great progress may, therefore, be done by the improvement of the availability of local data on ES by means of extending the scope of data collected at the commune level.

As not all ES are represented in the resources of the Polish public statistics, treating them as the only source of data may lead to the under-representation of some services and lack of information on other ones. The most important difficulties include also data fragmentation related to the fact that ES do not constitute an organising principle in collecting and presenting data. Currently, the term "ecosystem services" is not used in the public statistics resources; therefore, statistical data on them may be found only indirectly – through the analysis of statistical publications concerning various economic sectors and subjects. The creation of an on-line platform storing data on ES on a central and accessible server would increase data availability and enable the users to perform queries of data for a particular output.

The presented analysis opens the discussion on the development of a complete system of provisioning ES indicators in Poland. The identified data need to be discussed in an interdisciplinary manner, involving the correctness and usefulness of particular indicators, the *necessary* number of indicators and desired proportion between the indicators in physical and monetary units.

[28] M. Kandziora, B. Burkhard, F. Müller, *Mapping provisioning ecosystem services at the local scale using data of varying spatial and temporal resolution*, "Ecosystem Services" 2013 no. 4, p. 47-59.

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RELATION BETWEEN CHARACTERISTICS OF NATURAL ENVIRONMENT AND ECOSYSTEM SERVICES OFFERED, THEIR INDICES AND MEASURES (CASE STUDY OF THREE COMMUNES OF PODLASKIE VOIVODSHIP)

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SPECYFIKA ŚRODOWISKA PRZYRODNICZEGO A ZESTAW USŁUG EKOSYSTEMOWYCH, ICH WSKAŹNIKÓW I MIAR (NA PRZYKŁADZIE TRZECH GMIN WOJEWÓDZTWA PODLASKIEGO)

STRESZCZENIE: Określono zależności między przykładowymi usługami ekosystemowymi i dobrami naturalnymi trzech gmin województwa podlaskiego: Giby, Nowinka, Suwałki. Celem analizy jest powiązanie wybranych elementów środowiska przyrodniczego gmin z usługami dostarczanymi przez ekosystemy. Spośród trzech gmin – Giby wyróżniają się przewagą lasów, Nowinka jezior, Suwałki – użytków rolnych. Z wymienionych różnic wynikają najbardziej typowe dla każdej z gmin usługi ekosystemowe; dla Gib – zaopatrzeniowe uzyskane z ekosystemów leśnych; dla Suwałk – zaopatrzeniowe dostarczane z produkcji rolnej; dla Nowinki – kulturowe dostarczane z ekosystemów wodnych.

SŁOWA KLUCZOWE: usługi ekosystemowe, struktura użytkowania ziemi, typy siedliskowe lasu, ekosystemy wodne, grunty orne

Introduction

An awareness of the benefits that humans obtain from the natural environment lies at the basis of the developing concept of ecosystem services (ES). Ecosystem services are broadly defined as the set of ecosystem products (e.g. timber, forest fruit, game) and functions (e.g. purification of water and air, production of oxygen, places for recreation) that society takes advantage of [1]).

The present paper aims to link selected ecosystem services related to differential natural conditions, and particularly structure of land use, in three communes of the Podlaskie voivodship in Poland, namely Giby, Nowinka and Suwałki.

It is assumed that differences in the prevalence of particular land use patterns result in a multiplicity of services provided by ecosystems. The paper presents examples of ecosystem services that are secondary to the dominant pattern of land use in a specific commune. For the commune of Giby, these are provisioning services delivered by forest ecosystems, which occupy approx. 75% of the commune's area. For the commune of Nowinka, characterised by the highest percentage of lakes (approx. 15%), we chose to describe cultural services associated with recreation and ecotourism. The commune of Suwałki is characterised by a predominance of agricultural land use (arable land accounts for approx. 54%), which favours provisioning services related to food production.

Theoretical basis of investigations

The concept of ecosystem services (ES) is currently very popular and much researched. According to the simplest and most popular conceptualisation, there are four categories of ecosystem services: (1) provisioning services, including food and water; (2) regulating services, such as flood and drought control, preventing land degradation or disease control; (3) supporting services, including soil formation and biogene cycling; and (4) cultural services, i.e. recreational, spiritual, religious and other intangible values[2]. According to the classification developed by I. Green et al.[3], only two categories (provisioning and cultural services) comprise products and structures that are directly advantageous to human society, while the remaining two (regulating and supporting services) provide a structural and functional framework that influences the overall integrity of a landscape system and its capacity to produce specific services.

[1] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387; J. Solon, *Koncepcja „Ecosystem Services" i jej zastosowania w badaniach ekologiczno-krajobrazowych*, „Problemy Ekologii Krajobrazu" 2008 no. 21, p. 25-44.

[2] MEA, *Millennium Ecosystem Assessment Synthesis Report*, 2005, www.maweb.org [02-06-2006].

[3] I.M. Green, C. Folke, R.K. Turner, I. Bateman, *Primary and secondary values of wetland ecosystems*, "Environmental and Resource Economics" 1994 no. 4, p. 55-74.

The growing awareness of benefits that ecosystems provide to society makes it worthwhile to disseminate and develop the ES conception[4]. Papers on ES are proliferating, especially in the United States, but also in European countries, including Poland[5]. They represent diverse theoretical and practical value[6]. A common goal in many of these papers is, above all, the assessment of the effect of human activity on the supply of ecosystem services. The ecosystem services debate often revolves around planning protective measures in areas of natural value[7].

Importantly, the literature on ecosystem services provides a disorderly network of concepts and a similarly disorderly array of methods, leading to devaluation of its fundamental term. Assessments of ecosystem services account for most scientific literature in nature conservation, environmental economics and ecology[8];[9];[10]. The natural environment supplies humans with raw materials, finished products, energy and services. Some authors also perceive, analyse, classify and assess ecosystem services from two vantage points: biological-ecological and socioeconomic[11]. A. Mizgajski and M. Stępniewska[12] refer to ecosystem services as environmental services and define them as all benefits obtained by humans from ecosystem metabolism.

The present paper analyses two categories of ecosystem services: provisioning and cultural ones. Provisioning services refer to products obtained from ecosystems (such as food, fuel, fiber, genetic resources, biochemical substances, natural pharmaceuticals, water resources and natural raw materials used by art and culture, such as wood for ornaments or sculptures)[13]. Cultural services comprise intangible benefits derived from ecosystems (such as cognitive, recreational, reflective values, aesthetic experiences and spiritual enrichment).

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[4] J.A. Foley et al., *Global Consequences of Land Use*, "Science" 2005 no. 309, p. 570-574.

[5] E. Roo-Zielińska, B. Grabińska, *Ecosystem services – classification and different approaches at various levels of biosphere organisation – a literature review*, "Geographia Polonica" 2012 no. 85, v. 2, p. 65-81.

[6] M. Degórski, *Wykorzystanie świadczeń ekosystemów w rozwoju regionów*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 85-97.

[7] B. Egoh, *Integrating ecosystem services into conservation assessments: A review*, "Ecological Economics" 2007 no. 63, p. 714-721.

[8] K.E. Limburg et al., Special issue: *The dynamics and value of ecosystem services. Integrating economic and ecological perspectives complex systems and valuation*, "Ecological Economics" 2002 no. 41, p. 409-420.

[9] R Costanza, *Ecosystem services. Multiple classification system are needed*, "Biological Conservation" 2008 no. 141, p. 350-352.

[10] Z.M. Rosin et al., *Koncepcja świadczeń ekosystemowych i jej znaczenie w ochronie przyrody polskiego krajobrazu rolniczego,* „Chrońmy Przyrodę Ojczystą" 2011 no. 67(1), p. 3-20.

[11] B. Poskrobko, *Usługi* środowiska jako *kategoria ekonomii zrównoważonego rozwoju*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 21-30.

[12] A. Mizgajski, M. Stępniewska, *Koncepcja świadczeń ekosystemów a wdrażanie zrównoważonego rozwoju,* in: D. Kiełczewski, B. Dobrzańska (eds.), *Ekologiczne problemy zrównoważonego rozwoju*, Białystok 2009, p. 12-13.

[13] A. Becla, S.Czaja, A. Zielińska, *Pozaekonomiczne użytki środowiska przyrodniczego a usługi ekosystemów w świetle współczesnego rachunku ekonomicznego*, „Ekonomia i Środowisko" 2013 no. 2(45), p. 10-22.

Becla et al. (2013) emphasise that "a characteristic feature of cultural services it that they can be reused and the manner of using them depends considerably on the preferences of particular social groups". The identification and classification of services precedes their quantification, which involves the description of services in natural units compatible with those occurring in the natural environment.

Source of data

The initial stage of our research was analysis of a variety of planning documents, such as Studies of Determinants and Directions of Land-Use Planning (SUiKZP), statistical data about the Podlaskie voivodship and Suwałki district, data from the Regional Directorate of State Forests in Białystok, Environmental Protection Programmes for the Suwałki district, Environmental Protection Plans for the communes, data from Commune Offices, Local Development Programmes for the communes and the relevant Commune Development Strategies. Additionally, on the basis of a very detailed review of literature and on-line data, "services for" and "services from" land use in the three communes were identified.

The next stage involved the compilation of a possibly complete list of provisioning and cultural services. List of provisioning ecosystem services from forest ecosystems for the Giby and from agroecosystems for the Suwałki commune as well as list of cultural services supplied by aquatic ecosystems for the Nowinka commune had been elaborated. Apart from the category of a service, it details the index/measure, result of measurement, source of data and the service provider.

General characteristics of the three test communes

The choice of test communes was based on two fundamental criteria: (1) the degree of anthropogenic transformation (assessed tentatively on the basis of the proportion of forested area, population density and the presence or absence of industry) and (2) landscape diversity. Three communes in the Podlasie voivodship, namely Giby, Nowinka and Suwałki, were selected for the study involving the identification, valuation and assessment of ecosystem services.

Natural values

The commune of Giby is located in the north-eastern part of the Podlasie voivodship. It occupies a total area of nearly 324 km^2, which accounts for approximately 36% of the area of the Sejny district. The land use includes forests, agricultural land, rivers, lakes and wetlands. In its southern reach extends the picturesque Puszcza Augustowska (Augustów Primeval Forest). A portion of the area of

the commune belongs to Wigry National Park. The rivers Czarna Hańcza and Marycha flow through the commune. The Forest Districts Pomorze and Głęboki Bród, whose ranges partly overlap with the Giby commune, mainly support coniferous forest habitats with a dominance of pine. The mean age of forest stands in the commune is 67 years, and average stock exceeds 300 m^3/ha.

The commune of Nowinka is situated in the central part of the Suwałki-Augustów Lakeland, in the southern mesoregion shaped as an outwash plain by the waters of a melting ice sheet about 17-18 thousands years ago. The commune lies in the northern part of the Podlasie voivodship and in the northern part of the Augustów district. It occupies an area of 204 km^2, of which forests and lakes account for 60%. The Nowinka commune abounds in stagnant bodies of water, especially in the north-east. In the north, the commune extends over a part of Lake Długie Wigierskie. The dense forest complexes of Puszcza Augustowska are partially legally protected as a nature reserve ("Lake Kalejty") and as areas belonging to Wigry National Park. Of the wide gamut of landscape and natural attractions of the commune, it is Puszcza Augustowska that merits a special mention as one of the largest forest complexes in Poland. Wigry National Park, established in 1989, whose southern range lies in the Nowinka commune, is a landscape pearl of the Suwałki region, with its impressive faunal and floral richness comprising more than 100 species of rare plants (including 50 protected species), 80 species of birds, more than 30 species of fish and more than 40 species of mammals.

The commune of Suwałki is one of 9 municipal communes in the Suwałki district. It occupies an area of approx. 264 km^2 representing a young glacial landscape, mostly a hilly and outwash plain lakeland landscape. The commune focuses on agriculture and forest management, as reflected in its land use structure, where agricultural land and forested areas predominate. Agriculture plays a major role in the commune's economy. Due to the characteristic landscape of the Suwałki region, agriculture thrives on the plains. Land dedicated to agricultural production accounts for more than half of the commune's total area (54.5%), with individual farmers managing approx. 84% of the agricultural land. The predominance of agriculture in the commune is attested by its 1366 individual farms, of which 932 concentrate solely on farming, 60 are exclusively involved in non-agricultural activity, 155 have a mixed agricultural and non-agricultural profile and 219 are not active in the agricultural and non-agricultural sector. An individual farm in the commune covers on average an area of 15.3 ha.

The natural values of the Suwałki commune comprise above all its natural resources, i.e. areas supporting the development of tourism, such as forests, numerous lakes, the varied post-glacial landscape and natural resources found in Wigry National Park. The Suwałki commune is characterised by a high contribution of lakes (almost 11%) to land use structure. Water tourism is possible on seven lakes (Wigry, Pierty, Leszczewek, Mulaczysko, Omułówek, Czarne k. Bryzgla and Czarne k. Gawrychrudy), occupying a total area of 2420 ha, which corresponds to as much as 88.5% of the total surface area of lakes in Wigry National Park. Making the commune even more attractive are its many historical buildings, including a real pearl in the form of a former Camaldolese monastic complex

in Wigry, in a picturesque location on a hill overlooking Lake Wigry, one of the largest lakes in Poland.

The area of the Suwałki commune belongs to the Suwałki Forest District, with a predominance of coniferous forest habitats with pine as the dominant species.

Land use structure

The three communes differ in area and population density. The Giby commune occupies the largest area of the three, and Nowinka the smallest. These two communes have a similar population. The commune of Suwałki has the highest population density per km^2 (Table 1).

In the communes of Giby and Nowinka, the largest part of the area is occupied by forest ecosystems (approx. 75 and approx. 61%, respectively). The commune of Suwałki has the lowest forest cover (approx. 29%). The largest proportion of the area there is occupied by arable land (approx. 54%). The lowest proportion of arable land is found in Nowinka (approx. 11%), which also has a relatively large share of lakes (approx. 15 %) (Figure 1).

Table 1
Area and population of test communes

Characteristics	Unit	Commune		
		Giby	Nowinka	Suwałki
Area	[km^2]	324	204	264
Population	[thousand]	3	2,7	6,6
Population density	[population/km^2]	9	14	24,3

Source: Database – Commune, Institute of Tourism, 1998-2010.

Importantly, meadow and pasture ecosystems occupy similar portions of the total area in the communes of Nowinka and Suwałki (approx. 11%), while their proportion in Giby is by far the smallest.

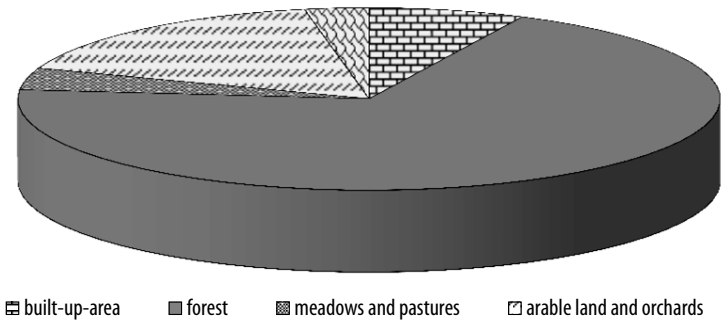
Provisioning and cultural ecosystem services, their measures and indices, for the three test communes

A sample provisioning service from forest ecosystems in the Giby commune

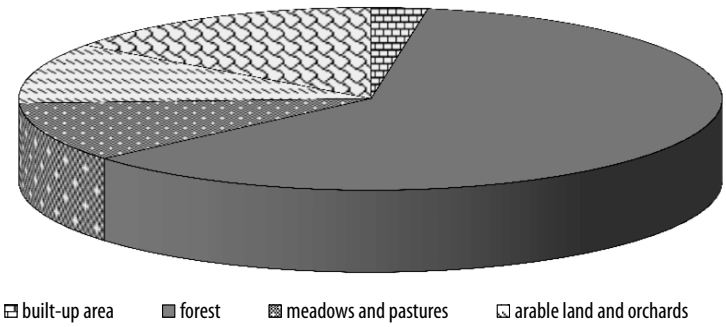
The Giby commune has the highest afforestation index of the three test communes (see Figure 1). Consequently, most of its provisioning services derive from forest ecosystems. The dominant forest habitat in the commune is the coniferous forest, mostly mixed mesic forests (occupying approx. 77% of forested land),

Figure 1
Land use structure of three test communes

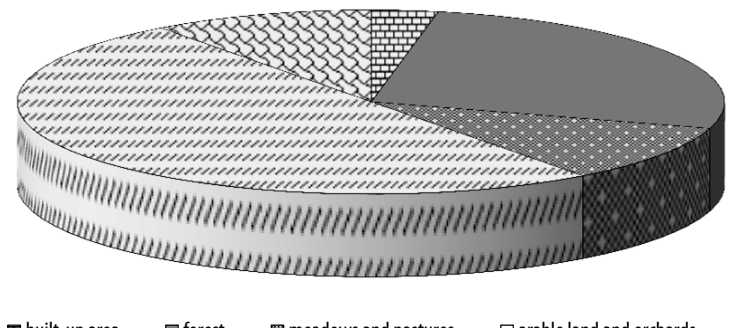
Giby



Nowinka

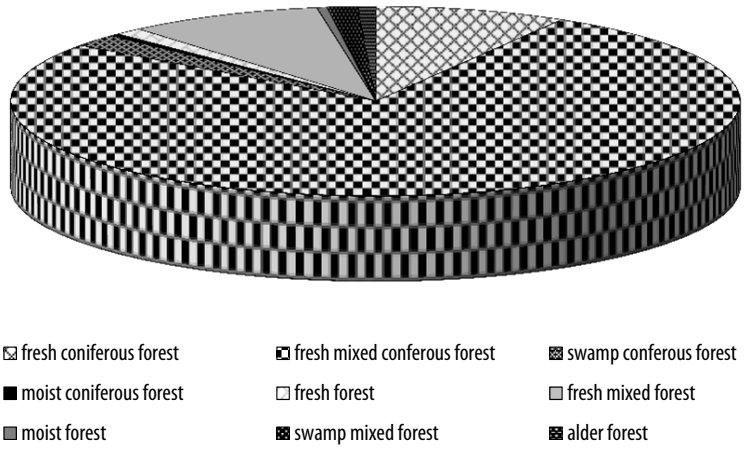


Suwałki



Source: own elaboration.

Figure 2
Shares (%) of forest habitat types in the Giby commune



Source: own elaboration.

with fresh coniferous forests and mixed fresh broad-leaved forests each contributing approx. 9% (Figure 2). Consequently, forest ecosystems provide most of the commune's ES. The services comprise broadly defined forest products, including wood and other wood products, products of the forest floor and the population of game species. Examples of these services are given in Table 2. Narrowly defined services provided by forest ecosystems in the Giby commune comprise large- and middle-sized timber, whose indices are: average volume of a forest stand, i.e. mean wood stock per unit of forest area (m^3/ha), and the measure of the service is mean annual timber logging (m^3/ha) – Table 2.

Other ES derived directly from forests in the Giby commune include the production of seeds, production of seedlings of main forest tree species, supply of Christmas trees for sale, supply of cones providing the best genetic material for afforestation. The forests of the Giby commune[14] supply seeds from seed-producing stands excluded from cutting and from managed seed-producing stands. Seed-producing stands supply approx. 123 kg seeds a year (Table 2). Directly related to the production of seeds is the production of cones. The gathering of cones of the Giby commune mainly supplies cones of pine and spruce (between 1300 kg and 1500 kg annually), reflecting the forest stand dominance pattern. Of note, the prevailing species in the forest stands of the Giby commune is pine, which reflects the fact that the largest proportion of forested areas in the commune is occupied by coniferous stands (see Figure 2). Spruce makes a much smaller contribution, while the admixtures of oak, maple, sycamore, elm, ash, birch and black alder account for only 1-2%.

[14] www.gleboki-brod.bialystok.lasy.gov.pl [20-09-2014]; www.pomorze.bialystok.lasy.gov.pl [20-09-2014].

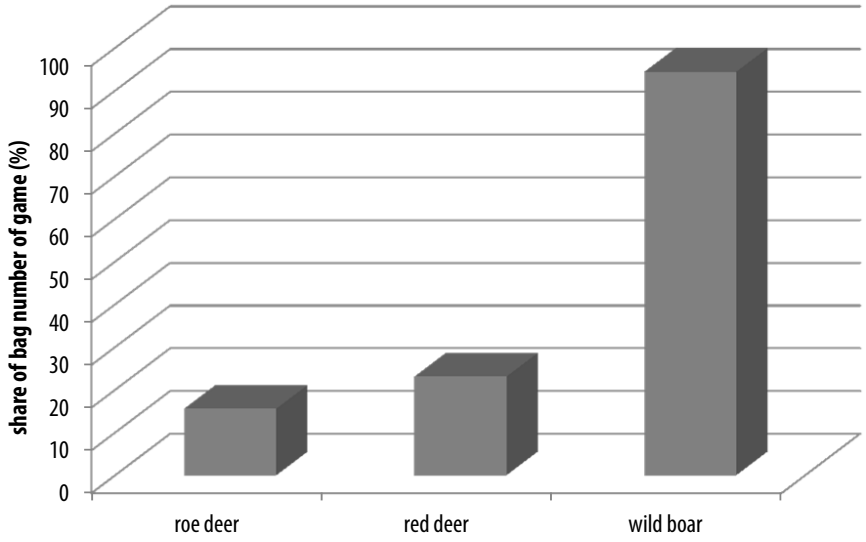
Table 2
An example of provisioning ecosystem services from forest ecosystems in the Giby commune

Services narrowly defined	Index/Measure	Measurment results*
Large- and middle-sized timber	average stocks of wood per forest area [m^3/ha]	627.00
	timber logging, average per year [m^3/ha]	9.81
Christmas trees	trees sold, average per year	216,00
Cones of coniferous trees	gathering of cones, average per year [kg]	2912.00
Tree seedlings of the main forest tree speciecs	average production per year [thous. pieces]	1782.50
Forest-tree seeds of high genetic value	seed production, average per year [kg]	123.00

* Monitoring of Forest Condition in Forest Districts

Source: own elaboration.

Figure 3
Shares of bags of game animals in the Giby commune – provisioning services



Source: own elaboration.

The production of seedlings of forest trees and shrubs is a very significant ecosystem service. In the Giby commune, this type of service yields an average of 1,782,500 seedlings a year (Table 2), mainly of pine, spruce, oak and (smaller quantities) of linden, maple and black alder.

Forest ecosystems also play a significant role in the supply of game and game meat. A sample narrowly defined ecosystem service obtained from the forest is the population of game species, measured as the bag of individuals hunted. The main game species hunted are roe deer, red deer and wild boar. According to an inventory of March 2012, the roe deer was the most abundant game species and

the stock of red deer was a little less abundant, while the population of the wild boar was the least abundant. In the bag, the highest count was that of wild boars, and the lowest, of roe deer (Figure 3).

A sample cultural service from aquatic ecosystems in the Nowinka commune

The pattern of human use of natural conditions in the Nowinka commune serves as an example of cultural services derived from aquatic ecosystems. The reason, among others, is that lakes have a high contribution among land use forms (approx. 15%) in the commune (see Figure 1). The cultural service broadly defined as recreational and ecotouristic value is associated with the particular value represented by surface water bodies (lakes and rivers) in the commune. Situated in Puszcza Augustowska, the commune of Nowinka includes 9 large lakes and 6 rivers. They are attractive above all to anglers and lovers of water sports such as sailing, canoeing and iceboating. The indices corresponding to the cultural services obtained from the lake ecosystems in the Nowinka commune comprise the number of lakes, the area of a lake, lake depth and lake quality class (Table 3). The quality assessment of the lakes was based on a set of several indices of water quality[15]. The nine lakes listed are classified as quality class I or II. The cleanest lakes are Busznica and Długie (Kalejty), classified as quality class I. The lakes differ widely in size, from approx. 17 ha to more than 2000 ha. The largest lake (Wigry) is an exceptional tourist attraction, being known all over Poland and attracting swarms of tourists for years. Lake Wigry is both the largest and the deepest of the nine lakes (Table 3).

For water courses, the relevant indices that should be considered with regard to potential services comprise the number of rivers, the length of a river, the width of the river channel and quality class. Table 4 presents the water quality status[16] of the six rivers of the Nowinka commune which are a source of recreational and ecotouristic services. The rivers are quality class I to III. Only the rivulet of Jałówka has quality class I. It empties into the Rospuda near a site called "Święte Miejsce", frequented by land excursions and cruises[17].

Angling opportunities can serve as an example of a valuable service offered by the commune. It can be measured in terms of the number of spots available for angling or the number of licence-days issued to anglers (Table 5). Canoeing tours are a major and popular tourist attraction in the commune. Among the most beautiful canoeing routes in Poland is that on the rivers Rospuda, Blizna and Szczeberka.

[15] An assessment system developed by the Institute of Environmental Protection. The classification accounted for physicochemical and biological indices, and the final score was assigned to a specific class (I, II, III or out of classification). Report of the Voivodship Environmental Protection Inspectorate in Suwałki, 2008.

[16] Overall assessment of water quality – based on an Ordnance of the Minister of Environment of 9 Nov 2011 as part of water monitoring effort in the years 2010-2013.

[17] www.suwalszczyzna.net [20-09-2014].

Table 3

Selected indices of cultural services and measurement results as exemplified by lakes in the Nowinka commune

Measurments results			
Lakes			
name	water quality class*	surface [ha]	depth of lake [m]
Blizno	II	238.50	28.80
Blizienko	II	38.80	16.80
Busznica	I	49.40	48.00
Długie (Kalejty)	I	159.70	12.00
Jałowo	II	17.50	11.90
Krusznik	II	26.80	18.00
Mulaczysko	II	18.30	20.50
Tobołowo	II	87.00	9.50
Wigry	II	2118.30	73.00

* Water quality was assessed as part of the Water Quality Assessment Monitoring Program in the years 2010-2012

Source: own elaboration.

Table 4

River quality class in the Nowinka commune - a sample index and measurements of cultural services

Rivers	
name	water quality class*
Blizna	II
Dłużanka	II
Jałówka	I
Olszanka	III
Rospuda	III
Szczeberka	III

* Water quality was assessed as part of the Water Quality Assessment Monitoring Program in the years 2010-2012

Source: own elaboration.

A sample provisioning service from an agroecosystem in the Suwałki commune

The commune Suwałki was included in the study to exemplify provisioning services provided by agroecosystems as arable land occupies an exceptionally high percentage of the area of the commune (see Figure 1). The rural profile of the commune is evidenced by the dominant role played by agriculture in the

Table 5
An example of cultural sevices from aquatic ecosystems in the Nowinka commune

Services			Index/Measure
broadly defined	narrowly defined	detailed specification	
Recreational and ecotouristic value	surface water	lakes	(a) number of lakes, (b) surface area of lakes [ha], (c) depth [m], (d) water quality class
		rivers	(a) number of rivers, (b) river length [km], (c) river channel width [m]
			angling (a) number of sites adapted for fishing, (b) number of fishing licence-days issued; **sailing** (a) number of watercourses, (b) number of domestic and international canoeing routes (c) number of cruises

Source: own elaboration.

Table 6
Sample provisioning services in the Suwałki commune

A. Service and index

Service		Index/measure
narrowly defined	detailed specification	
Agricultural plant products	grains, potatoes, industrial crops	(a) tonnes/ha. (b) crop area/ha
Livestock count	cattle, cows, swine, sows, sheep, horses, hens	stocking density (heads of livestock/100 ha of agricultural land)

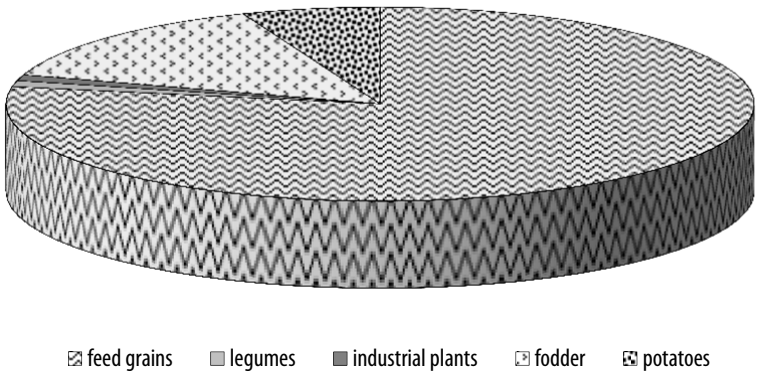
B. Measurement results of stocking density

Livestock count	Measurement result
Total cattle	39.00
Cows	18.30
Total swine	119.00
Total sheep	0.10
Horses	4.80
Hens	1003.00

Source: Local Development Program of the Suwałki commune for the years 2004-2013.

commune's economy. Agricultural production space accounts for more than half of the commune's area (approx. 54.0%). Plant products and the population of breeding animals are examples of narrowly defined ecosystem services provided by agriculture in the Suwałki commune (Table 6AB).

Figure 4
Cropping patterns on arable land in the Suwałki commune



Source: own elaboration.

The indices and measures of agricultural ecosystem services associated with plant production comprise yield per hectare or crop area (ha) – Table 6A.

The crop structure in individual farms demonstrates a dominance of cereals, which occupy nearly 80% of the crop area, while forage plants account for approx. 14%, and potatoes approx. 6% (Figure 4)[18].

The agriculture of the commune of Suwałki is also characterised by a large diversity of animal breeding, with swine and cattle breeding as the predominant types. The index for this service is the head count of livestock /100 ha agricultural land. Of note is also a high proportion of poultry in animal breeding production (Table 6B). Poultry breeding has a long tradition in the Suwałki commune. Several poultry farms are in operation now, with the largest one (40,000 broiler chickens) in Zielone Kamedulskie[19]. The agricultural profile of the commune is also owed to its 1,366 individual farms, the number possibly representing an index of the broadly defined category of provisioning services referred to as food production.

Conclusions

The preliminary results of desk studies and correlating the sample services to the diverse environmental conditions permit the following conclusions:

1. The three test communes, manifesting an agriculture- and forest-oriented functional profile and possessing exceptional environmental values on the country scale, represent qualitatively similar natural values.

[18] Program rozwoju lokalnego gminy Suwałki na lata 2004-2013, Suwałki 2004.
[19] Studium uwarunkowań i kierunków zagospodarowania przestrzennego Gminy Suwałki, tekst ujednolicony, Suwałki 2012.

2. The accumulation of natural resources in the communes provides for diverse benefits in the form of ecosystem services associated with rural and wooded areas and exceptional aquatic resources.
3. A comparison of land use patterns in the three communes revealed a predominance of forests in the Giby commune, arable land in the Suwałki commune and the highest percentage of lakes in the Nowinka commune. This provides grounds for expecting that the services offered by nature in the Giby commune will be classified as provisioning services derived from forest ecosystems, while those from Nowinka will predominantly represent cultural services associated with recreation and ecotourism and Suwałki will generally provide provisioning services from agricultural produce.

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THE INFLUENCE OF THE DATA ANALYSIS SCALE ON THE ESTIMATED SIZE OF ECOSYSTEM SERVICES

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WPŁYW SKALI OPRACOWANIA DANYCH NA SZACOWANĄ WIELKOŚĆ ŚWIADCZEŃ EKOSYSTEMÓW

STRESZCZENIE: Określanie wielkości świadczeń ekosystemów (ES) odbywa się często na podstawie wtórnych źródeł informacji, dlatego istotne jest rozpoznanie wpływu stopnia generalizacji danych źródłowych na dokonywane szacunki.

Celem badań było określenie wpływu stopnia generalizacji danych wejściowych na szacowane wielkości wybranych ES na terenie gminy Krajenka. Kwantyfikacji poddano lokalne walory rekreacyjne i estetyczne środowiska przyrodniczego, należące do grupy świadczeń kulturowych oraz produkcję płodów rolnych w agroekosystemach jako przykład świadczeń zaopatrujących.

W pracy wykorzystano zestaw opracowań kartograficznych i baz danych przestrzennych różniących się poziomem szczegółowości treści. Przy testowaniu hipotez badawczych wykorzystano techniki geoinformacyjne (GIS) i statystyczne, a wśród nich test ANOVA rang Kruskalla-Wallisa i test U Manna-Whitneya. Wykazano istotny statystycznie wpływ stopnia generalizacji danych wejściowych na wyniki kwantyfikacji świadczeń estetycznych oraz świadczeń zaopatrujących związanych z produkcją płodów rolnych.

SŁOWA KLUCZOWE: kwantyfikacja świadczeń ekosystemów, generalizacja kartograficzna, gmina Krajenka

Introduction

The methodological concept of the ES research is aimed at enriching argumentation in favour of moderate use of natural environment resources[1]. A vast majority of research in this area is based on information from secondary sources including cartographic studies. It raises the problem of defining the degree of detail of the input data on the results obtained, especially as regards economic valuation[2]. According to R. Costanza 2012[3], a key challenge in the ES valuation involves the imperfection of the information that one has access to and determination of the influence on the degree of detail of the information about processes in ecosystems.

The research included provisioning services connected with biomass production in ecosystems and cultural services in open areas connected with conditions for rest and relaxation (recreational services) and with experiencing the beauty of nature (aesthetic services).

The analysis was performed for the Krajenka Commune situated in the north part of the Wielkopolska region. It is an area of high natural value connected with the occurrence of forest complexes and natural bodies of water with small pressure of economic activities. According to the ecological and landscape classification prepared for the purposes of the ES assessment in Poland[4], the area of research is situated in the lake district zone characterised by an above-average level of the supply of regulating and cultural services, which is connected with considerable biodiversity and recreational attractiveness of this area.

The aim of the research was to define the effect of the spatial data scale on the results of estimating the size of selected ecosystem services. It was verified whether statistically significant differences occurred between the ES quantification results obtained using the same research method but assigned to spatial data sets from cartographic studies with varying degrees of detail.

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[1] A. Mizgajski, *Problemy percepcji idei zrównoważonego rozwoju w naukach przyrodniczych*, in: A. Graczyk (ed.), „Prace Naukowe Akademii Ekonomicznej. Zrównoważony rozwój w teorii ekonomii i w praktyce" z. 1190, Wrocław 2007, p. 171-180; A. Mizgajski, Świadczenia *ekosystemów jako rozwijające się pole badawcze i aplikacyjne*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 10-19.

[2] R.S. de Groot et al., *Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation*, in: P. Kumar (ed.), *Chapter 1: The Economics of Ecosystems and Biodiversity*, London 2010, www.teebweb.org [27-09-2014]; F. Müller, L. Willemen, R.S. de Groot, *Ecosystem services at the landscape scale: the need for integrative approaches*, "Landscape Online" 2011, p. 1-11.

[3] R. Costanza, *Ecosystem functions and services*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 8-17.

[4] A. Mizgajski, M. Stępniewska, *Ecosystem services assessment for Poland – challenges and possible solutions*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 54-73.

Research methods and assumptions

Quantification of provisioning services

The spatial differentiation of the biomass production level was defined by assigning the normative yields of basic cereals, including wheat, rye, triticale, oats and barley to the soil quality class and to complexes of agricultural suitability[5]. Yield sizes were updated to include data from more recent studies on cereal yields (cf. A. Macias 1996[6], H. Terelak et al. 2000[7], S. Krasowicz et al. 2009[8]). Apart from grain, as the main yield, the studies included data on the secondary yield in the form of straw was included. The size of the secondary yield production was estimated according to a conversion factor as 0.48 of the primary yield[9]. For grassland, the size of the meadow hay production was estimated, taking into account indices from the literature[10]. The monetary valuation of services connected with grain and straw production for basic cereals and the production of meadow hay were performed using arithmetic means of the price of agricultural products calculated on the basis of the data published by BDL GUS (Local Data Bank, Central Statistical Office) for the 2003-2012 decade.

Spatial data about complexes of agricultural suitability of soil and quality classes of arable land meadows came from agricultural soil maps at a scale of 1:5 000 and 1:100 000 and Land and Building Registers at a scale of 1:2 000 – 1:5 000.

Quantification of cultural services

To estimate the size of cultural services, the scored classification was used, which was based on the results of surveys conducted in randomly selected groups of Krajenka Commune inhabitants. The recreational attractiveness index for the land cover (WAR) and the landscape aesthetic attractiveness index (WAE) were

[5] T. Witek (ed.), *Waloryzacja rolniczej przestrzeni produkcyjnej Polski według gmin*, Puławy 1981.
[6] A. Macias, *Przyrodnicze uwarunkowania rozwoju lokalnego*, in: J.J. Parysek (ed.), *Rozwój lokalny i lokalna gospodarka przestrzenna*, Poznań 1996, p. 67-97.
[7] H. Terelak, S. Krasowicz, T. Stuczyński, *Środowisko glebowe polski i racjonalne użytkowanie rolniczej przestrzeni produkcyjnej*, „Pamiętnik Puławski-Materiały Konferencji" 2000 v. 120, p. 455-469.
[8] S. Krasowicz, T. Stuczyński, A. Doroszewski, *Produkcja roślinna w Polsce na tle warunków przyrodniczych i ekonomiczno-organizacyjnych*, „Studia i Raporty IUNG-PIB" 2009 z. 14, p. 27-54.
[9] Wskaźnik stanowił średnią arytmetyczną wartość wskaźników oszacowanych przez: D.H. McCartney, H.C. Block, P.L. Dubeski, A.J. Ohama, *Review: The composition and availability of straw and Schaff from smallgrain cereals for beef cattle in western Canada*, „Canadian Journal of Animal Science" 2006 no. 86(4), p. 443-455; W. Denisiuk, *Słoma – potencjał masy i energii*, „Inżynieria Rolnicza" 2008 no. 2(100), p. 23-30.
[10] H. Czyż, E. Niedźwiecki, M. Trzaskoś, *Charakterystyka czynników siedlisk łąkowych*, in: M. Rogalski (ed.), Łąkarstwo, Poznań 2004, p. 13-21; p. Bródka, A. Macias, *Kryteria i metody waloryzacji zasobów przyrodniczych*, in: S. Bródka (ed.), *Praktyczne aspekty ocen środowiska przyrodniczego*, Poznań 2010.

constructed. The construction of indices based on the percentage shares of respondents' answers (Rs), which assigned recreational and aesthetic attractiveness ranks to the individual types of the land cover, the land cover structure and the relief (equation 1).

$$WAR/WAE_{LULC/M/R} = Rs_a + Rs_b/2 \quad (1)$$

Explanation:
Rs_a – the (%) share of responses assigning the highest rank of recreational/aesthetic attractiveness to a given feature.
Rs_b – the (%) share of responses assigning the medium rank of recreational/aesthetic attractiveness to a given feature. explanation

The indices can be interpreted as a reflection of the social value of cultural services assigned by the commune inhabitants to a given type of land cover or relief (lie-of-the-land). They assume values from the range of 0 – 100 points, taking into account the fact that it is very unlikely to obtain extreme values for a research group consisting of a large number of respondents. The subjectivity of the individual assessment of the ES value was limited owing to the inclusion of information from a large group of randomly selected respondents characterised by diverse socioeconomic features and preferences as regards the perception of physiognomic features of the natural environment and rest in open areas. The representativeness of the results is limited to the area inhabited by the population, from which the research group was selected and to populations similar to the research group[11].

The assessment of the influence of the data analysis scale on the estimated size of services

The influence of the scale of the spatial data used on the estimated size of selected ES was tested by means of an experiment involving a comparison of the estimated ES values in areas randomly selected for analysis in the research area. They consisted of circular areas randomly covering fragments of the Krajenka Commune. The surface area of each testing ground was 3.14 ha (r=100 m). 365 research areas were selected for provisioning services and 332 areas were selected for cultural services.

[11] The description of the pilot studies and main surveys, including the structure of the questionnaire, the adopted methodological assumptions and description of respondents are presented in more detail in the following publications: P. Lupa, *Wartość rekreacyjna zbiorników wodnych w koncepcji świadczeń ekosystemów*, in: T. Wiskulski, M. Pilarski (eds.), *Współczesne zagadnienia, problemy i wyzwania w badaniach geograficznych*, v. 1, Gdańsk 2013, p. 41-54; P. Lupa, *Ecosystems' local recreational services valuation. Krajenka municipality case study*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 209-222.

Non-parametric tests were used in the statistical analysis of significance of differences in the estimated ES: the Kruskal–Wallis one-way analysis of variance and the Mann–Whitney U-test[12]. This allowed to verify two research hypotheses:

- H_0: no significant differences in the value of services between individual data accuracy groups (zero hypothesis),
- H_1: a significant difference between at least two data accuracy groups (alternative hypothesis).

The α=0.05 statistical significance level was adopted, which means that the probability of committing an error during the verification of hypotheses was not higher than 5%. When the probability of error was higher than the α level, it was concluded that there were no grounds for rejecting the zero hypothesis. Likewise, when the value was lower than the adopted statistical level α, it was concluded that there were grounds for rejecting the zero hypothesis and the alternative hypothesis was adopted.

Research results

Provisioning services

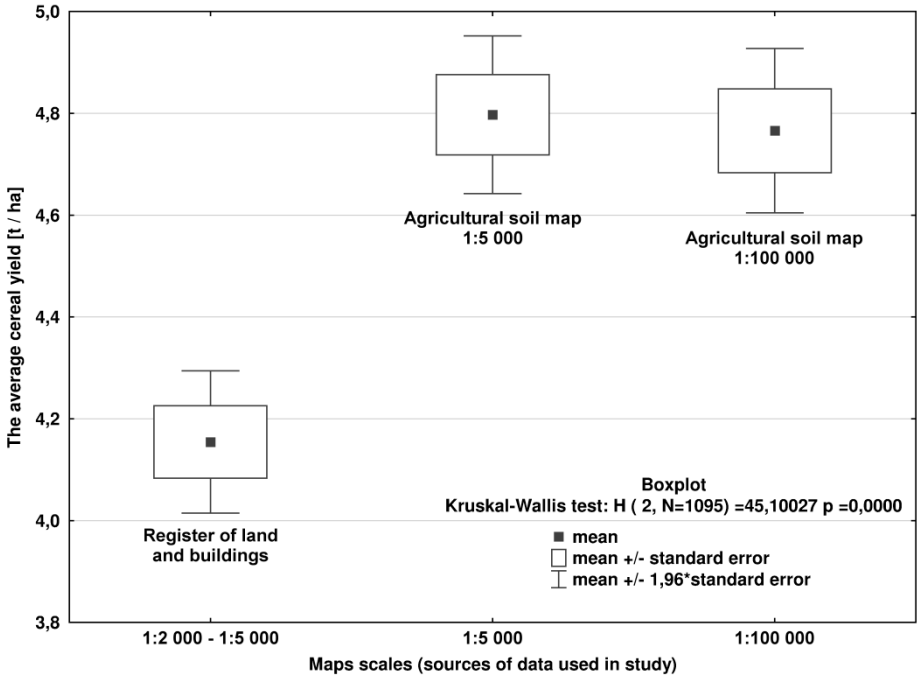
Estimated values of provisional services were assigned to individual soil fertility (quality) classes in agricultural ecosystems. The total crop production level was determined as 2.7 times higher on top-quality arable lands than on the least fertile lands. The differences between the best and poorest grassland complexes as regards provisioning services were 3.3 times higher, i.e. greater than for arable land.

The estimation of biomass production based on spatial structure of soil quality, which has been calculated at the varied detail of spatial data. It amounted to 4.15 t/ha/year (1,894 PLN/ha/year), when data from Land and Building Registers were used, while for data from agricultural soil maps, these values ranged from 4.77–4.80 t/ha/year (PLN 2,173–2,187 ha/year). The results obtained were 7 – 8% lower than average values calculated for agricultural ecosystems in the entire commune, which indicates a good representativeness level of the research sample.

Using the Kruskal–Wallis one-way analysis of variance, it was found that the difference between results obtained from data from various sources were statistically significant. The degree of generalisation of agricultural soil maps did not influence the result, which confirms the high quality of the generalisation procedure of these maps (Figure 1).

[12] A. Stanisz, *Przystępny kurs statystyki w oparciu o program STATISTICA PL na przykładach z medycyny*, Kraków 1998; A. Stanisz, *Podstawy statystyki dla prowadzących badania naukowe. Odcinek 6: ABC weryfikacji hipotez*, 2000, www.mp.pl [20-09-2014].

Figure 1
Graphic interpretation of statistical differences of biomass productivity levels depending on data sources used in study (maps scales)



Source: own study.

Cultural services

According to the survey results, forest and woodlots are the most highly valued areas for rest and recreation as well as surface waters in the research areas, for which the WAR index exceeds 70 points per maximum of 100 points (see equation 1). These values are twice as high as in developed areas, which are considered to be the least attractive (Table 1). The intermediate level of attractiveness was assigned to arable lands and grasslands.

The value of the average weighted index of recreational attractiveness of the land cover WAR for measurement areas calculated on the basis of data from Land and Building Registers was 61.78 points and it was almost identical with values obtained from data from the other sources. The spread of the results was only 0.92 points[13]. Thus, in this case, the degree of detail of individual input data did

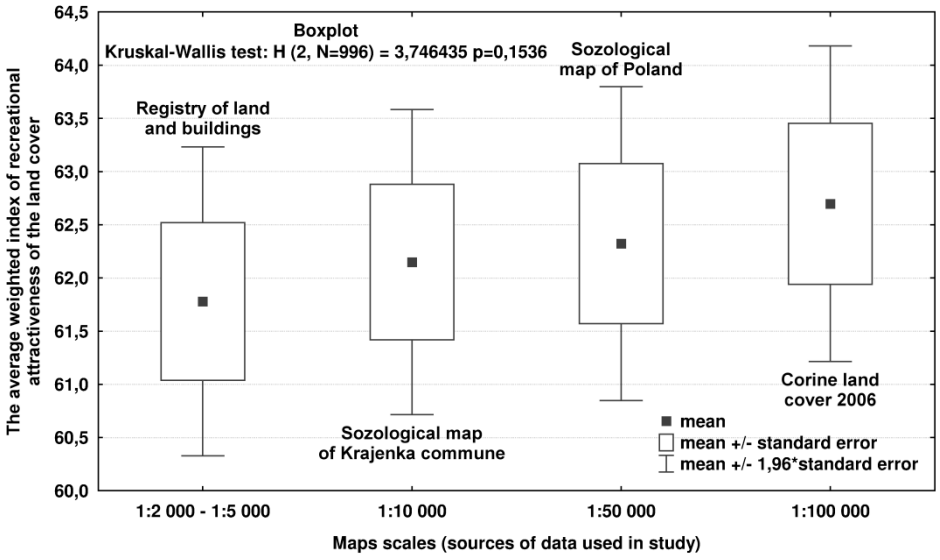
[13] The results of calculations for testing areas were by 0,5-1,6% higher than values of the index calculated for the entire commune, which indicates a very good degree of representativeness of the research sample.

Table 1
Valuation of recreational services in Krajenka Commune

No.	Basic types of land use / land cover (LULC)	Level of recreational attractiveness [% of answers, n=198]			WAR
		low	average	high	
1.	Forests and woodlots	6	35	59	76,3
2.	Surface waters	9	36	55	73,2
3.	Urban green	24	46	30	52,8
4.	Farmlands (arable lands)	28	49	23	47,5
5.	Meadows (grasslands)	22	64	14	45,7
6.	Built-up areas	35	56	9	37,1

Source: own study.

Figure 2
Graphic interpretation of statistical differences of WAR values depending on data sources used in study (maps scales)

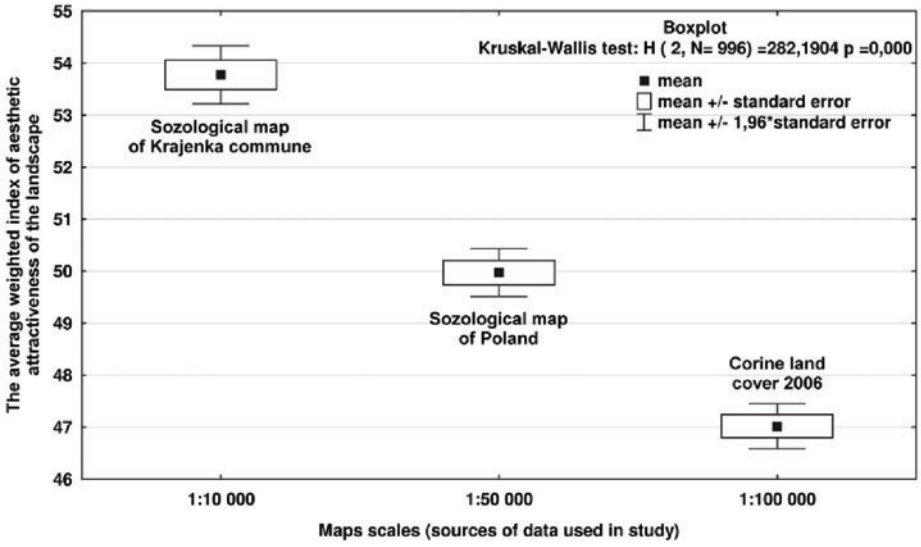


Source: own study.

not influence the quantification result. Despite a trend visible in the graphic representation (Figure 2), the differences turn out to be statistically insignificant.

As regards the landscape aesthetic attractiveness index WAE calculated for measurement areas, it was found that there was a statistically significant relationship between the degree of generalisation of the spatial data and the size of

Figure 3
Graphic interpretation of statistical differences of WAE values depending on data sources used in study (maps scales)



Source: own study.

the average weighted index (Figure 3). The level of this index grows together with a growing degree of detail of the spatial data source.

The index had the lowest value (47.02 points) when data from the Corine land cover 2006 database where used and its value was the highest (53.77 points) when data from the Sozological map of Krajenka Commune were used. It should be noticed that the results of research obtained for the testing areas differed only by 0.1–0.4% from the values calculated for the entire commune.

An additional study was performed as regards aesthetic services, which specifically considered the influence of the degree of detail on three measures of aesthetic value: land cover type (LULC), land cover structure (M) and relief (R).

Forests and surface waters were characterised by the highest value of aesthetic services among the tested land cover types, measured by the value of the WAE_{LULC} index. Considering the forest division according to the share of deciduous and coniferous trees, mixed forests were regarded as the most interesting, as followed by deciduous forests and coniferous forests. A significantly lower value of aesthetic services was estimated for dispersed habitation areas, next for meadows and farmlands. WAE_{LULC} adopted values ranging from 45.2 points for dense developments to 74.9 points for mixed forests (Table 2).

Depending on the degree of detail of the input data used, the value of the average weighted land cover attractiveness index WAE_{LULC} within the measurement areas was estimated at a level ranging from 58.86 to 59.67 points. Such low dif-

Table 2
Results of aesthetic services valuation (WAE_{LULC}, WAE_M, WAE_R values)

No.	Landscape features	Level of aesthetic attractiveness [% of answers, n=187]			Indicator
		low	average	high	
Land use / land cover types (LULC)					WAE_{LULC}
1.	Mixed forests	56	37	6	74,9
2.	Deciduous forests	53	39	7	73,0
3.	Surface waters	54	35	11	71,4
4.	Coniferous forests	45	44	11	67,1
5.	Dispersed habitation areas	25	52	22	51,3
6.	Meadows (grasslands)	19	61	20	49,7
7.	Farmlands	24	49	27	48,7
8.	Densely built-up areas	20	50	30	45,2
Land cover structure					WAE_M
9.	Areas with a mosaic land cover structure	45	42	13	66,3
10.	Areas with monotonous land cover structure	8	58	34	37,2
Relief					WAE_R
11.	Areas with diverse relief (river valleys, hills, etc.)	57	31	12	72,2
12.	Areas with monotonous relief (flat areas)	14	55	31	41,4

Source: own study.

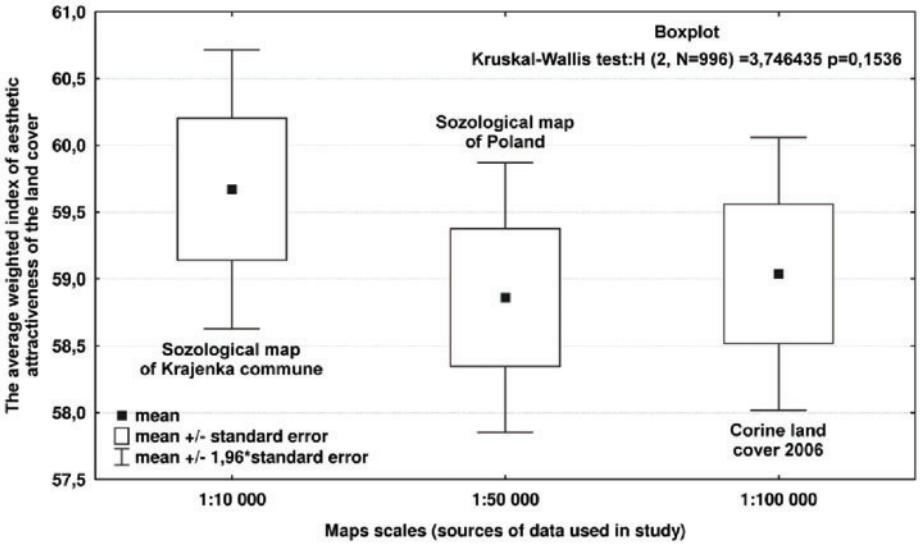
ferentiation in the value of this index shows that there is no significant influence of the type of the spatial data used. This conclusion is confirmed by the results of the Kruskal–Wallis one-way analysis of variance.

Areas with a mosaic land cover structure were characterised by high aesthetic attractiveness in the commune (WAE_M = 66.3), (Table 2), while areas with monotonous land cover diversity were the least interesting (WAE_M = 37.2). Considering three different sources of spatial data used during the quantification, the average weighted index of aesthetic attractiveness of the land cover structure assumed values ranging from 40.34 to 57.91 points for the measurement areas[14].

The conducted statistical analysis confirmed the occurrence of significant differences between values WAE_M calculated using input data with a different degree of generalisation (Figure 5). The research proved that the estimated level of the value resulting from the land cover structure decreases together with an increase in the degree of the input data generalization used for quantification.

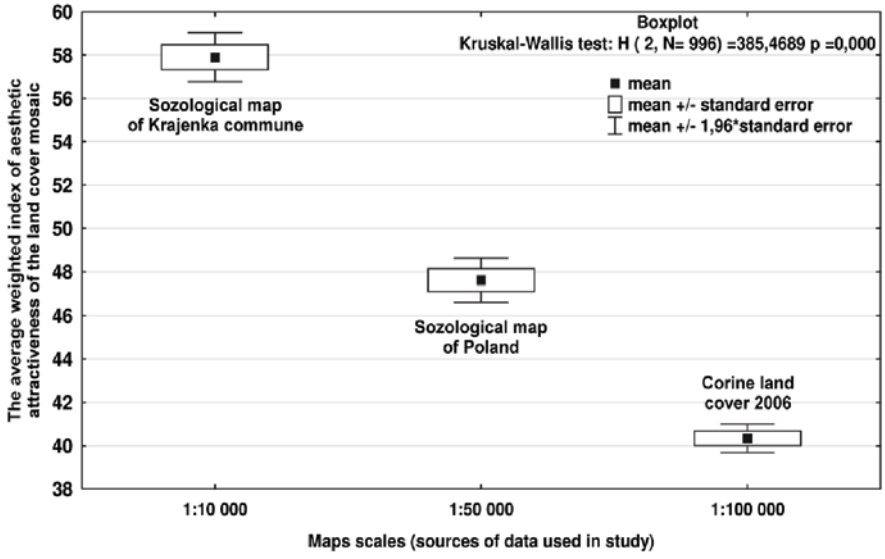
[14] The results of calculations for testing areas were by 0,4-1,7% lower than values of the index calculated for the entire commune, which indicates a very good degree of representativeness of the research sample.

Figure 4
Graphic interpretation of statistical differences of WAE_{LULC} values (land cover types) depending on data sources used in study



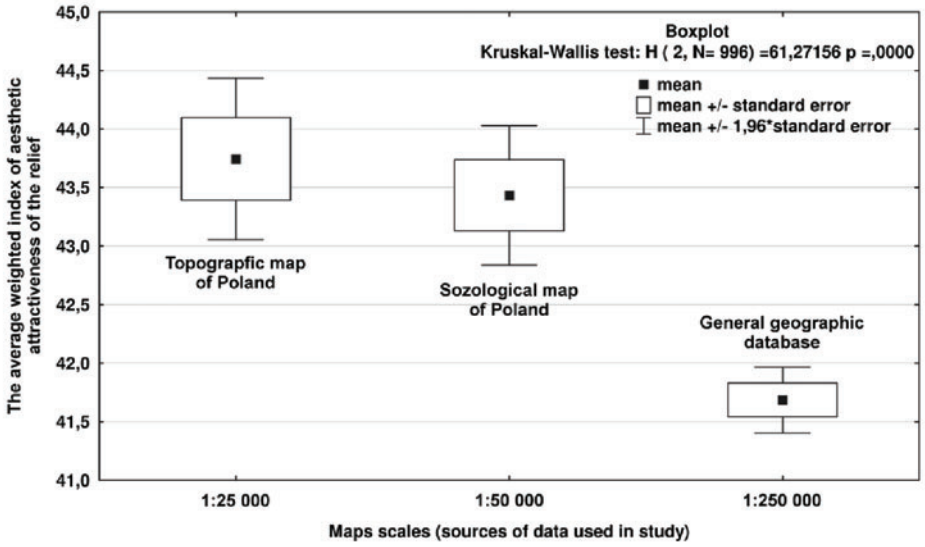
Source: own study.

Figure 5
Graphic interpretation of statistical differences of WAE_M values (land cover structure) depending on data sources used in study (maps scales)



Source: own study.

Figure 6
Graphic interpretation of statistical differences of WAE_R values (relief) depending on data sources used in study



Source: own study.

In the respondents' opinion, areas with diverse relief (borderline areas of river valleys and lake troughs, hilly areas with considerable height difference and high and varied slope) were by far more visually attractive than vast flat areas with monotonous lie-of-the-land and small height difference (e.g. outwash plains, strips of flat ground moraine). The WAER value was estimated at levels ranging from nearly 41.5 points for areas with monotonous lie-of-the-land to 72.2 points for areas with diverse relief. The average weighted index of the aesthetic attractiveness of the relief for the areas under analysis (WAE_R) assumed values ranging from 41.69 to 43.75 points, depending on the source of spatial data from which information about the elevation diversity of the area is obtained. These values differed only by 0.2–0.6% from the values of the index calculated for the entire commune, which confirms the representativeness of the tested sample.

Statistical analysis confirmed the existence of significant differences between WAE_R values calculated in accordance with the General geographic database at a scale of 1:250 000 (Figure 6), and a lack of such differences between the levels of such an index calculated from a topographic map at a scale of 1:25 000 and the thematic map at a scale of 1:50 000. The obtained result can be considered as approximate to the young glacial lowlands. Obviously the more intense relief needs for a more detailed scale of spatial data.

Conclusions

The results obtained can be assigned to the trend of methodological studies related to ES quantification. In the literature devoted to this area, a relationship is noticed between the obtained results of quantification and the degree of generalisation of the input data and the spatial scale at which a given service is considered (cf. K. M. Konarska et al. 2002[15], M. Kandziora et al. 2002[16], L. Hein et al. 2006[17], B. Marion-Lopez et al. 2009[18], Y. Zhang et al. 2013[19]). Against this background, this study analyses a specific set of ecosystem services on a local scale. The results obtained did not confirm previous findings (K. M. Konarska, op. cit.), which showed that an increase in the degree of detail of spatial data led to an increase of the size of the estimated services by several times. For provisioning services, results with the opposite trend were obtained as data with a higher degree of detail from cadastral maps resulted in a nearly 20% decrease in the estimated values of services than those obtained from less detailed agricultural soil maps. The results presented also make it possible to conclude that correctly generalised maps prepared on the same basis of empirical research do not cause differences in the values of the calculated provisioning services.

The results obtained for cultural services also show a diversified situation. The estimated level of recreational services did not show statistically significant different conditions by the degree of detail of the spatial data. Significant differences occurred, on the other hand, for aesthetic services, for which the calculated values were higher for more detailed sources of spatial data.

In general, it can be concluded that the diversity of the size of the spatial data should be considered critically in the light of the assessment of the source data used. It is of lesser importance for comparative studies when homogeneous databases are used. Assuming a similar systematic error, registered differences are not encumbered with this error. Particular care must be exercised while interpreting the absolute values and while comparing the results obtained on the basis of data from various sources.

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Anna Bartczak • Tomasz Żylicz

WILLINGNESS TO PAY FOR FOREST CLEANING IN POLAND. RESULTS FROM A CONTINGENT VALUATION SURVEY

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GOTOWOŚĆ DO PŁACENIA ZA SPRZĄTANIE LASÓW W POLSCE. WYNIKI BADANIA WYCENY WARUNKOWEJ

STRESZCZENIE: Rekreacja należy do najważniejszych usług ekosystemowych lasów przynoszących znaczące korzyści dla społeczeństwa. W artykule tym skupiamy się na problemie zaśmiecenia, jako czynniku obniżającym jakość wizyt w lasach. Przy zastosowaniu metody wyceny opartej na preferencjach zadeklarowanych obliczamy gotowość do płacenia (z ang. *Willigness To Pay* – WTP) za zmniejszenie tego problemu. W tym celu przeprowadziliśmy badanie ankietowe na dużej próbie osób odwiedzających lasy. Badanie odbyło się w terenie, respondentami były osoby odwiedzające poszczególne lasy. Wybraliśmy pięć lasów znajdujących się w sąsiedztwie średniej wielkości aglomeracji miejskich. Respondenci zostali poproszeni o odpowiedzi na pytania otwarte dotyczące ich WTP za zmniejszenie zanieczyszczenia w lesie. Zastosowano dwa takie pytania: pierwsze odnosiło się do zmniejszenia zaśmiecenia w odwiedzanym przez respondenta lesie, drugie zaś dotyczyło zmniejszenia zaśmiecenia lasów w całym województwie. W pierwszym przypadku gotowość do zapłaty oszacowano na 27 PLN (6.75 €), w drugim zaś na 36 PLN (9.00 €) w postaci wzrostu rocznych lokalnych podatków. W analizie wykorzystano model regresji interwałowej. Otrzymane wyniki zostały omówione w kontekście innych badań dotyczących rekreacji i zaśmiecenia w Polsce

SŁOWA KLUCZOWE: usługi ekosystemowe, zaśmiecenie lasu, rekreacja w lasach, wycena nierynkowa, preferencje zadeklarowane

Introduction

Visiting forests and related recreation activities play an important role in Poland's consumer surplus. The recreation value of Polish forests was estimated several times using Travel Cost and other methods. Some of these studies were focused on the Bialowieza Primeval Forest.[1] One of them – based on ten different study areas – demonstrated that the value of forest recreation on a per hectare and on a per visit basis is much higher in Poland than in other European countries.[2] Contrary to earlier hypotheses[3], it revealed that people's Willingness To Pay (WTP) for forest recreation is higher than in Western Europe.

While the high value attached to forest recreation in Poland may result from some country-specific characteristics, an interesting question is to what extent this value relates to forest-specific features. Using Choice Experiments, one recent study[4] linked people's WTP to such site-specific – mainly biological – features as species composition, age, tree-stand density and so on.

This study focuses on littering which is an important aspect of a 'non-biological' feature of a forest. Littering has emerged as one of the most visible disamenities observed by forest visitors. At the same time, it is likely to be even more important in the future, since the government of Poland introduced new household waste legislation. According to its proponents, local authorities will be more effective at channelling waste flows into legal procedures. However, according to the opponents, the new legislation will result in an even stronger tendency for 'midnight dumping' and thus even more littered forests.

Forest littering in Poland includes not only plastic bags and napkins, but all types of beverage containers, furniture, refrigerators, car tyres, and even car bodies. Forest littering has attracted the attention of researchers at least since the 1970s[5]. There have been analyses of organic littering and its impact on ecosystem services[6]. There have also been studies of people's preferences with respect to plastic bag littering[7] (e.g. Convery et al. 2007). Nevertheless, up to the best of our knowledge, there have been no systematic analyses of people's preferences with respect to forest littering. The Polish study attempts to address this problem by using mainly stated preference methods.

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[1] See e.g.: M. Czajkowski, M. Buszko-Briggs, N. Hanley, *Valuing changes in forest biodiversity,* "Ecological Economics" 2009 no. 68(12), p. 2910-2917.

[2] A. Bartczak et al., *Valuing forest recreation on the national level in a transition economy: The case of Poland*, "Forest Policy and Economics" 2008 no. 10(7-8), p. 467-472.

[3] *European Forest Sector Outlook Study 1960 – 2000 – 2020*, Main report, Geneva 2005.

[4] T. Żylicz, M. Giergiczny, *Wycena pozaprodukcyjnych funkcji lasu,* Raport końcowy dla Generalnej Dyrekcji Lasów Państwowych, Warszawa 2014.

[5] See e.g.: S. L. Crump, D. L. Nunes, E. K. Crossman, *The Effects of Litter on Littering Behavior in a Forest Environment*, "Environment and Behavior" 1977 no. 9(1), p. 137-146.

[6] For a summary see: K. Thompson, *Life after death: the role of litter in ecosystems*, "Functional Ecology" 2011, www.functionalecology.org [20-09-2014].

[7] See e.g.: F. Convery, S. McDonnell, S. Ferreira, *The most popular tax in Europe? Lessons from the Irish plastic bags levy*, "Environmental and Resource Economics" 2007 no. 38(1), p. 1-11.

Survey design and data

In July 2009 focus group meetings were conducted at the University of Warsaw in order to determine patterns of forest visitations, as well as specific reasons for choosing alternative locations. There were four such meetings each involving four subjects. This exercise convinced us that there were basically two key characteristics letting Poles choose among alternative forest locations. As anticipated by economic theory, distance emerged as the most important single attribute of a forest considered. In addition, focus groups demonstrated that littering was the second most important forest attribute considered by prospective visitors. This prompted us to design a survey to calculate WTP for reduced forest littering.

Carried out by a professional polling agency in October-November 2009, the survey included 709 respondents met in five forest locations in Poland. The five forests can be considered representative for different habitats and neighbourhoods. They are located in the vicinity of towns serving as regional administrative capitals. There are 16 such units in Poland. The regions vary with respect to the average forestation rate, species composition, and protection regime. Table 1 summarizes geographical and conservation characteristics of these sites.

Lasy Kozlowieckie (near Lublin) serve as an example of a forest in a mainly agricultural region where urban population has relatively low opportunities to select a place to visit. At the other extreme, visitors in Lasy Zielonogorskie (near Zielona Gora) have such opportunities available in abundant supply. Many forested areas subject to a particular tourist pressure are protected as 'Landscape Park' (a protection regime lower than that of a 'National Park'). However, one of the sites selected (Lasy Zielonogorskie) does not enjoy any specific protection regime.

Table 1
Characteristics of the forest sites

	Site	Protection regime	Forest type	Dom. species	Town (inhabitants)	Regional forest rate [%]
1	Puszcza Supraska	Landscape park	Conifer.	Pine, Spruce	Bialystok (294,000)	33
2	Lasy Kozlowieckie	Landscape park	Mixed	Oak, Pine	Lublin (352,000)	14
3	Puszcza Kozienicka	Landscape park	Mixed	Oak, Pine	Radom (225,000)	25
4	Puszcza Bukowa	Landscape park	Broad-leaf.	Beech	Szczecin (408,000)	32
5	Lasy Zielonogorskie	none	Conifer.	Pine	Zielona Gora (118,000)	49

Source: own elaboration.

Forest visitors were randomly polled along main paths, picnic areas and parking places during the day time and all days of the week. The target group was limited to adults only who came to the forest for recreation purposes. The questionnaire, which was tested in a pilot version by interviewing 50 respondents and evaluated by forest experts, consisted of two main components with the first one aimed at revealing forest visit patterns and the second part aimed at soliciting peoples' willingness to pay for reducing forest littering. The analysis presented in this paper is based on this second – Contingent Valuation (CV) – part. The scenario in the CV part referred to prevention, as well as to clean-up, since prevention can never be fully effective. Specific wording used was as follows.

"Our programme of keeping the forests tidy envisages hiring workers who remove the litter as well as those who try to prevent illegal dumping. In addition, it requires investing in equipment, such as e.g. nice looking garbage bins located by the forest entrances/exits. The cost of the programme will be partially financed by the fines imposed on those convicted of littering. Nevertheless the programme requires additional local taxes. The central government budget cannot be relied on in this case. The increased local tax revenues will go to the district forest management units ('nadlesnictwa') and they will be earmarked for clean-up activities. The programme will be monitored by external specialists. Its effects – i.e. the litter-free forest – will be visible in several months. However, in order to maintain these effects, the programme should be financed on a permanent basis."

There were two WTP questions asked. One referred to the programme of reduced littering in the forest visited, and the second one to a wider programme of reduced forest littering in the entire administrative region. The elicitation format was a payment ladder with zero and 14 positive bids, selected along an exponential scale. Respondent could also choose the option 'It is hard to say'. The payment mechanism was described as the annual tax paid lifetime. A series of debriefing questions was used in order to identify protest responses.

The model

Since the WTP question referred to respondent's maximum Willingness To Pay identified on a payment ladder, we used interval regression model (with 0 as the lower bound for the lowest interval and BID+1 as the upper bound for the highest interval).

The model can be written as:

$$y^* = x\beta + \varepsilon,\ \varepsilon \sim N[0, \sigma^2]$$

$$y = j \text{ if } A(j) \leq y^* \leq A(j+1) \text{ and } j = 0, 1, 2, \ldots \quad (1)$$

where y – indicates the WTP, x – the vector of explanatory variables, β – parameters, A – the number of bid on the payment ladder, ε – the error term normally distributed.

In this case, the loglikelihood function is given by:

$$\ln L = \sum_{i=1}^{N} ln\left[\Phi\left(\frac{UB_i - x\beta}{\sigma}\right) - \Phi\left(\frac{LB_i - x\beta}{\sigma}\right)\right] \quad (2)$$

where Φ is the normal cumulative distribution function, LB_i and UB_i denote, respectively, the lower and the upper bounds of the individual *i*'s WTP interval.

However, as noted by Cameron and Huppert[8] (1989), using mid-points as proxies for the dependent variable in the standard OLS procedure produces biased results. The raw estimates were thus log-transformed in order to account for the naturally skewed distribution (Cameron and Huppert 1989, Lindhjem and Navrud 2011, Ahtiainen et al. 2012)[9]. Thus our mean WTP can be estimated as:

$$E(WTP)=\exp(x\beta+\sigma^2/2) \quad (3)$$

Table 2

Explanatory variables used in the interval regression model

Acronym	Description
GEN	Gender, dummy variable 1 for males
EDP	Education, dummy variable 1 for primary education
EDH	Education, dummy variable 1 for higher education
AGE	Age continuous variable (years)
INC	Net monthly income, continuous variable (in 100 PLN)
Δ+I	Future income, dummy variable 1 for income perceived as growing over the last 5 years
Δ-I	Future income, dummy variable 1 for income perceived as declining over the last 5 years
Δ?I	Future income, dummy variable 1 for respondents who were uncertain about their incomes over the last 5 years
VIS	Number of visits in a forest over the last 12 months, continuous variable
LIT	Littering, dummy variable 1 if respondent spotted an illegal dumping site in the forest
BIA	Białystok, dummy variable 1 for respondents interviewed in Puszcza Supraska
LUB	Lublin, dummy variable 1 for respondents interviewed in Lasy Kozlowieckie
RAD	Radom, dummy variable 1 for respondents interviewed in Puszcza Kozienicka
SZC	Szczecin, dummy variable 1 for respondents interviewed in Puszcza Bukowa
POP	Population of the neighbouring town (in thousands of inhabitants) continuous variable

Source: own elaboration.

[8] T.A. Cameron, D.D. Huppert, *Ols versus Ml estimation of non-market resource values with payment card interval data,* "Journal of Environmental Economics and Management" 1989 no. 17(3), p. 230-246.

[9] See e.g.: Ibidem; H. Lindhjem, S. Navrud, *Are Internet surveys an alternative to face-to-face interviews in contingent valuation?* "Ecological Economics" 2011 no. 70(9), p. 1628-1637; H. Ahtiainen, et al., *Benefits of meeting nutrient reduction targets for the Baltic Sea – a contingent valuation study in the nine coastal states*, "Journal of Environmental Economics and Policy" 2014 no. 3(3), p. 278-30.

In order to explain WTP choices in terms of respondent and site characteristics we applied the explanatory variables described in Table 2.

Results

Respondents' perception of the scenario was fairly positive. Likert-like scale (1 – negative, 2 – neither negative nor positive, 3 – slightly positive, 4 – rather positive, 5 – definitely positive) was used. Percentage of respondents who chose 5 to describe their attitude towards the programme of reduced littering in the forest they visit was 27%; percentage of those who chose 5 for the programme of reduced littering in all the forests in the region was even higher: 46%. In both cases there was an option 'no opinion'. Only 4%-5% chose this option.

Respondents were also asked about reasons for visiting this particular forest. As anticipated, little littering ranked high on the list. As much as 27% of respondents indicated that littering was decisive when they selected a forest to visit. The shares of those who pointed at biodiversity and tourist infrastructure were somewhat higher – 35%.

Several questions addressed littering. 42% of respondents admitted spotting some litter such as plastic bags, cans or pieces of paper. 9% characterized the forest as 'excessively littered'. 29% saw illegal dumping sites. 20% declared that they would visit the forest more frequently, if it was less littered. Most of them declared at least a 50% increase of their visitation rate.

Table 3 shows the Willingness To Pay results for those respondents whose WTP declarations were positive (81% of respondents stated that they were willing to pay to reduce littering in the forest visited and 83% declared they would like to pay for cleaning all the forests in their administrative regions). To estimate the mean WTP the interval regression was run without covariates and bootstrapped using 500 repetitions to obtain 95% confidence intervals. The protesters (8% of the sample) were excluded from the analysis. We identified them using the following responses to debriefing statements: 'Strongly disagree' with the statement 'The program can be implemented within a few years'; and 'Strongly disagree' with the statement 'The money collected would indeed be used in an efficient way to clean up the forest'.

Table 4 presents our interval regression models (I for the visited site, and II for all the forests in the administrative region) investigating determinants for WTP in order to reduce littering in forests. The dependent variable is WTP identified through the payment ladder. As explained in Section 3 above, explanatory variables are gender, age, education, net income, prediction of income change over the next 5 years, number of forest visits, spotting by the respondent an illegal dumping site in the visited forest, size of the neighbouring town and dummies for the forest sites analyzed.

An important result of both estimations is the statistically significant (positive) value of β_{LIT}, i.e. the parameter of the dummy variable LIT recording the fact

Table 3
WTP for reduced forest littering [PLN]

Category	Mean WTP	Standard Error	95% Conf. Interval
Single (visited) forest	27.45	1.76	24.00 – 30.90
All forests in administrative region	35.61	2.44	30.83 – 40.40

Source: own elaboration.

Table 4
Results of the interval regression models

Category	Model I WTP for clean-up of this forest		Model II WTP for clean-up of all the forests in the region	
	Coefficient (β)	Robust standard error	Coefficient (β)	Robust standard error
GEN	-5.61	5.27	-6.39	6.65
EDP	0.02	0.13	**-0.29***	0.18
EDH	-2.68	5.30	-12.17	8.66
AGE	5.07	5.43	-7.86	6.84
INC	**0.45****	0.23	**0.57***	0.31
Δ+I	10.87	7.40	**14.38***	8.76
Δ-I	-17.13	18.70	-16.43	21.93
Δ?I	-1.46	4.98	-2.26	6.25
VIS	**0.13*****	0.04	**0.18*****	0.05
LIT	**14.57*****	5.05	**20.67*****	7.76
BIA	**-27.41****	11.63	**-39.29*****	13.05
LUB	-0.83	9.63	9.54	10.46
RAD	**-22.99****	10.19	**-27.31****	10.72
SZC	**-28.06****	13.83	**-26.20***	14.17
POP	**0.04*****	0.02	**0.04****	0.02
Constant	18.45	13.48	36.33**	17.85
Log-pseudolikelihood	-1619.23		-1682.93	
Chi2 (df)	48.74(15)***		76.87(15)***	
Pseudo-R2	9%		12%	
Number of observations	573		621	

*,**,*** significance at 0.1, 0.05 and 0.01 levels, respectively. In our analysis we excluded protesters, those respondents who did not declare their income, and those who were uncertain about their WTP.

Source: own elaboration.

that respondent had a recent experience of forest littering. It suggests that littering is indeed perceived as a disamenity which can be mitigated effectively.

Discussion

WTP estimates indicate that people are willing to pay for reduced forest littering, although the amount depends on many factors. First, and perhaps most important is its positive and significant correlation with the number of visits. Respondents understand that the use value derived from their multiple visits will be enhanced if the litter reduction programme is implemented. Additionally, WTP declarations differ widely between sites. Lasy Zielonogorskie hosts respondents who stated highest bids; the other four sites were characterized by lower bids. This could have been influenced by extremely high bids declared by few respondents interviewed; nevertheless we did not decide to exclude these observations as they were below the peak of the ladder (the top numbers were not declared by anybody). Some of the socio-economic characteristics – like income and age – are taken care by variables listed in section 3 above. The geographical characteristics is captured by the variable POP explaining the intensity of recreational demand. As anticipated, it is positive and significant. However, there may be a number of other important factors contained in site-specific dummies. The data gathered do not allow for more specific interpretations.

We confronted the WTP data with additional observations on the forest-littering problem. Two supplementary qualitative (in-depth) surveys were carried out: one with local officials, and another one with forest managers. The first one included 25 respondents. Most of them (61%) admitted that their municipalities suffered from forest littering. On the other hand, a much smaller fraction (38%) admitted that their municipality had an illegal dumping site. It seems that some of the officials refuse to acknowledge that they fail to manage the household waste in their jurisdictions. The second one included 38 respondents. All of them (100%) admitted that their forests were littered. Most of them (87%) admitted there were illegal dumping sites in forests. These two problems dominated over all the other ones listed, like stealing timber, excessive populations of some herbivores, poaching, and loss of flora and fauna. It seems that foresters are fully aware of the forest littering problem.

As revealed in another study[10], littering turned out to be the most important single factor explaining attitudes towards forests. Respondents in that study were concerned with the problem mainly because forest littering compromised their consumer surplus from forest recreation. In a Choice Experiment, the implicit price calculated for the attribute '50% reduction in forest littering' ranged from 4.97 € for non-users to 7.97 € for users, and for the attribute '90% reduc-

[10] M. Czajkowski et al., *Providing Preference-Based Support for Forest Ecosystem Service Management in Poland*, "Forest Policy and Economics" 2014 no. 39, p. 1-12.

tion in forest littering' ranged from 5.34 € for non-users to 11.76 € for users. These results are somewhat higher than calculated in this study, but they refer to a national scenario rather than a local one.

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ENVIRONMENTAL COSTS FOR EXPLOITATION VARIANTS OF RACIBÓRZ DRY POLDER

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KOSZTY ŚRODOWISKOWE WARIANTÓW EKSPLOATACJI POLDERU RACIBÓRZ

STRESZCZENIE: Celem badań była wycena kosztów środowiskowych związanych z różnymi wariantami eksploatacji polderu Racibórz Dolny na Odrze. Dla czterech wariantów odpływu wody z polderu (woda 2-letnia, 5-letnia, 10-letnia i 20-letnia) określono powierzchnię zagrożonych obszarów Natura 2000 i innych ekosystemów. Wycena metodą wskaźnikową wykazała znaczną przewagę wariantu III z najsłabszą ochroną przeciwpowodziową (zatrzymywanie wody 20-letniej lub większej). Wariant ten zagrozi tylko 2% powierzchni siedlisk Natura 2000 w dole rzeki i nie zaszkodzi lasom w czaszy polderu, generując 37 razy mniejsze koszty środowiskowe niż wariant I.

SŁOWA KLUCZOWE: świadczenia ekosystemów, koszty środowiskowe, wycena środowiska, polder Racibórz, Natura 2000

Introduction

Natural river valleys are valuable habitats and supply ecological services. Construction of dam and outflow control can significantly change hydrographic conditions downstream. Modern investments in water management should balance flood control of population and protection of wetlands. Dry polders are areas for temporal water retention in case of bigger river flows. They are alternative for construction of conventional water reservoirs with permanent pool.

Racibórz dry polder is one of rare large investments in contemporary water management in Poland. Serious plans of construction were undertaken after catastrophic flood on Oder river in 1997. Feasibility study[1] from 2003 proposed destined construction of water reservoir. In 2005 first environmental impact assessment (EIA) report[2] was prepared for investment. This report was rejected next year by Polish Ministry of Environment, because report not showed impact of investment on Natura 2000 areas in Oder valley downstream dam. Such assessment was included in EIA for „Project of flood control for Oder valley"[3] which covered also construction of Racibórz dam.

New EIA report[4] prepared in 2009 assumed construction of dry polder instead of water reservoir. This report was completed in 2011 and environmental approval was valid in next year. Construction of dry polder started in 2013 and is planned to finish in 2017.

Exploitation variants of Racibórz dry polder

Decrease of frequency of wetlands flooding downstream dam could be main danger for nature associated with exploitation of water reservoir in Racibórz. According to results of simulations for flood wave with probability of occurrence once a 10 years, water level in Oder could drop by 1.0-2.5 m on distance 150 km down Racibórz.

Regular flooding is important for conservation and longevity of different terrestrial and water ecosystems. Especially habitats located above river are exposed to flow limitation. Willow-poplar riparian forests are substituted by

[1] *Studium wykonalności zbiornika Racibórz Dolny na rzece Odrze. Raport główny*, Warszawa 2003.
[2] *Zbiornik przeciwpowodziowy Racibórz Dolny. Raport o oddziaływaniu inwestycji na środowisko*, Warszawa 2005.
[3] *Projekt ochrony przeciwpowodziowej doliny Odry. Ocena oddziaływania na środowisko. Streszczenie*, Warszawa-Gliwice-Wrocław 2005.
[4] *Raport o oddziaływaniu na środowisko przedsięwzięcia polegającego na budowie zbiornika przeciwpowodziowego Racibórz Dolny na rzece Odrze woj. śląskie – polder*, Warszawa 2009.

oak-hornbeam forests (dry-ground forests) which are accommodated to flooding lack. Rare alder-ash riparian forests can totally disappear[5].

In second EIA report three variants for exploitation of Racibórz dry polder were proposed[6]:

- variant I, proposed by investor, with assumption of outflow from dry polder equal to 2-year flood (running of reservoir for flows higher 470 m^3/s); in result areas presently flooded once a 5 year or less frequently would be devoid of flooding with disappearance of habitats (96% of Natura 2000 areas);
- variant II, called „rational alternative variant", with assumption of outflow from dry polder equal to 5-year flood (780 m^3/s); in result areas presently flooded once a 10 year or less frequently would be devoid of flooding with losses of 43% of Natura 2000 areas;
- variant III, called „the most beneficial for nature", with weaker flood control (showed risk of ground water-logging for 35 localities) and assumption of outflow from dry polder equal to 20-year flood (1210 m^3/s); in result areas presently flooded once a 20 year or more frequently would be preserved and only 2% of Natura 2000 areas would be losses.

Other variant analysed by the Ministry of Environment[7] – outflow from dry polder equal to 10-year flood (1070 m^3/s) with losses of 27% of Natura 2000 areas was not considered in this EIA report. Variants of outflow of 50-year flood (1800 m^3/s) or 100-year flood (2300 m^3/s) were also not considered, although initial reservoir conception assumed interception only catastrophic waters. It is important that Oder flood embankments were constructed for 100-year flood. These variants could eliminate problem of dry polder impact on priority habitats – willow-poplar riparian forests.

In dry polder bowl negative impact of exploitation was expected in result of destruction of riparian forests in situation of often and long flooding with height 2-3 m above ground level. For each variant oxbow lake on Plinc (Pleśnica) stream with area 220 ha will be destructed by construction of dam[8].

Variant III with reduction of flow to 1210 m^3/s (flood with probability of occurrence once a 20 years) was finally chosen for implementation. This variant joins considerably less intervention in Oder water regime (leaving of approximate to natural flows in river bed) with flood control. Variant III also allows to preserve Natura 2000 habitats in dry polder bowl. Time for maximum water damming (3-4 days) is too short for negative impact on habitats of forest „Las koło Tworkowa". Additionally obligation for environmental compensation[9] was determined in decision of the General Directorate for Environmental Protection (GDOŚ).

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[5] *Projekt ochrony...,* op. cit., p. 25.

[6] *Raport o oddziaływaniu...,* op. cit., p. 173.

[7] *Projekt ochrony...,* op. cit., p. 25.

[8] D. Panasiuk, R. Miłaszewski, *Koszty środowiskowe realizacji obiektów hydrotechnicznych na przykładzie zbiornika Racibórz*, in: *Studium środowiskowych i społecznych kosztów rozbudowy infrastruktury technicznej w województwie śląskim oraz sposoby ich minimalizacji*, Katowice 2010.

[9] *Analiza wpływu przedsięwzięcia „Budowa zbiornika przeciwpowodziowego Racibórz Dolny na rzece Odrze, woj. śląskie (polder)" na stan wód oraz zgodności projektu z art. 4(7) RDW,* copied material.

Impact on habitats for different dry polder exploitation variants

Following Natura 2000 special areas of conservation (SACs) are located in Oder valley below dam and in scope of dry polder impact:

- "Łęg Zdzieszowicki" (site code PLH160011) with surface 619.9 ha – elm-ash riparian forests, oxbow lakes and dry-ground forests;
- "Żywocickie Łęgi" (PLH160019) with surface 101.7 ha – willow-poplar riparian forests;
- "Ujście Nysy i Stobrawy" (on "Shadow List 2010") with surface 4961.6 ha – elm-ash and willow-poplar riparian forests, alluvial meadows and others, oxbow lakes and dry-ground forests;
- "Grądy w Dolinie Odry" (PLH020017) with surface 8348.9 ha – dry-ground forests, elm-ash and willow-poplar riparian forests, alluvial meadows and others, oxbow lakes.

In valley downstream there are also special protection area (SPA) "Grądy Odrzańskie" (PLB020002) with surface 19999.3 ha, nature reserves, landscape parks, nature and landscape complexes, ecological sites and natural monuments[10]. There are following protected areas in dry polder bowl and its surroundings:

- SAC "Las koło Tworkowa" (PLH240040) with surface 115.1 ha (projected nature reserve) – elm-ash and willow-poplar riparian forests;
- SPA "Stawy Wielikąt i Ligota Tworkowska" (PLB240003) with surface 914.5 ha, covered ponds Wielikąt (nature and landscape complex) and forest Las Tworkowski;
- natural valuable: oxbow lake on Oder in Sudół surroundings, oxbow lake on Plinc stream with ponds close Brzezie and exploitation hollow close Nieboczowy[11].

Surface of ecosystems which could disappear for respective exploitation variants of Racibórz dry polder are showed in table 1. From among 38 thous. ha of areas in Oder valley downstream dam and flooded once a 50 year or often, calculation covered 4968 ha of the most natural valuable ecosystems sensitive to flooding absence (Natura 2000 habitats) and 8 thous. ha of remaining green crops. Additionally 522 ha of forests and meadows in dry polder bowl were considered. They will stop to serve production function but will be flooding areas.

Impact of dry polder exploitation variants on water ecosystems and arable grounds in dry polder bowl was not considered.

[10] *Natura 2000*, www.natura2000.gdos.gov.pl [23-09-2014].
[11] *Raport o oddziaływaniu…*, op. cit., p. 497.

Table 1
Surface of lost ecosystems for exploitation variants of Racibórz dry polder

Ecosystems	Reduction of surface for exploitation variants [ha]			
	variant I (reduction to 2-year flood)	variant II (reduction to 5-year flood)	reduction to 10-year flood	variant III (reduction to 20-year flood)
Natura 2000 habitats downstream dry polder				
3150 (oxbow lakes, Natura 2000)	281.20	137.81	49.61	0.17
6440 (alluvial meadows, Natura 2000)	200.24	41.48	20.59	0.00
6510 (other meadows, Natura 2000)	1 410.17	693.29	311.59	59.20
*91E0 (willow-poplar riparian forests, Natura 2000)	425.50	136.04	91.04	8.13
91F0 (elm-ash riparian forests, Natura 2000)	2 440.40	1 118.30	879.59	47.52
2330 (dunes, Natura 2000)	2.07	0.00	0.00	0.00
Total Natura 2000 habitats sensitive to flooding absence	4 759.58	2 126.92	1 352.42	115.02
Remaining ecosystems downstream dry polder				
remaining green crops	6 460.31	5 298.23	3 435.39	1 335.19
Habitats in dry polder bowl				
forests and coppices	161.51	161.51	161.51	0.00
meadows and pastures	360.04	360.04	360.04	0.00
TOTAL	11 926.00	8 131.26	5 493.92	1 450.21

Source: D. Panasiuk, R. Miłaszewski, *Koszty środowiskowe*…, op. cit.

Index method of environmental cost valuation

For valuation of environmental costs, index method based on Costanza at al.[12] results in 1994 dollars was used. These numbers are global averages and in future using of local valuations could be more appropriate. However these valuations are not available presently.

Average value of ecological services provided by ecosystems of lakes and rivers were valued by Costanza's team on 8 498 USD/ha annually, ecosystems of wetlands – 14 785 USD/ha annually (swamps/floodplains – 19 580 USD/ha), ecosystems of temperate forests – 302 USD/ha annually, ecosystems of grass/rangelands – 232 USD/ha annually, and other green crops – only 92 USD/ha annually[13].

[12] R. Costanza et al., *The value of the world's ecosystems services and natural capital*, "Nature" 1997 no. 387, p. 253-260.
[13] D. Panasiuk, *Wartość środowiska w analizach kosztów i korzyści zbiorników wodnych w Polsce*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 167-175.

These services are mainly non-market. Swamps and floodplains are ecosystems, which were valued, by Costanza's team, 2 times higher than services of water ecosystem with the same surface. Ecosystem services provided by floodplains composes of:

- water supply (provisioning of water by watersheds, natural reservoirs and aquifers and next draining in drought period) – 39%;
- limited flood control (part of disturbance regulation) as retention of lower flood waters in natural polder – 37%;
- recreational and cultural values – 11%;
- waste treatment (recovery of mobile nutrients) – 8%;
- other services as gas regulation – 4%.

Services provided by grass/rangelands composes of food production, nutrient control and erosion control. In result of flooding limitation these services could be lost or substituted by services provided by artificial reservoir (flood control and water retention). Services provided by temperate forests are raw material and food production (wood and ground cover), climate regulation, nutrient control and recreation[14].

Global rough numbers can seem too simple, but they are not complicated and more communicable for practitioners as water management experts or other engineers. Żylicz[15] pays attention to simplification and lacks in estimations made by Costanza's team. However he ascertained they are useful reference and probably order of magnitude between ecosystem services of wetlands and forests is preserved[16].

Costanza's team estimation was used for example in WWF Polska elaboration[17] concerning valuation of areas flooded by damming of Włocławek reservoir in 1970. Indexes of ecosystem services were multiplied by surfaces of different habitats with rate 4 PLN/USD and next capitalised using three different discount rates[18].

Environmental costs for different dry polder exploitation variants

For estimation of environmental costs associated with exploitation of Racibórz dry polder, values of ecosystem services converted to Polish złoty with purchasing power parity rate 2 PLN/USD, were used.

[14] D. Panasiuk, *Wycena świadczeń ekosystemów zbiornika Goczałkowice wraz z otoczeniem*, Katowice 2012.
[15] T. Żylicz, *Wycena usług ekosystemów. Przegląd wyników badań światowych*, „Ekonomia i Środowisko" 2010 no. 1(37), p. 31-45.
[16] T. Żylicz, *Valuating ecosystem services*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 18-38.
[17] *Studium kompleksowego rozwiązania problemów stopnia i zbiornika Włocławek. Prognoza skutków społeczno-ekonomicznych i środowiskowych*, Warszawa 2001.
[18] D. Panasiuk, op. cit., p. 172.

Table 2
Environmental costs connected with exploitation variants of Racibórz dry polder

Ecosystems	Losses of ecological services [million PLN annually]			
	variant I (reduction to 2-year flood)	variant II (reduction to 5-year flood)	reduction to 10-year flood	variant III (reduction to 20-year flood)
Natura 2000 habitats downstream dry polder				
3150 (oxbow lakes, Natura 2000)	11.01	5.40	1.94	0.01
6440 (alluvial meadows, Natura 2000)	7.84	1.62	0.81	0.00
6510 (other meadows, Natura 2000)	55.22	27.15	12.20	2.32
*91E0 (willow-poplar riparian forests, Natura 2000)	16.66	5.33	3.57	0.32
91F0 (elm-ash riparian forests, Natura 2000)	95.57	43.79	34.44	1.86
2330 (dunes, Natura 2000)	0.08	0.00	0.00	0.00
Total Natura 2000 habitats sensitive to flooding absence	186.39	83.29	52.96	4.50
Remaining ecosystems downstream dry polder				
remaining green crops	3.00	2.46	1.59	0.62
Habitats in dry polder bowl				
forests and coppices	0.10	0.10	0.10	0.00
meadows and pastures	0.17	0.17	0.17	0.00
TOTAL	189.65	86.01	54.82	5.12

Source: D. Panasiuk, R. Miłaszewski, *Koszty środowiskowe*…, op. cit.; D. Panasiuk, *Wartość środowiska*…, op. cit., p. 174.

For Natura 2000 habitats located in scope of dry polder impact and sensitive to flooding absence, ecosystem services index 39 160 PLN/ha annually for floodplains was used. For remaining green crops in Oder valley located downstream dam and for meadows and pastures in dry polder bowl index 464 PLN/ha was taken. For forests and coppices in dry polder bowl it was index 604 PLN/ha. Table 2 shows environmental costs calculated for these assumptions.

Environmental costs were estimated on level 190 million PLN annually for variant I of dry polder exploitation, 86 million PLN/year for variant II, 55 million PLN/year for capturing of 10-year flood and only 5 million PLN/year for variant III. These costs for variant I would be 37 times more than for finally chosen variant III. For floods other than catastrophic ones, natural floodplains deliver high level of flood control services.

After cost capitalisation for 30-years period, environmental costs for variant I are equal to 3.3 billion PLN (with discount rate 4%) and 2.1 billion PLN (with discount rate 8%). For variant II these costs were estimated on level 1.0-1.5 billion PLN, for capturing of 10-year flood – 0.6-1.0 billion PLN, and for variant III – only 58-89 million PLN, see Table 3.

Table 3
Annual and capitalised environmental costs connected with exploitation variants of Racibórz dry polder

Environmental costs	Losses of ecological services (million PLN annually)			
	variant I (reduction to 2-year flood)	variant II (reduction to 5-year flood)	reduction to 10-year flood	variant III (reduction to 20-year flood)
Annual costs	190	86	55	5
30-year capitalisation, r = 4%	3 279	1 487	948	89
30-year capitalisation, r = 8%	2 135	968	617	58

Source: D. Panasiuk, R. Miłaszewski, *Koszty środowiskowe*..., op. cit.

Of course capitalised environmental costs for discount rate 8% are lower than these costs calculated for discount rate 4%.

Conclusions

Comparative analysis of losses in ecosystems show that lower level of environmental costs will be achieved for finally chosen variant III of dry polder exploitation (running of reservoir for flows higher than 20-year flood). However only variants of reservoir running for bigger flows could allow totally preserve priority habitats.

Analysis of available elaborations allowed to estimate surfaces of natural valuable floodplains and meadows, which could be exposed to ground overdrying in result of implementation of respective exploitation dry polder variants. Calculated environmental costs cover only use value of ecosystem but not consider their option and existence values. Currency rate and inflation are sources of next uncertainties. Using of local Polish estimations could decrease level of environmental costs but consideration of significance of ecological corridors could increase these costs. These reasons limit use of absolute numbers for environmental costs.

Estimation of environmental costs for exploitation variants of Racibórz dry polder was made in framework of works on elaboration „Study on environmental and social costs of development of technical infrastructure in Silesia province and measures of their minimisation". Author thanks to Centre for Natural Heritage of Upper Silesia (CDPGŚ) in Katowice for works financing.

Andrzej Affek • Anna Kowalska

BENEFITS OF NATURE. A PILOT STUDY ON THE PERCEPTION OF ECOSYSTEM SERVICES

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KORZYSTANIE Z DOBRODZIEJSTW PRZYRODY. PILOTAŻOWE BADANIA DOTYCZĄCE PERCEPCJI KORZYŚCI PŁYNĄCYCH Z EKOSYSTEMÓW

STRESZCZENIE: W artykule zaprezentowano wyniki badań kwestionariuszowych przeprowadzonych wśród mieszkańców i turystów w wytypowanych miejscowościach gminy Nowinka (województwo podlaskie). Celem badań było określenie rzeczywistego korzystania z dobrodziejstw przyrody pochodzących z lokalnych ekosystemów oraz rozpoznanie poziomu wiedzy respondentów dotyczącej czerpania z nich korzyści. Zastosowano metodę door-to-door. Wskazano, jakie świadczenia ekosystemów są rozpoznawane i cenione przez lokalną społeczność oraz czynniki różnicujące poziom świadomości badanych i rzeczywiste wykorzystanie świadczeń na terenie badań.

SŁOWA KLUCZOWE: ankieta *door-to-door*, pytania otwarte vs pytania zamknięte, Suwalszczyzna i Ziemia Augustowska

Introduction

Human well-being depends on many services provided by nature including food, steady supply of clean water, recreation or protection from natural hazards etc. The state of the environment and the following ecosystem services supply are affected by human activities, which cause their damage and reduction or improvement and increase[1]. This strong connection seems to be widely-known to scientists but not to the general public[2]. In many cases benefits that people derive from ecosystems[3] or ecosystem processes[4] are taken for granted and people are unaware of their importance to them. This concerns for example water flow regulation, carbon sequestration or soil formation. Therefore, ecosystem values are not the most important in decisions relating to natural resources. To increase public awareness and participation in environmental decision-making, especially in regions with a significant share of protected areas, research on identification and valuation of ecosystem services among local communities have been undertaken[5]. Beside predominant economic valuation[6], noneconomic social valuation has been also commonly used in the decision-making processes[7]. Usually, it is based on social science methodology (individual in-depth interviews, questionnaires etc.)[8], because this way of collecting data shows satisfactory response rates[9].

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[1] A. McMichael et al., *Linking Ecosystem Services and Human Well-being*, in: D. Capistrano (ed.), *Multiscale Assessments,* "The Millennium Ecosystem Assessment Series" 2005 no. 4, p. 43-60.
[2] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 253-260.
[3] MEA, *Millennium Ecosystem Assessment,* Washington D.C. 2005.
[4] R. Tirri et al., *Elsevier's Dictionary of Biology*, Amsterdam 1998; K.J. Wallace, *Classification of ecosystem services: Problems and solutions*, "Biological Conservation" 2007 no. 139, p. 235-246.
[5] C.M. Raymond et al., *Mapping community values for natural capital and ecosystem services*, "Ecological Economics" 2009 no. 68(5), p. 1301-1315; A. Pietrzyk-Kaszyńska, M. Grodzińska-Jurczak, *Ecosystem services perception. The example of local governments representatives in Małopolska voivodship*, "Ekonomia i Środowisko" 2012 no. 2(42), p. 83-90; G. Brown, J.M. Montag, K. Lyon, *Public Participation GIS: A Method for Identifying Ecosystem Services*, "Society and Natural Resources" 2012 no. 25, p. 633-651; N.S. Sodhi et al., *Local people value environmental services provided by forested parks*, "Biodiversity and Conservation" 2010 no. 19, p. 1175-1188.
[6] T. Żylicz, *Valuating ecosystem services*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 18-38.
[7] M. Kumar, P. Kumar, *Valuation of the ecosystem services: A psycho-cultural perspective*, "Ecological Economics" 2008 no. 64(4), p. 808-819.
[8] C.M. Raymond et al., *Mapping community values for natural capital and ecosystem services*, "Ecological Economics" 2009 no. 68(5), p. 1301-1315; A. Pietrzyk-Kaszyńska, M. Grodzińska-Jurczak, *Ecosystem services perception. The example of local governments representatives in Małopolska voivodship*, „Ekonomia i Środowisko" 2012 no. 2(42), p. 83-90.
[9] G. Brown, *Mapping spatial attributes in survey research for natural resource management: Methods and applications*, "Society and Natural Resources" 2005 no. 18, p. 1-23; L. Tyrvainen,

This paper presents the results of questionnaire carried out among inhabitants and tourists staying in the selected localities of Nowinka commune (Podlasie voivodship). The aim of the study was to quantify the actual use of local ecosystem services and to examine respondents' knowledge and attitude towards benefits deriving from them. We investigated (i) which ecosystem services are recognized and valued in the community and (ii) what are the factors that differentiate respondents in relation to the level of awareness of ecosystem services and their actual use in the study area.

Methods

The pilot survey was carried out in June 2014 in Nowinka commune. This rural commune encompasses 203,84 km^2 located in Augustowska Plain (53°56′N, 22°58′E). Forests comprise over 63% of its area, while arable lands about 16% and grasslands over 10%. Lakes cover about 10%. Lands of great natural value exceed 84% of the area. The population density of the commune accounts for 14 inhabitants/km^2 [10].

The questionnaire was distributed by two researchers among residents and tourists staying in 16 villages of Nowinka commune. The method *door-to-door* was applied. In total, 117 questionnaires were collected back. The survey was anonymous. The questionnaire was divided into 3 parts. The first section comprised 4 open-ended questions concerning the use of local ecosystem services, the second presented the complex list of 45 ecosystem services with possibility to indicate the frequency of use, the last contained a set of socio-demographic questions regarding age, sex, education, source of income, place of residence etc. The scientific term *ecosystem services* was not used in the questionnaire. We replaced it by more colloquial and intelligible phrase *benefits of nature*.

Data from the questionnaires were entered into the computer and uploaded to the statistical program (SPSS ver. 17). Responses to open-ended questions were standardized in terms of writing and meaning and were transformed into binary variables. A set of socio-demographic variables were used for comparisons between subgroups. Pearson's chi-squared test was used as a test of independence to assess whether paired observations on two variables, expressed in a contingency table, are independent of each other (e.g. responses from people of different sexes to see if one's sex is related to the response). Pearson's chi-squared test (χ^2) was applied to evaluate how likely it is that any observed difference between the sets arose by chance.

K. Makinen, J. Schipperjin, *Tools for mapping social values of urban woodlands and other green areas*, "Landscape and Urban Planning" 2007 no. 79(1), p. 5-19.

[10] *Bank Danych Lokalnych* 2014, www.wroclaw.stat.gov.pl [20-09-2014].

Results

Respondents

Of 117 respondents interviewed, 65% were female and 35% male. The majority of them (58%) were between 30 and 60 years old, 21% were under 30 and about 20% were above 60. Most respondents reported having secondary (52%) or higher (41%) education. Farming, mental work or pension were the most frequent income sources among surveyed people. The study was carried out in the rural area. More than 66% of respondents were permanent rural residents, while 34% came from towns and cities. The majority of the respondents who declared themselves as urban permanent residents were second-home owners. Only few of them were short-term visitors.

Ecosystem services recognized and valued in the community

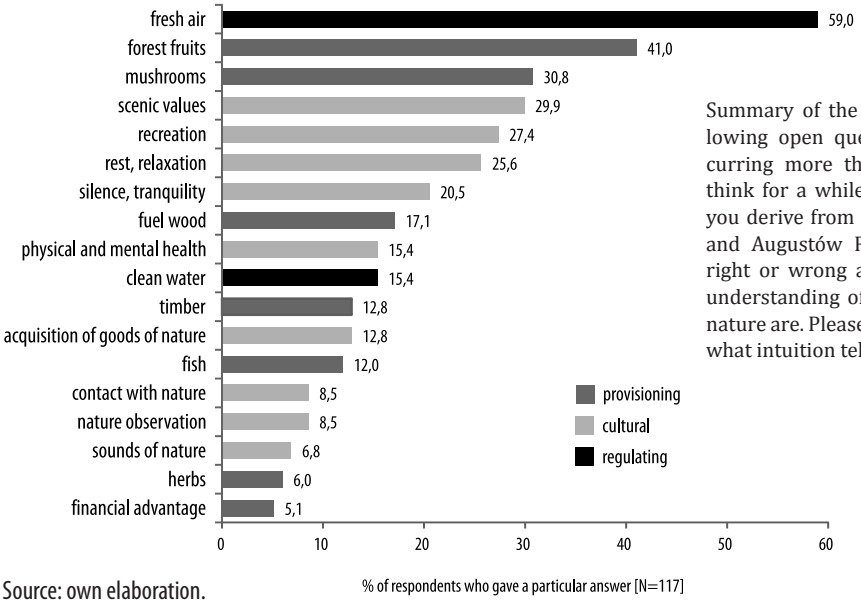
Fresh and clean air was the most frequently mentioned ecosystem service in respondents' answers to the general open question of the first section. It was followed by some provisioning services, like a supply of forest fruits, mushrooms and fuel wood, along with a set of cultural services e.g. scenic values, recreation, rest and relaxation, silence and tranquility (Figure 1). The between-group comparison showed different approach to ecosystem services among respondents, particularly when place of permanent residency was the grouping variable (Figure 2)[11]. In general, rural residents focused on provisioning services while urban residents paid more attention to cultural services. Interestingly, these differences did not occur when the real use of ecosystem services is considered.

Actual use of local ecosystem services

According to the results of the second section, obtained for the closed questions, actual use of local ecosystem services proved to be much higher than it was originally declared by respondents in open questions (Figure 3). Statistically significant differences between rural and urban residents in terms of actual use of services only occur in the case of fuel wood (χ^2=6,63; p=0,01).

[11] Other between-group comparisons showed that, for instance, women significantly more often mentioned herbs (χ^2=4,07; p=0,04) and contact with nature (χ^2=5,98; p=0,01) as benefits of nature. Better educated respondents listed generally more benefits. They pointed more often to scenic values (χ^2=7,64; p=0,02), health (χ^2=8,65; p=0,01), silence/tranquility (χ^2=6,85; p=0,03) and rest/relaxation (χ^2=11,35; p=0,00).

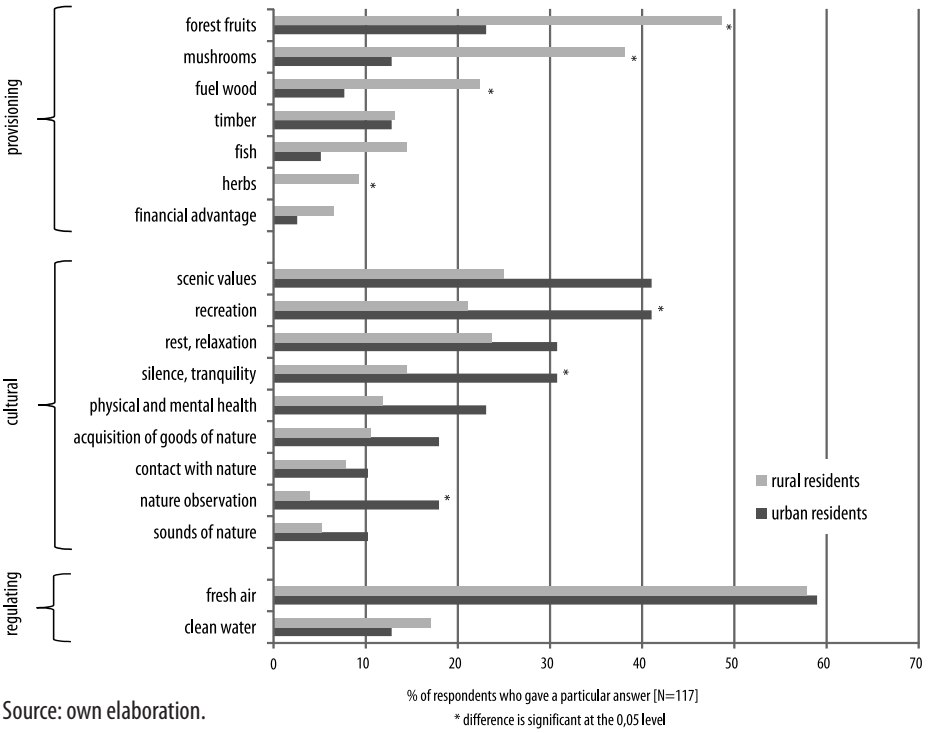
Figure 1
Benefits of nature recognized by respondents



Summary of the responses to the following open question (responses occurring more than 3 times): "Please think for a while and list the benefits you derive from the nature of Suwałki and Augustów Region. There are no right or wrong answers, good or bad understanding of what the benefits of nature are. Please respond according to what intuition tells you."

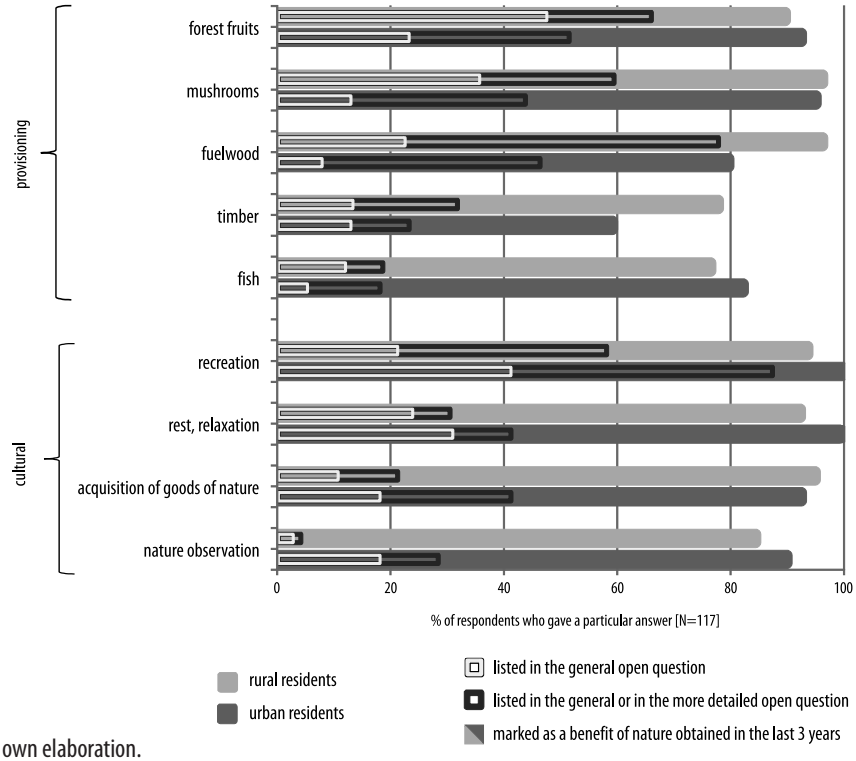
Source: own elaboration.

Figure 2
Benefits of nature recognized by respondents. Comparison between rural and urban residents



Source: own elaboration.

Figure 3
Responses to open and closed questions about the benefits of nature



Source: own elaboration.

Discussion and conclusions

Contrary to our skeptical surmise, shared by other researchers[12], local community has the capacity to identify benefits of nature and their use in the region. Our results are in line with the observations of Pereira et al., Sodhi et al. and Brown et al.[13]; the latter described wide knowledge about nature and a strong connection to the outdoors among participants of their study in Colorado.

[12] N.S. Sodhi et al., *Local people value environmental services provided by forested parks*, "Biodiversity and Conservation" 2010 no. 19, p. 1175-1188; J. Ghazoul, *Challenges to the uptake of the ecosystem services rationale for conservation*, "Conservation Biology" 2007 no. 21, p. 1651-1652; C. Kremen, G.C. Daily, A.M. Klein, D. Scofield, *Inadequate assessment of the ecosystem service rationale for conservation: reply to Ghazoul*, "Conservation Biology" 2008 no. 22, p. 795-798.

[13] E. Pereira, C. Queiroz, H.M. Pereira, L. Vicente, *Ecosystem services and human well-being: a participatory study in a mountain community in Portugal*, "Ecology and Society" 2005 no. 10(2), p. 14-36; N.S. Sodhi et al., *Local people value environmental services provided by forested parks*, "Biodiversity and Conservation" 2010 no. 19, p. 1175-1188; G. Brown, J.M. Montag, K. Lyon, *Public Participation GIS: A Method for Identifying Ecosystem Services*, "Society and Natural Resources" 2012 no. 25, p. 633-651.

Local people's awareness of nature's benefits largely correspond to the scientific knowledge developed under the concept of ecosystem services. Within answers to open-ended questions a wide range of ecosystem services was listed, including provisioning, cultural and regulating services provided by local environment (supporting services considered as processes necessary to provide most of the direct benefits). Fresh and clean air (regulating service) was the most frequently mentioned ecosystem benefit in respondents' answers. This result is in contrast to previous reports, which showed that identification of regulating services by non-specialists is a challenge[14], while cultural and provisioning services are directly experienced and intuitively appreciated[15].

Rural residents attach greater importance to material benefits of nature, while urban residents come to the study area primarily for cultural activities close to nature. The similar relationship is observed by Sodhi et al.[16]. They find that people with longer residency valued regulating and provisioning services provided by neighboring forests more.

Many researchers report that the background characteristics of respondents play a particularly decisive role in the perception of ecosystem services[17]. In our study, between-group comparisons based on variables other than the place of residency (e.g. age, sex, education, source of income) show surprisingly few significant differences in the perception and actual use of benefits of nature. Moreover, our respondents show slightly different preferences. For instance, Sodhi et al.[18] observed that people that were better educated valued more forest reserves for their regulating services. In our study, level of education differentiated the perception of some cultural values instead of regulating services.

The phrase *benefits of nature* proved to be adequate and useful as a keyword promoting the concept of ecosystem services and in social studies.

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[14] G. Brown, J.M. Montag, K. Lyon, *Public Participation GIS: A Method for Identifying Ecosystem Services*, "Society and Natural Resources" 2012 no. 25, p. 633-651.
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PROBLEMS OF MAPPING PROVISIONING AND RECREATION ECOSYSTEM SERVICES IN METROPOLITAN AREAS

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PROBLEMY MAPOWANIA USŁUG EKOSYSTEMÓW ZAOPATRZENIOWYCH I REKREACYJNYCH W OBSZARACH METROPOLITALNYCH

STRESZCZENIE: Mapowanie potencjału usług ekosystemowych jest ważnym etapem identyfikacji korzyści prowadzonych przez ekosystemy i ich wyceny ekonomicznej. W artykule przedstawiono analizę dwóch kategorii usług ekosystemowych: zaopatrzeniowych oraz rekreacyjnych, które przeprowadzono dla trzech europejskich obszarów metropolitalnych, które łączy zastosowanie narzędzi planistycznych służących ochronie terenów otwartych. Badano obszary zielonych pierścieni rozciągające się w promieniu 20 km od granicy obszarów zwartej zabudowy. Jako podstawę analizy wykorzystano ogólnodostępne dane CORINE Land Cover. Badano w jaki sposób dane o pokryciu/użytkowaniu terenu powinny zostać wykorzystane do scharakteryzowania obszarów określonych jako zielone pierścienie. W granicach analizowanych buforów dominują usługi zaopatrzeniowe głównie produkcji rolnej. Określenie udziału obszarów usług rekreacyjnych jest w mniejszym stopniu zależne od cech użytkowania terenu i trudniejsze do oszacowania. Na przykładzie wykazano że ich udział może się wahać od dominującego do nieistotnego w zależności od przyjętych kryteriów. Zaproponowano uzupełnienie kryteriów definiujących tereny wykazujące potencjał dla tej usługi o informacje jakościowe dotyczące struktury własnościowej, intensywności produkcji rolnej oraz założeń rozwoju infrastruktury turystycznej. Wykazano że zastosowane podejście jest przydatne w porównaniach struktury przestrzennej potencjału dla serwisów ekosystemowych.

SŁOWA KLUCZOWE: usługi ekosystemów, mapowanie usług ekosystemów, kształtowanie obszarów metropolitalnych, zielony pierścień

Introduction

The two main approaches to research on Ecosystem Services (ES) mapping can be found in the literature during last few years mainly in special issue of Ecological Indicator no. 21 (2012). First1 mapping of ES through analyses of land cover or/and land use (LULC), where in the result one can get indirect information about Ecosystem Services potential. This makes possible to map benefits that come through general land management, but doesn't provide information on kind of ES and benefits that we can gain from particular ecosystem. The information is related usually to more than one type of Ecosystem Service, sometimes even to whole group as provisioning, regulating, cultural. As an example Burkhard[1] provisioning ES can be mapped through reduced information about land use as agricultural lands and forests. Second approach[2] is based on mapping of particular ES to capture relation between particular benefits and it's area of supply (sometimes also demand). This approach helps to define the actual area that brings the benefit to the very well defined category of ES. The disadvantage of such approach may be relatively narrow understanding of interrelations of the particular ES with other factors. As an example one can map flood regulating ES or fiber supply usually these kind of research refer to local scale because of very specify detail data.

In this paper we follow first of the mentioned approaches and focus on multifunctional aspect of ES mapping. Although mapping of ES based on LULC data was applied in some studies mentioned before, it hadn't been used such approach applied to the green belts.

We assess the areas that provide ES in metropolitan areas of selected European cities: London, Vienna and Randstad. For all of them tools were proposed to apply for open space protection in the surroundings of the city/cities to control urban sprawl. This kind of planning instrument is used to be called *green belt*. The concept of green belt for more than 100 years inspired city planners to keep the outskirt of the cities out of built up areas, that mean areas with strong limitation of new development[3] The list of main goals to use this planning instrument for these cities is presented in Table 1. There are different reasons to protect open spaces around analyzed cities related to various roles to sustain them.

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[1] B. Burkhard, F. Kroll, B. Nedkov, F. Müller, *Mapping ecosystem service supply, demand and budgets*, "Ecological Indicators" 2012 no. 21, p. 17-29; L. Koschke, C. Fürst, S. Frank, F. Makeschin, *A multi-criteria approach for an integrated land cover based assessment of ecosystem services provision, "*Ecological Indicators" 2012 no. 21, p. 54-66.

[2] F. Eigenbrod et al., *The impact of proxy-based methods on mapping the distribution of ecosystem services,* "Journal of Applied Ecology" 2010 no. 47, p. 377-385; S. Frank, Ch. Fürst, L. Koschke, F. Makeschin, *A contribution towards a transfer of the ecosystem service concept to landscape planning using landscape metric, "*Ecological Indicators" 2012 no. 21, p. 30-38.

[3] P. Hall, *Cities of Tommorow,* Oxford 1990; M. Amati, M. Yokohari, *The establishment of the London Greenbelt: Reaching consensus over, "*Journal of Planning History" 2007 no. 6, p. 311-337; H.W. Frey, *Not green belts but green wedges: the precarious relationship between city and country*, "Urban Design International" 2000 no. 5, p. 13-25.

In Vienna the main goal was to protect nearby forest for recreation needs, then also to conserve traditional agriculture as vineyards and to keep agriculture on the best Austrian soils in Danube valley[4]. Similar motivation was to establish the green heart of the Netherlands in Randstad consisting of agricultural lands. The iconic example of greenbelt in London had been set to control urban sprawl but also to preserve productive agricultural areas and green open spaces suitable for recreation[5]. Additionally the table shows difference between functions that are fulfilled by open spaces in the surrounding of the analyzed ten cities. Functions of greenbelt and the like instruments had been analyzed by Yokohari, Yang and Jinxing, Bengston and Youn, Amati and Yokohari[6].

Open spaces within greenbelts mostly consist of natural and seminatural ecosystems that provide variety benefits to cities inhabitants[7,8]. Benefits provided by green belts are contemporary understood through the ES concept. Discussion how functions of landscape or environment can be transmitted to ecosystem services is still quite dynamic starting from Jax, Wallace, Bollinger and Kienast, till Haines-Young, Potschin and Kienast and also Burkhard et al.1[9]. Additionally the problem can be understood wider – while functions are mainly understood by environmentalist as natural processes by planners or urbanists functions are more recognized as management (uses) of the land (landscape).

Main aim of this paper is to find out how (or if) the differences in the LULC between the compared areas influence green belt functions. For this reason we selected those which occur in almost all European metropolitan areas: recreation and protection of agricultural land. We investigate how much of the metropolitan area provides potential two groups of ES: provisioning and cultural. To reach this

[4] M. Breiling, G. Rulad, *The Vienna Green Belt: From Localized Protection to a Regional Concept,* in: M. Amati (ed.), *Urban green belts in the Twenty-first Century*, Ashgate 2012.
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[7] R.S. de Groot, M. Wilson, R. Boumans, *A typology for the description, classification and valuation of Ecosystem Functions*, "Goods Services Economics" 2002 no. 41(3), p. 393-408.
[8] R.S. de Groot, *Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes*, "Landscape and Urban Planning" 2006 no. 75, s. 175-186.
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Table 1
Goals and instruments used to protect open spaces within analyzed metropolitan areas

Goals to protect open spaces within metropolitan areas	Tool to protect open space within metropolitan areas	City
Recreation areas Tradition of agriculture Limitation of urban sprawl	System of protected open spaces within metropolitan area	Vienna
Control urban sprawl Physiognomic/ landscape protection Protection of agricultural land Recreation areas	System of open spaces that surrounds the city	London
Productivity of agricultural land Limitation of urban sprawl Recreation areas	System of open spaces is located inside the group of cities (polycentric region of Amsterdam, Rotterdam, the Hague and Utrecht)	Randstad

Source: own elaboration based on planning documents for London, Vienna and Randstad metropolitan areas.

objective we test how the information on potential for these ES might be represented with simple and widely accessible data from European databases (LULC and protected areas). If successful, such approach might be useful tool for comparisons made over a large number of compared metropolitan areas across the Europe, where completing the detailed data for all of these is almost impossible.

Methods

Three European metropolitan areas: Vienna, London and Randstad were chosen for analysis. They represent different types of greenbelts (Table 1), similar goals to set this planning tool and some dissimilarities between the local conditions reflected in the LULC structure within their green belts. The second criterion was similarity of the goals and applied tools for open spaces protection. The area of green heart within conurbation of Randstad (Amsterdam, Rotterdam, The Hague) was added to the analysis because of its specific unique character non comparable to the other European green belt areas, especially related to the cultural functions fulfilled (for details see discussion section).

The green belt areas were analyzed as buffer zones of the fixed radius of 20 kilometers around main urban areas of the cities. Such approach, in opposite to the use of legal borders of protected greenbelts of various sizes and character, facilitates comparison of the analyzed areas. The radius of 20 km was determined through the landscape structure analysis, which result was that the configuration specific for the green belt areas can be mostly found within this distance. This extent is also comparable to the areas considered as green belt around most of the European cities.

For mapping of the ES the widely accessible European datasets were used: Corine Land Cover 2000 (CLC) and EU nature protection areas Natura 2000 sites (EEA). The reference scale of CLC database is 1:100 000, which is widely agreed as appropriate for comparisons of such large areas. The thirty five LULC categories are provided for the analyzed metropolitan areas. These were grouped to characterize the potential for the two main benefits: provisioning and recreation ES.

The Provisioning Ecosystem Services or production functions are understood in this study according to de Groot as biomass production – agriculture, timber production and also other energy resources. The group of provisioning ES we refer to the feeding function of green belt – preserving farmland, best soils and traditional farming types as vineyards, pastures or simply preserving economic value of agriculture, but also to keep forest for timber production, and some areas suitable for mineral extractions. This approach was also presented by de Groot, Koschke and Burkhard1215. Similar to Koschke and Burkhard12. As offering potential for the provisioning ES the following categories were used: all classes of agricultural areas (CLC 211-244), mineral extraction sites (CLC 131) as well as nonproductive forest. To delimit the last category protected areas of Natura 2000 sites were excluded from combined three kinds of forest: broad leaved (CLC 311), coniferous (CLC 311) and mixed (CLC 312).

Among cultural ES we focus on areas suitable for recreation. Bengston and Youn12 as well as Amati and Yokohari13 bring emphasis to the substantial role of the metropolitan areas potential for recreation to supply leisure and sport areas in and out of the city limits. In definition of land use important for recreation we follow the approach proposed by Koshke et al.2 and Burkhard et al.1 and use the following classes: green urban areas (CLC 141), sport and leisure areas (CLC 142), water courses and water bodies (CLC 511, 512), from class of forest and seminatural areas we consider all forests groups, scrub and/or herbaceous vegetation associations, from class of open spaces we included beaches, dunes, sands (CLC 311, 312, 313. 321, 322, 323, 324, 331). Additionally, according to the recommendation these authors, selected agricultural lands classes were added with significant share of natural vegetation as: pastures, complex cultivation patterns, land principally occupied by agriculture with significant areas of natural vegetation, agro-forestry areas (CLC 231, 242, 243, 244) and one class of permanent crops vineyards (CLC no. 221).

The assessment of the metropolitan areas potential to fulfill the ES is performed separately for each group: provisioning and recreation. The percentage of the area is calculated occupied by the combined LULC classes within the whole green belt area. Also the configuration of the areas covered by these classes is visually analyzed. This allows us to check if there is a relation between these characteristics and declared green belt like instruments for these areas.

Results

The comparison of areas with potential for provisioning and recreation functions is provided in Figure 1a as percentage of the green belt areas of the three analyzed cities. The spatial distribution of these areas is presented on maps shown on Figure 2.

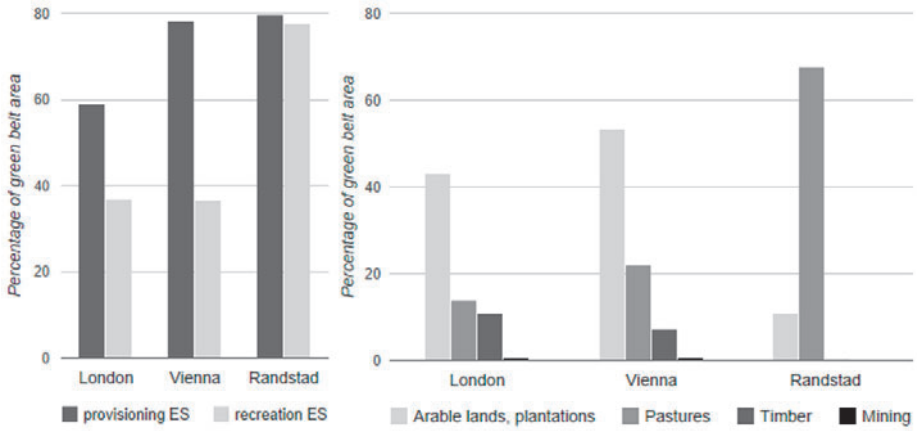
The areas of the provisioning ES are significant for all compared areas, especially for Randstad and Vienna (almost 80%) in London this area is relatively smaller (59%). From three ES types that contain provisioning group (Figure 1b) the food production prevails in metropolitan areas. In all buffer zones agricultural land that converts solar energy into edible plants and animals covers the highest area and fulfils the vital role to supply the city. These areas mainly consist of croplands in London and Vienna, and in Randstad pastures dominate. Substantial is small proportion of productive forest, particularly in conurbation of Randstad (the Netherlands) and London. Mineral extraction within analyzed areas has no significant role.

Predominant agricultural function suggests that the ecosystems within green heart of Randstad and in the surroundings of Vienna and London have a significant impact on city vitality. The spatial analyzes of the provisioning ES within all ten metropolitan areas clearly reflect goals of open space (green belt like instruments) protection proposed by planners. In addition, clearly marked by a lack of productive forests in vicinity of the Randstad and London.

ES related to recreation usually concern outdoor activities, but also provide leisure facilities i.e. those elements which enhance the recreation ability of the area. The largest area with potential of recreation arise in Randstad with almost

Figure 1

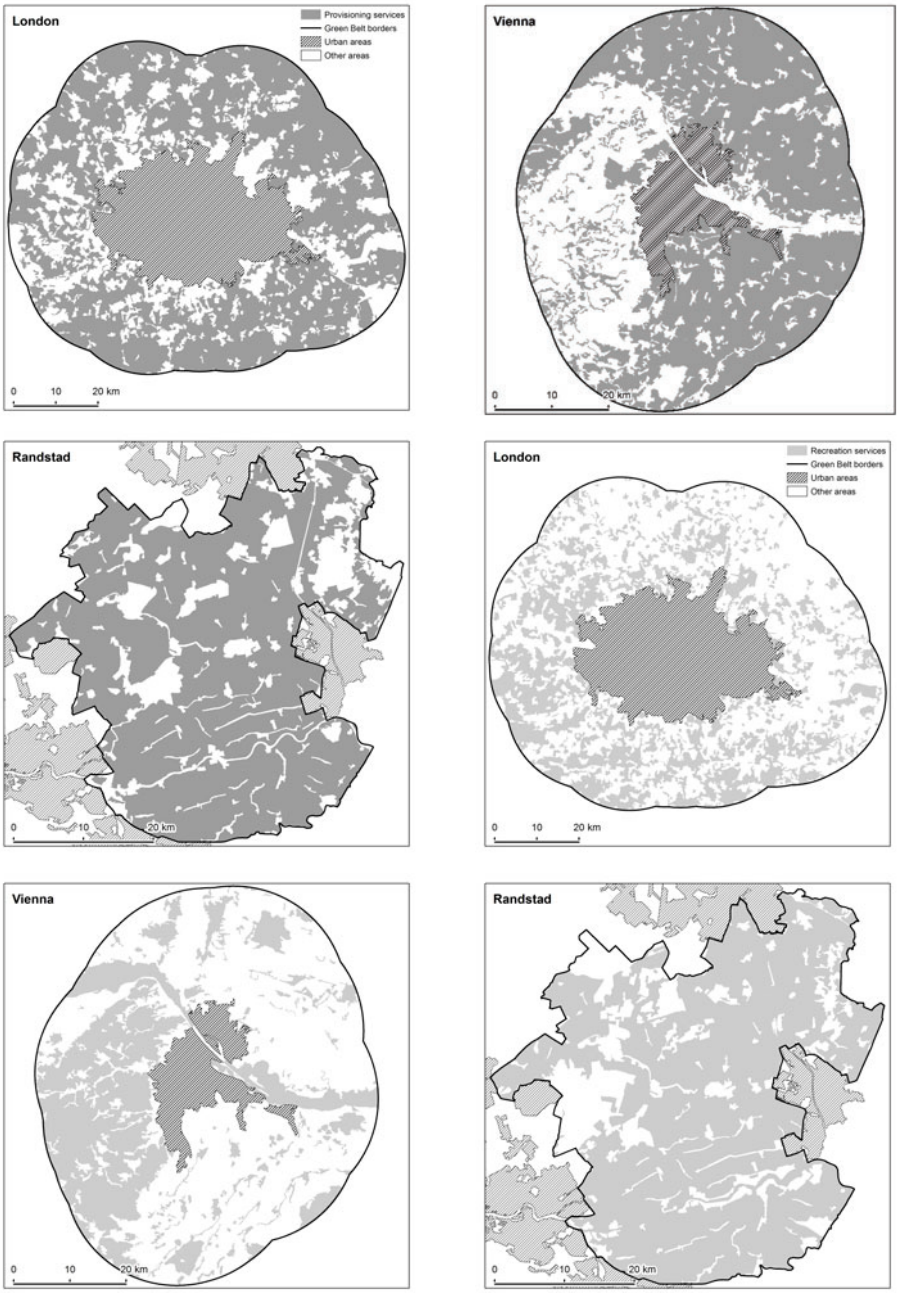
The percentage of the areas within buffer zones of metropolitan areas of London, Vienna and Randstad: a) comparison between provisioning and recreation ES, b) structure of provisioning ES



Source: own study.

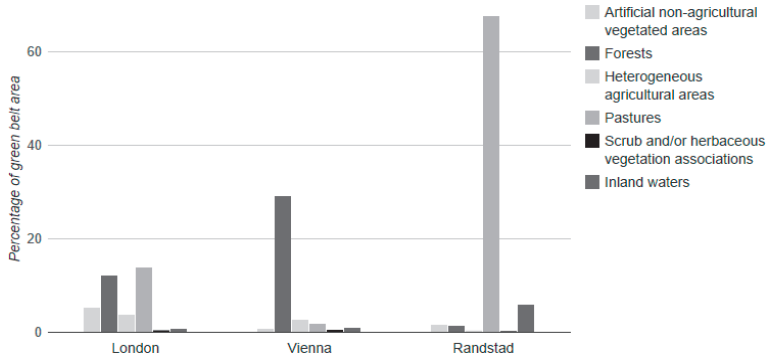
Figure 2

Areas with potential of providing two groups of ecosystem services (upper line) provisioning and (lower line) recreation within buffer zones of metropolitan areas of London, Vienna and Randstad



Source: own study.

Figure 3
The percentage of the areas within buffer zones of metropolitan areas of London, Vienna and Randstad with detailed structure of recreation ES



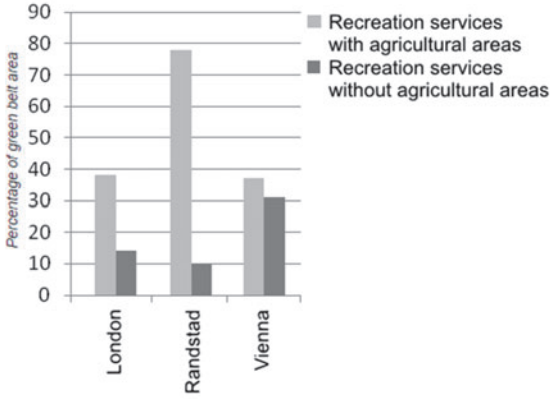
Source: own study.

80% cover of all the analyzed area. This area is mostly used as agricultural lands, particularly pastures. In other metropolitan areas less than 40% are covered by the recreation function. This is a result of different proportion between the pastures (London 14%, Vienna 22%) and arable lands which are not suitable for recreation. The detailed LULC structure (Figure 3) shows three kinds of areas playing main role within recreation areas of the green belts: pastures in Randstad (68%), forest in Vienna (29%), and both classes are significant in London (pastures 14%, forest 12%). In Randstad water bodies are also visible (6%). The results suggest that areas supplying the city with food and raw materials, are in parallel of the greatest potential for outdoor recreation.

It might be considered as a kind of surprising that Vienna area with more significant share of forest areas looks to be less suitable for recreation than Randstad where open spaces are dominant. Therefore further analysis was performed to investigate how the recreation function should be considered. For this reason we mapped it using changed criteria, namely without the most doubtful agriculture categories as pastures, complex cultivation patterns, land principally occupied by agriculture and agro-forestry areas. The result is compared to the hitherto considered percentage of land cover including these areas on Figure 4. Two kinds of metropolitan areas are visible in the results.

First, the differences in the mapped areas with capacity for recreation are major in the Randstad, London and in Vienna the difference is rather minor, less than the 10 percent points. The highest differences are noticeable in the Randstad where it reaches nearly 70% of the cover area. That means that the recreation function is determined by ecosystems created mainly by pastures, and also to a minor extent: complex cultivation patterns, land principally occupied by agriculture and agro forestry areas.

Figure 4
Two versions of percentage of the area with capacity to recreation ES.

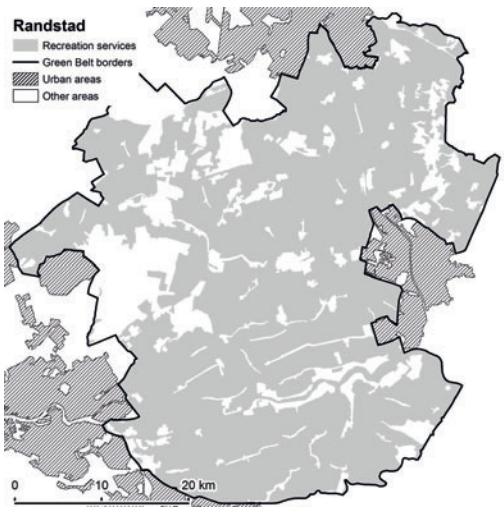


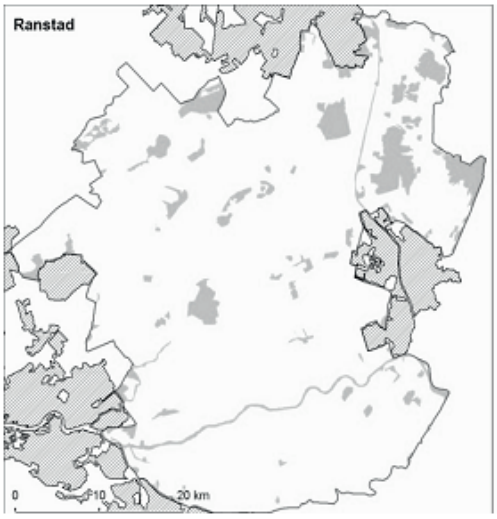
Source: own study.

Figure 5
Comparison of two approaches to Recreation ES mapping

5a – map that contains CLC categories as: green urban areas, sport and leisure areas, water courses and water, all group of forests scrub and/or herbaceous vegetation associations, beaches, dunes, sands and from agricultural categories: pastures, complex cultivation patterns, land principally occupied by agriculture, agro-forestry areas, vineyards and olive groves

5b – map that contains CLC categories as: green urban areas, sport and leisure areas, water courses and water, all group of forests scrub and/or herbaceous vegetation associations, beaches, dunes, sands and from agricultural categories: vineyards and olive groves





Source: own study.

The two versions of mapped recreation ES are presented in figure 5: a) shows the map obtained when meadows and pastures were included to the analysis, b) green heart zone with categories of recreation when the controversial categories are excluded. The comparison of these two approaches shows contrast in interpretation of existence of the potential for recreation ES within the Randstad area. In first figure this area is mostly suitable for outdoor activities, while according to the second, this area is not suitable.

Discussion and conclusions

In this paper we show that the proposed approach for mapping of the potential for provisioning and recreation ES using combined LULC classes provides satisfactory overview. This confirms findings of above cited authors. Although such comparison was not performed for green belt areas.

Further discussion is still needed on criteria used for definition of the ES groups. While provisioning ES are relatively accurately defined (the area of food and fiber production is rather clear), many doubts arise concerning ambiguously defined criteria that delineate categories of LULC suitable to recreation. In the literature main discordances are associated to the categories of agricultural areas. For example some authors consider the role of arable lands class (CLC 211) as ecosystems appropriate to outdoor recreation20, while others1 note their minor role. According to research of Koschke other classes: pastures, complex cultivation patterns, land principally occupied by agriculture, with significant areas of natural vegetation, agro-forestry areas, vineyards, and also olive groves seem to be proved as ecosystems that supply recreation activities.

Based on the provided comparison we suggest that one of solutions might be individual definition of recreation ES areas according to the following factors: intensity of agriculture, ownership structure, tradition of the recreation infrastructure development. First two factors might be considered as comparison of the Vienna area with Randstad and London. The most of Austrian agricultural areas are accessible for recreation and the intensity of agriculture is relatively lower than in the Randstad area as vineyards. In London area the habit of fencing parcels may limit accessibility of agricultural lands. The tradition of recreation infrastructure development in most of European countries causes concentration of the main tourist infrastructure (picnic areas, hiking nodes or starting tours places) near natural and seminatural areas: forests, watercourses. In the areas of accessible agricultural lands such elements are also present: biking or hiking trails and other elements as view towers or vista points. Nevertheless its presence corresponds to the goals of developments of the tourist infrastructure. Metropolitan buffer of Vienna is again different in this field than other analyzed areas, where long distance trails are kind of tradition. It seems that based on above provided conditions the three areas analyzed within this study might be accounted to two separate groups with different criteria of definition of the recreation

ES. Nevertheless such definition causes many doubts with comparisons of separately defined areas, what is subject to further research.

Within this paper we show that the proposed approach is useful for comparison between the different areas. The advantage is using data, which are widely accessible and standardized for the whole European Union. The proposition of grouping of the green belt areas with similar conditions for particular ES facilitates relation of the applied instruments to other areas where such solutions are under consideration, like most of Polish metropolitan areas.

The presented approach provides additional information about function of open spaces within outskirt of big cities and could be helpful for planners to define greenbelt or greenbelt like instrument to protect ecosystems that brings various benefits for human beings.

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THE USE OF LAND COVER DATA IN ECOSYSTEM SERVICES ASSESSMENT

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WYKORZYSTANIE BAZ POKRYCIA TERENU DO OCENY ŚWIADCZEŃ EKOSYSTEMOWYCH

STRESZCZENIE: Przedmiotem badań była ocena sekwestracji węgla, jako popularnego wskaźnika regulacyjnych świadczeń ekosystemowych, przy użyciu dwóch baz pokrycia terenu – Urban Atlas (UA) i Corine Land Cover (CLC). Badania objęły zachodnią strefę miejską i podmiejską Warszawy z fragmentem Kampinoskiego Park Narodowego (gminy Stare Babice, Izabelin, Łomianki i dzielnice Warszawy – Bemowo, Bielany). Wyniki świadczą, że dane CLC i UA nie są wystarczającym materiałem kartograficznym do oceny świadczeń ekosystemowych w skali lokalnej. Opracowywanie planów przestrzennego zagospodarowania na poziomie gmin lub ich fragmentów, powinno opierać się na badaniach terenowych, których celem będzie weryfikacja danych UA i CLC. Należy również wykorzystywać wskaźniki, które nie bazują bezpośrednio na danych UA i CLC.

SŁOWA KLUCZOWE: świadczenia (usługi) ekosystemowe, pokrycie terenu, Urban Atlas, Corine Land Cover, sekwestracja węgla

Introduction

Scale, time and location of the ecosystems are the main features for mapping and assessment of ecosystem services. In the TEEB Manual for Cities: Ecosystem Services in Urban Management[1] it is written that "one of the challenges is to ensure that communication takes place between the environmental- and planning departments and that information about the ecosystems services is considered as part of the planning process". In Poland, the planning process covers the four main stages of planning studies: national (in scale of 1:500 000-1:1000 000), voivodeship (1:100 000-1:200 000), commune (1:10 000 – 1:25 000), and local (1:1000 – 1:5000). Just like in Natura 2000, the main factor of spatial planning[2] from the perspective of the ecosystems and their services is the spatial planning at the commune and local level. National and regional levels are necessary for consistency of ecosystems, their goods and services protection. Each level, but especially local one, allows assessing the potential influence of spatial planning on the value of the ecosystem services and consequentially the quality of the lives of the residents of specific districts and neighbourhoods. The preservation of the ecosystems and their capacity to provide services seems particularly important for the urban areas, because the majority of the populations lives within them, spends time there, and reaps benefits from the ecosystems located nearby. The inhabitants of big cities are willing to work in their centres, but often want to live in the suburbs to raise their well-being. This produces the urban sprawl effect[3]. This zone is home to particularly endangered ecosystems and their services. Their protection depends on the local spatial development plans. Regardless of its rank, each survey must recognise the natural conditions in form of an ecophysiographic study and projections of impact on the environment, which is regulated by the act concerning spatial planning[4]. The scale of the study is an important, perhaps key factor in the application of the ecosystem services mapped and assessed in the future, which is the intention of the European Commission establishing the guidelines for such studies – MAES (*Mapping and Assessment of Ecosystems and their Services*)[5]. The suggested cartographic starting point for such

[1] TEEB, *The Economics of Ecosystems and Biodiversity (2011), TEEB Manual for Cities: Ecosystem Services in Urban Management*, www.teeweb.org [20-09-2014], p. 34.
[2] M. Kistowski, M. Pchałek, *Natura 2000 in spatial planning – the role of ecological corridors*, Warsaw 2009, p. 9.
[3] M. Gutry-Korycka (ed.), *Urban sprawl. Warsaw Agglomeration case study*, Warsaw 2005.
[4] The act dated 27th March 2003 concerning spatial planning. Journal of Laws of 2003 No. 80 item 717.
[5] J. Maes et al., *Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020*, Luxembourg 2013.

studies is the Corine Land Cover (CLC)[6]. For urban ecosystems, it is the Urban Atlas (UA)[7], due to its superior resolution.

The objective of this study is to compare the assessed carbon sequestration as the most popular indicator regulating ecosystem services[8] with the application of CLC and UA within the communes inside the urban sprawl zone. Carbon sequestration is defined as change in C storage in aboveground and belowground biomass that result from tree growth during a single growing season[9]. Grass and herbaceous plants take part in C sequestration, but the role is insignificant[10]. Urban and suburban area is not only the source of carbon, but also the area of carbon storage and sequestration. For instance in USA, forests and forest products currently store the equivalent to 10-20% of U.S. fossil fuel emissions. The urban forest role is important in this process also. Urban forests are responsible for 20 percent of total reductions C in California (avoided emission area included)[11].

Data and Methods

The study area included the communes located between Warsaw and the Kampinos National Park. Choosen communes are representive for showing typical urban sprawl area. Each of them represent different pattern of land cover (dominance of built-up area, dominance of agriculture area and forest). Two districts of the city of Warsaw were selected (Bielany and Bemowo), which had a great share of agricultural terrains and were not a part of the main city core[12] back in the 1970s, the Łomianki rural-urban commune, and two rural communes, Izabelin and Stare Babice. The location of communes and their land cover are suitable to assessing and monitoring of land cover changes, spatial and temporally ecosystems changes.

CLC and UA were applied to establish their land cover classes and to calculate the basic landscape metrics for each commune and district: Number of patches (NP) and Patch density – number of patches/ha (PD). The calculations were made in Fragstat 4.2[13], while the GIS analyses were performed in Esri ArcGIS 10.1. The main parameters of CLC and UA: Minimum Mapping Unit (MMU) and

[6] www.eea.europa.eu [20-09-2014].
[7] Ibidem.
[8] M.W. Strohbach, D. Haase, *Above-ground carbon storage by urban trees in Leipzig, Germany: Analysis of patterns in a European city*, "Landscape and Urban Planning" 2012 no. 104, p. 95-104; Z.G. Davies et al., *Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale*, "Journal of Applied Ecology" 2011 no. 48, p. 1125-1134.
[9] M. E. Gregory, X. Qingfu, A. Elena, *A new approach to quantify and map carbon stored, sequestered and emissions avoided by urban forests*., "Landscape and Urban Planning" 2013 no. 120, p. 70-84.
[10] H.K. Jo, G.E. McPherson, *Carbon storage and flux in urban residential greenspace*, "Journal of Environmental Management" 1995 no. 45(2), p. 109-133.
[11] D.C. McKinley et al., *A synthesis of current knowledge on forests and carbon storage in the United States*, "Ecological Applications" 2011 no. 21(6), p. 1902-1924.
[12] M. Gutry-Korycka (ed.), *Urban sprawl. Warsaw Agglomeration case study*, Warsaw 2005.
[13] K. McGarigal, S.A. Cushman, E. Ene, *FRAGSTATS v4: Spatial Pattern Analysis Program for Categorical and Continuous Maps*, Computer software program produced by the authors at the

Table 1
Tree cover for CLC and UA classes, x – category does not appear within the surveyed area [%]

Category	Urban Atlas	tree cover [%]	Corine Land Cover	tree cover [%]
MMU	0.25 ha		25 ha	
Artificial surface	Continuous Urban Fabric (average degree of soil sealing: > 80%)	5	111 Continuous Urban Fabric	X
	Discontinuous Dense Urban Fabric (average degree of soil sealing: 50-80%)	15	112 Discontinuous Urban Fabric	15
	Discontinuous Medium Density Urban Fabric (average degree of soil sealing: 30-50%)	30		
	Industrial, commercial, public, military and private units	5	121 Industrial and commercial units	5
			122 Road and rail networks and associated land	5
	Green urban areas	70	141 Green urban areas	70
	Sports and leisure facilities	10	142 Sport and leisure facilities	10
Forest and semi-natural area	Forests	90	311 broad-leaved forest	90
			312 Coniferous forest	90
			313 Mixed forest	90
			324 Transitional woodland scrub	65
Agricultural area	Agricultural + Semi-natural areas + Wetlands	5	222 Fruit trees and berry plantation	5
			231 Pastures	5
			242 Complex cultivation patterns	10
			243 land principally occupied by agriculture with significant area of natural vegetation	50
Others	Isolated Structures	15		
	Land without current use	10		

Source: own study.

quantity of classes within the artificial surface, agriculture areas, and forests areas, are different (Table 1).

In the next step the annual amount of carbon sequestered per acre per year has been estimated. In this research carbon sequestered has been calculated us-

University of Massachusetts, Amherst 2012, Available at the following web site: www.umass.edu [20-09-2014].

ing the formula of Rowntree and Nowak[14], where multiply percent tree cover by 0.00335. An assessed percentage of tree cover was established for a given class of land cover (Table 1). At least carbon sequestration has been converted into tons C per hectares per year.

Results

The high UA resolution and more allotments for built-up areas provides both rural and urban communes with more individual units (NP) in a given commune/district and higher density per ha (PD), (Table 2). The diverse resolution and method of preparing the material also entailed a diverse interpretation of the tree-covered terrains, which provided different areas for the given classes. From the perspective of the ecosystem services, including the regulating ecosystem services, the presence of forests is a good example. Despite the numerous classes assigned to forest areas (Table 1), CLC ultimately reduces their areas due to the classification of certain areas as green urban areas. This is particularly visible in the Bielany district, where the Bielany Forest is classified as a green urban area, which made the forest area 499.8 ha (Table 2). According to statistical data[15], the forest area in Bielany is 804 ha. The estimated value (939 ha) was provided by the UA study. If the research is used for planning studies for communes and districts, such differences can provide flawed evaluation of the services and benefits provided to humans from urban ecosystems. For carbon sequestration, the forests have greater potential due to the great tree density (our assessment: average of 90%). For green urban areas, these can be parks dominated by lawns and individual trees, but also forest parks. For these reasons, the estimated tree cover percentage value is lower.

The assessed carbon sequestration value for the surveyed areas was similar. There were considerable differences in the estimated carbon sequestration for the city of Łomianki. This results from the diverse qualification of the artificial surface, which is 74% on the CLC map and 61.9% on the UA map, where the CLC has more land cover classes with a specific tree cover percentage assigned (Table 1).

Conclusions

The differences in carbon sequestration result from the various legends in both classification systems, from the various level of generalisation. CLC holds more categories for areas not built up. A flaw of CLC is the appearance of mixed categories (242, 243), the share of which is big in Poland due to the fragmented

[14] R.A. Rowntree, D.J. Nowak, *Quantifying the role of urban forest in removing atmospheric carbon dioxide*, "Journal of Arboriculture" 1991 no. 17(10), p. 269-275.
[15] Statistical Review Warsaw, May 2012.

Table 2
Comparison of units structure and carbon sequestration among 6 study sites

Category	Area (ha)	NP (CLC)	NP (UA)	PD (CLC)	PD (UA)	Carbon tons/ha/year (CLC)	Carbon tons/ha/year (UA)	Forest ha (CLC)	Forest ha (UA)
Bemowo district	2492.2	55	734	2.207	29.452	0.175	0.170	304.1	293.1
Bielany district	3230.6	54	718	1.672	22.225	0.273	0.279	499.8	939.6
Izabelin rural commune	6494.6	98	454	1.509	6.990	0.620	0.624	5325.5	5333.3
Łomianki city	839.4	27	422	3.217	50.274	0.183	0.122	89.0	74.5
Łomianki rural commune	3039.8	54	580	1.776	19.080	0.194	0.233	649.7	822.3
Stare Babice rural commune	6334.9	88	1010	1.389	15.944	0.189	0.200	1413.9	1408.8

Source: own study.

structure of the rural areas. The tree cover percentage may be very diverse for these mixed categories. The tree cover percentage may also be very diverse for the urban green areas (from parks with sparse tree canopies to parks with dense tree cover and urban forests).

The available CLC and UA databases are only useful for comparison. The assessment of the actual carbon storage and carbon sequestration requires detailed tree canopy cover maps derived from orthophotos and the parameterisation of the C volume based on field surveys.

Despite the high resolution, the weak points of Urban Atlas in local surveys were revealed in the analysis of the provision ecosystem services. Ecosystem services provided at urban patch level (house, front garden, squares etc.) cannot be displayed by the Urban Atlas data[16]. Additionally, UA is developed only for cities with population over 100 000, which limits its use (27 cities in Poland).

As the most frequently used indicator of regulating ecosystem services in the Warsaw urban sprawl zone within 6 administration units, the surveys of carbon sequestration established that CLC and UA are not satisfactory cartographic material for the local scale in the assessment of the ecosystem services. The creation of spatial development plans at the level of the communes and their fragments should include field surveys aimed to verify the data obtained from the CLC and UA database and apply the indicators, which are not closely associated with the CLC and UA database. In the case of cities not covered by Urban Atlas, CLC should include verification of the data concerning the forest and semi-natural area.

[16] N. Larondelle, D. Haase, *Urban ecosystem services assessment along a rural–urban gradient: A cross-analysis of European cities,"* Ecological Indicators" 2013 no. 29, p. 179-190.

Małgorzata Burchard-Dziubińska

URBAN FARMING – UNDERESTIMATED SOURCE OF ECOSYSTEM SERVICES. ALLOTMENT GARDEN CASE STUDY

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ROLNICTWO MIEJSKIE – NIEDOCENIANE ŹRÓDŁO USŁUG EKOSYSTEMOWYCH. STUDIUM PRZYPADKU OGRÓDKÓW DZIAŁKOWYCH

STRESZCZENIE: W miastach i metropoliach na całym świecie rosnąca populacja mieszkańców, aby osiągnąć wysoki standard życia, potrzebuje więcej terenów zielonych. Tymczasem stare ogrody działkowe stają się zagrożone z uwagi na wysokie ceny gruntów w centrach miast. Konieczne staje się wypracowanie i wprowadzenie nowych argumentów na rzecz ochrony tych obszarów jako właściwych dla rolnictwa miejskiego. W takim przypadku nierynkowe metody wyceny mogą być pomocne w szacowaniu z punktu widzenia wszystkich mieszkańców miasta wartości usług ekosystemowych związanych z ogrodami działkowymi. Uwzględnienie wartości tych usług, wpływając dodatnio na cenę działek, powinno ułatwić ich zachowanie w dotychczasowym zastosowaniu.

SŁOWA KLUCZOWE: usługi ekosystemowe, rolnictwo miejskie, metody wyceny

Ecosystems and ecosystem services

Before discussion, the problem of ecosystem services provided by allotment gardens in cities should be defined the basic concepts: In accordance to the UN Convention on Biological Diversity, an ecosystem is a dynamic complex of plant, animal and micro-organism communities and non-living environment interacting as a functional unit. The interpretation of ecosystems in this paper also entails agricultural and semi-natural systems. Functions of ecosystems, defined as the capacity of the ecosystem to provide directly or indirectly goods and services, that satisfy human needs, may result in the supply of ecosystem services. Ecosystems provide a wide variety of economically valuable services, including gas regulation, climate regulation, waste treatment, water regulation, water supply, disturbance buffering, plant and animal habitat, nutrient cycling and other[1].

Ecosystem services include both economic goods and services provided by ecosystem to society[2]. For instance, the function "capacity to supply fruits and vegetables" may provide two services: 1) recreation and 2) supply of fruits and vegetables as food product, involving two different sets of stakeholders. The user has the choice: valuing services or functions. Both express, in principle, the benefits supplied by the nature to society. The main difference is that valuation of services is based on valuation of the flow of benefits, and valuation of functions is based on the environment's capacity to supply benefits.

In literature following types of ecosystem services are distinguished: provisioning services, regulating services, cultural services and supporting services. Based upon Millennium Ecosystem Assessment short description of these categories is as follows[3]:

- Provisioning services reflect goods and services produced by or in the natural, semi-natural or agricultural ecosystem (for example fruits, wood, fish).
- Regulating services result from the capacity of ecosystem to regulate climate, hydrological and biochemical cycles, earth surface processes and variety of biological processes.
- Cultural services relate to the non-material benefits people obtain from ecosystem via recreation, cognitive development relaxation and spiritual reflection.
- Supporting services represent the ecological processes that underlie the functioning of ecosystems.

[1] T. Żylicz, *Valuating ecosystem services*, „Ekonomia i Środowisko" 2012 no. 2, p. 20.
[2] R. Costanza, et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997 no. 387, p. 253-260.
[3] MEA, *Millennium Ecosystem Assessment*, *Ecosystems and Human Well-being: Synthesis*, Washington D.C. 2005, p. 10, www.millenniumassessment.org [20-09-2014].

The issue of growing costs of biodiversity loss and ecosystem degradation was described in the study *The Economics of Ecosystems and Biodiversity*, in which "value of nature" has been widely discussed[4].

In this paper these concepts are going to be used to analyze the services provided by ecosystems in association with urban farming in allotment gardens. In this case there are some difficulties in analyzing the supporting services and their value. Hence, only provisioning, regulating and cultural services will be taken into consideration.

Long history of urban farming

Historical examples of urban farming

The best known examples of urban farming are associated with wars. During the First World War president Woodrow Wilson called upon all American citizens to utilize any available open space for food growth. By the year 1919 over 5 million gardening-lots were growing food and over 500 million pounds of agricultural production were harvested. By the time of the Second World War the administration set up a National Victory Garden Program, that concerned the establishment of functioning agriculture within cities. As many as 5.5 million Americans took part in the Victory Garden movement and over 9 million pounds of fruit and vegetables were grown per year, accounting for 44% of U.S.-grown produce throughout that time. Similar in the United Kingdom (the campaign "Dig for Victory") and Canada citizens were successful in growing vegetables in their Victory Gardens. However the history of such urban farming is much longer and has its roots in movement against poverty and food insecurity. The Great Somerford Free Gardens in the Wiltshire village of Great Somerford were created in 1809 following a letter from Rev. Stephen Demainbray to King George III in which he asked the king to spare, in perpetuity, 6 acres from the Inclosure Acts for the benefit of the poor of the parish[5]. In rapid developing industry cities in the early 19th century the idea of allotment gardens came to life in many countries (in the Netherlands first gardens were founded in 1838, in Prussia so-called Schreber Movement in Leipzig in 1864, during the Great Depression in 1893, citizens of a depression-struck Detroit were asked to use any vacant lots to grow vegetables, in Norway the oldest, Etterstad Kolonihager, dates to 1908). With the large number of people migrated from the rural areas to the cities to find employment there had arisen a problem of social neglect in different forms, including malnutrition. To improve overall situation of poor workers', families were allowed to grow their own food. The city administrations, churches or their employers were provided open spaces for gardening purposes. These were initially called the "gar-

[4] *The Economics of ecosystems and biodiversity*, European Communities 2008, www.unep.ch [29-10-2014].
[5] R. Savill, *England's oldest allotments celebrate 200 years*, www.telegraph.co.uk [12-05-2014].

dens of the poor". It existed in two forms: allotment and community garden. Allotments are parcels cultivated individually, contrary to other community garden types where the entire area is attended collectively by a group of people[6].

New wave of urban farming

Nowadays, the idea of supplemental food production beyond rural farming operations and distant imports is still inspiring new activities both in highly developed and developing countries. For example, new wave of urban farming as a response to the problems associated with the crisis started after 2008 in many big cities in U.S. The New York City Department of Environmental Protection offers a grant program for private property owners in combined sewer areas of New York City. The minimum requirement is to manage 1" of stormwater runoff from the contributing impervious area. Projects include green roofs, rooftop farms, and rainwater harvesting on private property in combined sewer areas. Because of the special municipal grant programs, such as The Green Roof Tax Abatement Program, and Green Infrastructure Grant Program, New York City now has the world's largest rooftop farms[7]. Some urban gardeners have used empty lots. The City has a composting program. There are also provided free seedlings, courses on growing and selling food. NGOs are also involved in this activity.

Similarly in California in response to the recession of 2008, a coalition of community based organizations, farmers and academic institutions formed the Pomona Valley Urban Agriculture Initiative. It is addressed to the poorest inhabitants, mostly Latino and African–American, among those the aggregate poverty and aggregate unemployment are very high[8].

Another interesting example is a town Todmorden in Yorkshire (United Kingdom), which has successfully developed innovative urban agriculture model in "propaganda gardens". In the project, which began in 2008, food crops have been planted at forty locations throughout the town[9]. Initiative Incredible Edible Todmorden was born after the meeting "against the tide of the Americanization of the British diet, of the Tesco-ization of food retailing, of the dissociation of food from its agricultural and geographic provenance, as well as of a centuries-late response to the off-shoring of British agricultural biodiversity and of food pro-

[6] E. MacNair, *The Garden City Handbook: How to Create and Protect Community Gardens in Greater Victoria*, Polis Project on Ecological Governance, Victoria BC 2002.

[7] F. Fabricant, *From roof to table*, "The New York Time" 2010, July 27, www.nytimes.com, www.treehugger.com [20-09-2014].

[8] Demographic information from the U.S., www.Quickfacts.census.gov [25-08-2014].

[9] J. Paull, *Please Pick Me – How Incredible Edible Todmorden is repurposing the commons for open source food and agricultural biodiversity*, in: J. Franzo, D. Hunter, T. Borelli, F. Mattei (eds.), *Diversifying Foods and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health*, Oxford 2013, p. 336-345.

duction generally"[10]. However the most important issues ware social and educational aspects, biodiversity was taken into consideration.

In many cities in less developed countries urban farming movement is actually present with support received from local authorities, NGOs and volunteer workers. In Bangkok (Thailand) in early 2000, two urban gardens were started under the direction of the NGO Thailand Environment Institute (TEI). The main tasks were to[11]:

- teach members of the communities the benefits of urban green space.
- create the social framework to plan, implement, and maintain the urban green space.
- create a process of method to balance the needs of the community with the needs of the larger environmental concerns.

Different forms of urban farming are successfully developed in Cairo (Egypt), Beijing (China), Mumbai (India). Gardens organized by schools to reach at the same time two goals: teaching and diversifying the diet of students from dwellers' families, are popular.

Allotment gardens in Poland

First allotment gardens in the territory of the present Republic of Poland were created in 1901. Post-second-war history and development of allotments started from 9 March 1949, when the Parliament adopted the Law "On employee allotments" (Journal of Laws No. 18, item. 117). The new law came into force on the 19th January 2014. This allowed to save the legacy of allotment gardening in Poland, including almost 5.000 gardens. In the years 1960-2011 the number of allotments has increased by 62.4%, their area of almost 210% and the number of plots of 242%. In turn, average size gross of a plot (together with the area of general purpose) decreased of 496 m^2 in 1960 to 449 m^2 in 2011. In the same period average gross area of garden allotment was increased from 4.6 ha to 8.8 ha, and the number of plots per each of them has more than doubled (from 93 to 196).

Table 1
Allotment gardens (AG) in Poland

Category	1960	1970	1980	1985	1990	1995	2000	2005	2011
Number of AG	3042	3069	5404	7488	7938	5285	5169	4960	4941
Area in hectars	14033	18873	27124	40059	43097	43951	43706	43523	43427
Number of plots (in thousands)	283	393	614	899	970	980	965	968	968

Source: *Environmental Protection Yearbook* GUS, Warszawa 2012.

[10] Ibidem, p. 337.
[11] E.D.G. Fraser, *Urban Ecology in Bangkok Thailand: Community Participation, Urban Agriculture and Forestry*, "Environments" 2002 no. 30(1).

The role of urban farming in contemporary cities and metropolises

In the long history of allotment gardens and urban farming around the world the most important were provisioning services. The production of fruits and vegetables had developed to provide food for citizens who suffered because of malnutrition caused by heavy life conditions during wars or connected with unemployment and poverty. On the second place were cultural services. Gardening in allotment garden has positive impact on society in several aspects. These include recreation and leisure, individual health and well-being, community health and well being, environmental health, opportunities for outdoor activities[12].

Nowadays, the allotment gardens (like other green areas) are considered as source of several regulating services, which play an increasingly more important role in expanding and crowded cities.

Taking into consideration that already more than half the world's population lives in cities and the number of urban citizens is still growing, not only the problem of providing access to fresh food in proper amount is becoming more and more severe. Another difficult issue is air pollution, particularly in rapid developing big cities with strong pressure on transport development. Permanent smog and noise are a health hazard. Worsening living conditions for all city – residents stimulates the quest for new patterns of construction and land management. Empty plots, roofs and walls are potential space for urban farming, which could play different social, economical and environmental roles. Under such conditions the old allotment gardens gaining importance because of regulating services provided by: carbon sequestration, regulation of temperature, control of erosion, regulation of species reproduction and biodiversity conservation, pollination, protection against noise and dust, water retention. They play also an important role in landscape beautification and environmental restoration and remediation (by using and reusing natural resources and urban wastes to yield a diversity of crops and livestock)[13].

Positive environmental impact of food production in allotment gardens results from energy efficiency and reduction of carbon footprint – locally grown food could save transport-related emissions[14] and thereby can reduce each city's carbon footprint by reducing the amount of transport that occurs to deliver goods to the consumer. Also allotment gardens can act as carbon sinks[15] offsetting some of carbon accumulation in urban areas, where pavement and buildings outnum-

[12] L. Butler, D.M. Moronek (eds.), *Urban and Agriculture Communities: Opportunities for Common Ground*, Iowa 2002.
[13] J. Smit, A. Ratta, J. Nasr, *Urban Agriculture: Food, Jobs, and Sustainable Cities*, UNDP, New York 1996, NY.
[14] M. Xuereb, *Food Miles: Environmental Implications of Food Imports to Waterloo Region*, Public Health Planner Region of Waterloo Public Health, November 2005.
[15] D.B. Rowe, *Green Roofs as a Means of Pollution Abatement*, National Center for Biotechnology Information, U.S. National Library of Medicine, n.d. Web. 25 Mar. 2013.

ber plants. Plants absorb atmospheric Carbon Dioxide (CO_2) and release breathable Oxygen (O_2)[16].

The reduction in ozone and other particulate matter can benefit human health[17]. Reducing these particulates and ozone could reduce mortality rates in urban areas along with increase the health of those living in cities[18].

The implementation of allotment gardens in vacant lots can be a cost-effective method for removing chemicals and other wastes. In the process known as phytoremediation, plants and the associated microorganisms are selected for their chemical ability to degrade, absorb, convert to an inert form, and remove toxins from the soil[19]. Phytoremeditation is both an environmentally friendly, cost-effective, and energy-efficient measure to reduce pollution. Phytoremediation only costs about $5–$40 per ton of soil being decontaminated[20]. Implementation of this process also reduces the amount of soil that must be disposed of in a hazardous waste landfill.

Plants and green areas help also to reduce noise pollution. The exposure to continual noise is a serious public health problem which it can cause hearing impairment, hypertension and ischemic heart disease, annoyance, and sleep disturbance[21].

Valuation of allotment gardens ecosystem services

The mentioned benefits provided by allotment gardens ecosystems have a wide range of recipients. Stakeholders are not only owner of plots, who produce their crops, but all people residing in or otherwise depending upon the area affected by the ecosystems services.

In the discussion about the role of allotment gardens in the contemporary cities and metropolises economical arguments are of high importance – in particular price of land where plots are situated. Competitive against the allotment gardens' possibilities to use as sites for residential or other purposes inevitably

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[16] M. Xuereb, op. cit.

[17] H. Mayer, *Air pollution in cities*, "Atmospheric Environment" 1999 no. 33, p. 4029-4037.

[18] In the article written by D.B. Rowe, *Green roofs as a means of pollution abatement*, the author argues that a rooftop containing 2000 m^2 of uncut grass has the potential to remove up to 4000 kg of particulate matter. According to the article, only one square meter of green roof is needed to offset the annual particulate matter emissions of a car; "Environmental Pollution" 2011 no. 159, v. 8-9, p. 2100-2110; Selected papers from the conference Urban Environmental Pollution: Overcoming Obstacles to Sustainability and Quality of Life (UEP2010), 20-23 June 2010, Boston, USA.

[19] H. Black, *Absorbing Possibilities: Phytoremediation*, "Environ Health Perspectives" 1995 no. 103(12), p. 1106-108.

[20] M.M. Lasat, *Phytoextraction of metals from contaminated soil: a review of plant /soil/metal interaction and assessment of pertinent agronomic issues*, "Journal of Hazardous Substance Research" 2000 no. 2, p. 1-25; C. Cluis„ *Junk-greedy Greens: phytoremediation as a new option for soil decontamination*, "Biotechnology Journal" 2004 no. 2, p. 61-67.

[21] W. Passchier-Vermeer, W.F. Passchier, *Noise exposure and public health*, "Environmental Health Perspectives" 2000 no. 108(1), p. 123-131.

Table 2

Valuation methods and value types – possibilities of apply in valuation of allotment gardens ecosystem services

Valuation method	Suitable for valuation of	Suggestions of analyze			
		direct use values	indirect use values	option values	non-use values
Market valuation	goods and services traded on the market	x	x		
Contingent valuation methods	goods and services that are easily to comprehend for respondents	x		x	x
Hedonic pricing	environmental amenities reflected in the prices of specific goods, in particular property	x			
Damage function approach	losses of ecosystem services which cause economic damage (e.g. through an increased noise and dust pollution)		x		
Travel cost method	recreation services	x			
Ecological valuation	biodiversity conservation service				x

Source: own description based on L. Hein, *Economics and Ecosystem, Efficiency, Sustainability and Equity in Ecosystem Management*, Cheltenham UK, Northampton, MA USA, 2010, p. 41.

leads to liquidation of the gardens. In typical calculation, the market value of fruits and vegetables produced in allotment gardens is not able to offset the revenues from alternative uses of these sites. Moreover, the provisioning function is often replaced by cultural functions, primarily related to recreation, which is harder measurable in money. Local governments, seeking for higher budget incomes, are ready to change local plans. Such problems were observed in the last two decades in several cities in Poland. Many allotment gardens, still situated in cities centers, are "tasty morsel" for developers. Based on the theory of ecosystem services and their valuation arguments can be formulated for the protection of allotments in cities. Methodological suggestions are presented in Table 2.

All provisioning services (e.g. fruits, vegetables) and some cultural services (e.g. recreation) have direct-use value. Indirect use value stems from the indirect utilization of ecosystems, mainly by the positive externalities that ecosystems provide to society (e.g. air purification, noise suppression, beautification of space). Option value relates to future demand for services when people are willing to pay to keep the option of using a resource in the future for well known and new (unknown) purposes (e.g. new herbal medicine). Non-use value is imminent attribute to ecosystem. From anthropocentric point of view it could be beauty of gardens but ecocentric point of view is worth noting as well. Example is "right to exist" of plants and animals species in urban space[22].

[22] L. Hein, *Economics and ecosystem, efficiency, sustainability and equity in ecosystem management*, M.A. 2010, p. 36.

Conclusions

New arguments based on valuation methods particularly of ecosystem regulating services could add to the discussion on urban farming in allotment gardens noteworthy input.

Space is at a premium in cities and is accordingly expensive and difficult to secure. Maintaining lands of allotment gardens in their current use could be easier through the estimation of value of regulatory and cultural services, which are rather not reflected in the price of these plots. It means, that new research should be conducted to find more precise information what is real the value of non-market services of urban semi-natural ecosystem in allotment gardens for all citizens and not only for plots owners.

This will enable to look from a different perspective at the issue of existence in the urban centers of old allotment lots. Its value is now underestimated, which makes it difficult to protect this area "as gardens for all".

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THE VALUATION OF TREES IN THE URBANIZED AREAS WITH THE COMPENSATION/ REPLACEMENT METHOD AND BENEFITS ANALYSIS (THE CASE OF THE CITY OF GNIEZNO)

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WYCENA WARTOŚCI DRZEW NA TERENACH ZURBANIZOWANYCH METODAMI KOSZTU ODTWORZENIA I ANALIZY KORZYŚCI (PRZYKŁAD MIASTA GNIEZNA)

STRESZCZENIE: Do określenia wartości drzew na terenach zurbanizowanych są stosowane różnorodne metody. W związku z odmienną metodyką, uzyskiwane wyniki są często trudne do porównania. Powoduje to liczne trudności, zarówno w wymiarze teoretycznym, jak i praktycznym. W artykule podejmowana jest próba porównania wyników wyceny wartości drzew uzyskanych dzięki zastosowaniu dwóch metod wyceny – metody kosztu odtworzenia i analizy korzyści. Badaniami objęte zostały drzewa przyuliczne miasta Gniezna.

SŁOWA KLUCZOWE: świadczenia ekosystemów, drzewa, wycena, wartość ekonomiczna

Introduction

The knowledge of the economic value of trees has a significant meaning for managing the stand of trees in the urbanized areas. Information in this area may be unusually useful in investment planning, assessing the impact of the investment on the surrounding natural environment, establishment and development of green areas and their appropriate cultivation. Lack of appropriate information may lead to unplanned and often unrealized losses, transferred into particular quantifications. The cause may be lost benefits because of limited profits coming from the trees, particularly oxygen production, carbon dioxide absorption and water retention.

The estimations of the economic value of the stand of trees were made in the United States and chosen European countries[1]. The estimations were conducted with different methods. In Poland, despite running research on the tree values, the research was rather qualitative than quantitative. So far, no comprehensive economic estimation of the state of trees was conducted for particular spatial unit. It stems from a few reasons: lack of obligation of conducting natural environment valuation in Polish conservancy laws, lack of appropriate, consistent and comprehensive valuation method which would be adopted by the conservancy administration and lack of knowledge and appropriate distribution of already developed methods.

The aim of this article is to present the results of the valuation of street trees in the town of Gniezno. Thanks to the assumed methodology of the research, the obtained results help to compare the value which was determined with the compensation/replacement method and the value determined based on the provided ecosystem services.

Trees as the subject of economic valuation

Trees have specific properties which significantly influence their value. These properties include: the species, age, morphological features, change in time(height, volume increase, shape change),changes concerning the increased vitality in the development process, plants flexibility while adapting to new environmental conditions, location. These features have significant meaning in determining the criteria of tree value estimation[2].

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[1] See e.g.: D.J. Nowak, D.E. Crane, J.F. Dwyer, *Compensatory value of urban trees in the United States, "*Journal of Arboriculture" no. 28(4), p. 194-199; G.H. Donovan, D.T. Butry, *Trees in the city. Valuing street trees in Portland, Oregon, "*Landscape and Urban Planning" 2010 no. 94, p. 77-83; M. Giergiczny, J. Kronenberg, *Jak wycenićwartość przyrody w mieście? Wycena drzew przyulicznych w centrum Łodzi,* in: T. Bergier, J. Kronenberg (eds.), *Zrównoważony rozwój – zastosowania,* Kraków 2012, p. 73-89.

[2] H.B. Szczepanowska, A. Latos, *Synteza badań i założenia merytoryczne metody wyceny wartości drzewa dla warunków polskich,* Warszawa 2009.

The compensation/replacement method (CM/RM) is most often used in the cities to estimate the value of trees. This method has been legally recognized in many countries. The cost-benefit analysis (CBA) is frequently used. Hedonic price method (HPM), conditional value method (CVM) and conditional choice method (CEM) are used more rarely.

The compensation/replacement method includes the cost of planting and cultivating the trees, which are the compensation of removed or damaged trees. The variants of this method are used in different way in different countries. In the United States this method was used for the valuation of trees in the New York City and it amounted to USD 5.2 billion (996 dollars per tree), in Jersey City – USD 101 million (USD 742 per tree), in Boston USD 1.3 billion (USD 1058 per tree),and in Oakland USD 757 million (477 dollars per tree). In total, the value for the whole country was estimated at USD 2.4 trillion[3].

The cost-benefit analysis is also used to estimate the economic value of trees. It involves balancing the costs related with maintaining city greenery with expected benefits provided by trees in cities. This method was used in the New York City. The research included 592 000 trees. The analysis showed that trees in the streets of New York bring to its inhabitants the net profit of USD 122 million annually (209 dollars per tree). The following benefits were included in the research: the limitation of energy consumption, CO_2 absorption, pollution absorption, water retention and the impact of trees on the properties. It was estimated that 1 dollar spent on planting and cultivation of trees brings to the city the profits amounting to USD 5.60[4].

Another method which is often applied is the hedonic price method. It is underlined in many conducted research that the natural environment, e.g. trees along the street, impacts the price of a particular property a buyer is willing to pay (particularly in urbanized areas). In Portland, the biggest city of the State of Oregon236,000 trees were inventoried[5]. The research included 2608properties. It was stated that the presence of the trees growing within the distance not exceeding 30.5m from a housecontributed to the increase of the property value of approximatelyUSD 8870(3% of the property value). After rounding this result off, the authors indicated that the trees along the city streets have the value of USD 1.35 billion. It was also stated that the house surrounded by trees growing along the streets were easier to sell. The buyers made the decisions to buy these houseon average 1.7 days earlier. However, it seems that this method is less significant in Poland due to a number of different economic and social conditions[6].

Contingent valuation method involves conducting survey interview. While presenting a hypothetical scenario, the buyers give an answer and quote the price they would be willing to pay for the delivery of particular goods. The plan of

[3] D.J. Nowak, D.E. Crane, J.F. Dwyer, op. cit.
[4] P.J. Peper et al., *New York City, New York — Municipal forest resource analysis*, Davis 2007.
[5] G.H. Donovan, D.T. Butry, op. cit.
[6] A. Bernaciak, N. Strzelecka, *Natural values as a factor in the location of residential invetsments*, "Economic and Environmental Studies" 2014 no. 14, v. 2, p. 149-162.

the research, conducted in the United States, in 44 cities of the Missouri state, assumed the creation of a fund which would allow for betterkeeping of trees in the cities. The inhabitants expressed their support for establishing the tree fund by paying taxes. In bigger cities, more than half of the inhabitants were willing to paybetweenUSD 14-16 per householdannually[7].

The value of trees in a city may also be estimated with the choice experiment method. Similarly to contingent valuation method, it requires the preparation of hypothetical scenarios of providing services, but the difference is that the respondents have torank these scenarios from the most to the least convenient for them. This method was used in Poland to value the price of street trees in Łódź[8].

The research conducted so far in the economic value of trees allow to draw some conclusions. First of all, there is no one consistent, universal method, which could be applied for economic valuation of trees globally, and consequently could be the legal and formal base for the activities of administration institutions. Secondly, the use of different methods in trees valuation leads to obtaining different results, which may cause significant practical complications. The values obtained in different research conducted with different methods are not comparable to each other. Thirdly, the ecosystem benefits provided by the trees, which are in fact demanded by the society, are not always included in the applied valuation methods.

The compensation/replacement method and benefits analysis – methodological basis of the comparative studies

The valuation of trees with the replacement value, particularly for Polish spatial and environmental conditions was thoroughly developed by Institute of Spatial Management and Housing[9]. The method concerns the cost of the tree replacement by expressing the financial compensation for the potential loss of the tree. The tree circumference of 25 cm was assumed as the limit size of trees which should be reinstated in the form of natural restitution. The cost of a growing tree in this particular circumference was assumed as so called basic value. This value is verified with the application of so calledmaterializing factors.These factors concern the tree condition, its location, species and growth. Depending on the circumference, the calculating formula of the real tree value(RWD) is presented in the following way[10]:

- for the trees of the circumference 20/25 cm: RWD = WP x K x L (1)
- for the trees of the circumference below 20 cm: RWD = WP x M x K x L; (2)
- for the trees of the circumference above 25 cm: RWD = WP x G x P x K x L;(3)

[7] T. Treiman, J. Gartner, *Are residents willing to pay for their community forests? Results of a contingent valuation survey in Missouri, USA,* "Urban Studies" 2006 no. 43 v. 9, p. 1537-1547.
[8] M. Giergiczny, J. Kronenberg, op. cit.
[9] H.B. Szczepanowska (ed.), op. cit.; H.B. Szczepanowska, A. Latos, op. cit.
[10] H.B. Szczepanowska (ed.), op. cit.

where:
WP – basic value in PLN for particular tree species;
K – condition coefficient;
L – location coefficient;
M – coefficient of decreasing the value depending on the tree circumference size;
G – species value coefficient;
P – tree growth coefficient.

The value of services provided to social and economic system by trees (benefits analysis) has been the reference point in this research. Although trees are the source of many benefits included in Common International Classification of Ecosystem Services (CICES)[11], it is suggested only these benefits be included in the valuation whose value can be calculated most precisely. These benefits include:the absorption of carbon dioxide, oxygen productionand water retention. The calculation of the value of these benefits may be made with relatively high precision. It is very difficult to value other benefits. Even if it is possible, the result of such valuation has a significant mistake. It is suggested naming the sum of the values calculated for three types of benefits asthe minimum service value [MWU]. The real value of provided benefits [RWS]is definitely higher than the minimum service value (therefore the denomination "minimum"), however this value is difficult to calculate,therefore it is not included in quantitative categories.

$$RWD > MWU\ (pd, pt, rw) \tag{4}$$

where:
CWD – the total value of a tree
RWD – the real value of a tree
MWU – the minimum service value
pd – carbon dioxide absorption
pt – oxygen production
rw – water retention

The determination of such value may have significant practical meaning. It allows to relatively easily calculate the value of particular object and confront it with possible consequences of the activities taken on such object(e.g. removal, the decrease of provided benefits). Therefore it may be a useful instrument in local urban planning or the assessment of the environment impact.

The calculation of the provided benefits remains an important issue: the absorption of carbon dioxide (pd), oxygen production (pt)and water retention (rw).

The data concerning the amount of carbon dioxide absorbed by trees was compiledbased on the data available in literature[12]. The data indicates that the

[11] European Environment Agency (EEA), *Common international classification of ecosytsem services* (CICES), 2013, *Consultation on version 4,* www.cices.eu [18-06-2014].
[12] D.J. Nowak, A*tmospheric carbon dioxide reduction by Chicago's Urban Forest,* in: E.G. McPherson, D.J. Nowak, R.A. Rowntree, *Chicago's Urban Forest ecosystem: results of the Chicago, Urban Forest Climate Project,* Forest Service 1994; American Forests 2014, *Tree facts,* www.americanforests.org [18-06-2014]; NCSU, *Tree facts,* www.ncsu.edu [18-06-2014]; AEA (Arbor Environmental Alliance), *Carbon&Tree Facts,* www.arborenvironmentalalliance.com [18-06-2014];

Table 1
The amount of services provided by trees

Tree circumference [cm]	Absorption of carbon dioxide [kg/year]	Oxygen production [kg/year]	Water retention [l/year]
8-25	10.90	2.90	1000.00
26-40	21.60	15.80	1750.00
41-71	48.00	22.60	2125.00
72-99	94.80	45.60	2500.00
100-143	141.50	68.40	3500.00
144-170	235.10	91.10	4500.00
171-239	399.00	110.30	5282.00
Above 240	486.60	118.00	6064.00

Source: own elaboration based on the literature data indicated in the text.

average amount of CO_2 absorbed by a tree amounts to 164.90 kg/year (from 10.90 kg/yearfor the smallest trees to 486.60 kg/year for the biggest ones). Eight classes of the trees' circumferences were established based on the literature. The appropriate amounts of absorbed carbon dioxide were established correspondingly (Table 1).

The price of EUA certificate for the Polish market was assumed in order to determine the value of absorbed carbon dioxide unit. The average monthly prices of carbon dioxide in 2013 varied between 3.57 to 5.22 PLN/CO_2 ton (the average – 4,47 euro/ton). The average annual exchange rate was assumed for currency calculations. After performing the appropriate currency and unit calculations, the price of 1 kilogram of CO_2 in time of performing the analysis amounted to 0,02 PLN/kg.

Similarly, the value of oxygen production was determined based on the literature data[13]. The data analysis indicated that the amount of oxygen delivered by

Urban Forestry Network, www.urbanforestrynetwork.org [18-06-2014]; A.L. Soares et al., *Benefits and costs of street trees in Lisbon, Portugal, "*Urban Forestry & Urban Greening" 2011 no. 10; "Ekspertyza natemat ekonomicznych I ekologicznych zysków wypływających z Programu Lesistości Miasta pod kontem absorpcji CO_2 – Gmina Wrocław"; E.G. McPherson, J.R. Simpson, *Carbon dioxide reduction through urban forestry*. *Guidelines for professional and volunteer tree planters,* Forest Service 1999; D.J. Nowak, D.E. Crane, *Carbon storage and sequestration by urban trees in the USA, "*Environmental Pollution" 2002 no. 116, p. 381-389; *The morton arboretum*, www.mgrieblerdev.devcloud.acquia-sites.com [12-06-2014].

[13] D.J. Nowak, R. Hoehn, D.E. Crane, *Oxygen production by urban trees in the United States,* "Arboriculture&Urban Forestry" 2007 no. 33(3), p. 220-226; J. Borowski, 2013, *Dlaczego warto sadzić I pielęgnować drzewa?, www.*sadybamazury.wordpress.com [15-06-2014]; T. Tylkowski, *Drzewa dla terenów zieleni*, „Przegląd Komunalny" 2006 no. 8, www.e-czytelnia.abrys.pl [15-06-2014]; American Forests, *Tree facts,* www.americanforests.org [15-06-2014]; M. McAliney, *Arguments for land conservation: Documentation and information sources for land resources protection*, Sacramento CA 1993; E.G. McPherson, *Benefits of trees, watershed, energy and air,* "Arborist News" 2004 no. 13(6), p. 29-35.

one tree varies between 0.70 and 3500 kg annually and increases proportionally to the tree circumference. Eight ranges of tree circumferences were established along with their corresponding amount of produced oxygen (Table 1).

The value of a produced oxygen unit was established based on the market offer of medical oxygen. During the study, the lowest price of 1 kg of oxygen amounted to 14.00 PLN/kg.

Similar proceedings were assumed for another benefit, the retention of water.The scope of retention was established based on literature data[14].

Assuming that the scope of retention is proportional to the size of a tree and following the available data, the scope of retention was established for eight circumference ranges (Table 1).

The establishment of a coefficient to determine the value of retention in financial categories may be somehow difficult. The following argumentation was assumed. Trees absorb water from the ground and transport it to the leaves through the vascular cambium. Water vapors out of the plant through leaves. This process reminds the functioning of a water pump. The cost of a pump work may be determined based on the electricity used for this purpose. Therefore the value of the service of pumping a particular unit of water can be established based on the costs such as the electricity used for this purpose (other costs, including the costs of purchasing the pump are excluded). To perform the appropriate calculations, the pump with the lowest cost of pumping a unit of water was chosen from the pumps available in the market. Simultaneously, the maximum power consumption of the pump and the lowest price of electricity during the conducted analysis were taken into consideration. Based on these assumptions, the value of pumping 1 m^3 of water was established and it amounted to 0.02 PLN/m^3.

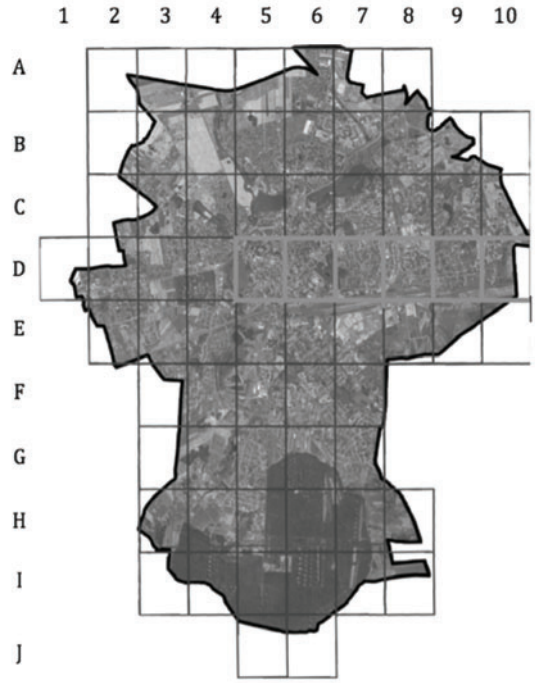
The value of street trees in the town of Gniezno

The research of the economic value of trees was conducted in the town of Gniezno in September 2013. The area of the research was marked with vector numerical map, which divides the city into 68 equal parts. These were placed in the topographic map of Gniezno in 1:50 000 scale. The parts were called sections (figure 1).

The particular sections were marked longitudinally – with the subsequent letters of the alphabet and latitudinally – with the numbers from 1 to 10. The surface of each section is 79.9 ha. Six sections in the longitudinal sequence from D5 to D10 were chosen for the research. The chosen sections start from the suburb area (D10) and end in the city centre (D5). Each section is characterized by different spatial structure. The total area that was researched covered 479.4 ha.

[14] E.G. McPherson, op. cit., p. 29-35; A.L. Soares et al., op. cit.; www.urbanforestrynetwork.org [12-06-2014]; The Morton Arboretum, www.mortonarb.org [12-06-2014].

Figure 1
Division of the town of Gniezno into sections



Source: own elaboration.

5154 trees were inventoried in the researched area including 1619 street trees (31%). Most of the trees were located in D6 section (41% of the total number of trees), where there was the domination of trees accompanying the architectural buildings. The trees were located next to public buildings, schools, churches and in the playground parks. The lowest number of trees was found in D10 section, characterized by the dominating agricultural function (Table 2).

The economic value of trees in the research area, calculated with the compensation/replacement method was estimated at over PLN 50 million. The average value of one tree is over PLN 13.5 thousand. Meanwhile, the value calculated based on the provided ecosystem services is slightly above PLN 2.5 million annually, and the average value of one tree in this case amounts to PLN 560. It must be emphasized that the compensation/replacement method refers to the whole life-cycle of a particular tree. Therefore, the time frames, when the value of the provided services is summed up, should be determined in order to compare the results obtained from these two methods. These time frames can be associated with the average lifespan of a tree in the urban development. The lifespan of 30 years was assumed for the needs of this research. In this period of time the value of trees calculated with the cost analysis method amounted to more than PLN

Table 2
The results of tree inventory in the town of Gniezno, sections D5-D10

Specification	D5	D6	D7	D8	D9	D10	Total
Number of trees in section	1845	2107	892	239	55	16	5154
Including street trees	240	645	513	150	55	16	1619
Number of deciduous trees	1254	1624	762	185	55	16	3896
Number of coniferous trees	591	483	130	54	–	–	1258
Average circumference [cm]	62,25	73,14	74,96	77,85	90,42	104,69	80,55
Average tree condition*	17,85	16,69	17,37	16,77	17,11	18,65	17,41
Tree condition assessment	average	average	average	average	average	good	average
Urban coefficient	1,1	1,1	1,3	1,3	1,3	1,3	1,3
Average value of location coefficient	0,96	1,06	1,09	1,18	1,05	1,2	1,08
The most popular tree species	*Thuja occidentalis*	*Thuja occidentalis*	Small-leaved lime (*Tiliacordata*)	European ash (Fraxinusexcelsior)	European ash (*Fraxinusexcelsior*)	European ash (*Fraxinusexcelsior*)	*Thuja occidentalis*
The most popular street tree species	Norway maple (*Acerplatanoides*)	Small-leaved lime (*Tiliacordata*)	Small-leaved lime (*Tiliacordata*)	European ash (Fraxinusexcelsior)	European ash (*Fraxinusexcelsior*)	European ash (*Fraxinusexcelsior*)	Small-leaved lime (*Tiliacordata*)

* The condition of trees, urban coefficient and location coefficient were determined pursuant to the tree valuation methodology suggested by Szczepanowska [2009]

Source: own elaboration.

Table 3
The value of trees in the town of Gniezno in researched sections [PLN]

Value category [PLN]	Section						
	D5	D6	D7	D8	D9	D10	Ogółem
Total compensation/replacement value	17 286 575,00	20 446 551,12	8 338 116,97	3 787 590,14	607 459,35	277 720,55	50 744 013,13
Average compensation/replacement value	12 595,44	9 726,12	11 612,98	15 847,66	14 126,96	17 357,53	13 544,45
Total value of services annually	772 642,61	1 080 857,92	486 146,10	134 263,19	32 077,56	11 892,94	2 517 880,31
Average value of services annually	418,78	512,98	545,01	561,77	583,23	743,31	560,85
Total value of services in lifecycle (30 years)	23 179 278,24	32 425 737,47	14 584 383,08	4 027 895,57	962 326,72	356 788,25	75 536 409,33
Average value of services in lifecycle (30 years)	12 563,29	15 389,53	16 350,21	16 853,12	17 496,85	22 299,27	16 825,38
Total value of services of carbon dioxide absorption	83 374,32	121 270,56	49 075,80	13 589,58	4 174,32	1 229,04	272 713,62
Total value of services of oxygen production	23 093 490,00	32 301 444,00	14 533 974,00	4 013 940,00	958 062,00	355 530,00	75 256 440,00
Total value of services of water retention	2 407,38	3 022,91	1 333,28	365,99	90,40	29,21	7 249,17

Source: own elaboration.

75.5 milion, and the average value – almost PLN 17 thousand (Table 3). The obtained results are therefore very similar to the results obtained with the compensation/replacement method. However, the previous assumption must be resembled that the value received from summing up the benefits obtained from only three services is treated as the minimum value. The real value, which is not calculated but theoretically assumed, takes into consideration the sum of all provided services. Therefore it is higher than the calculated minimum value.

Conclusions

It is necessary to adopt a homogeneous, universal and precise valuation method so that the tree valuation not only had the theoretical meaning but could serve for the optimization of management processes in environmental protection administration (spatial planning, environmental impact assessment).The more estimated character of the conducted valuation, the lower usefulness of such valuation. Simultaneously, the research progress in the area of ecosystem services and the importance attached to this issue by the European Union ecological policy demand the inclusion of this element in the valuation method.

The inclusion of ecosystem services provided by the trees, at least to the measurable scope expressed in money values, is a significant methodological challenge. It is particularly challenging due to the fact that the economic value of trees has many aspects, it depends on the adopted assumptions and the applied methodology.

The conducted research indicated that two different methods of calculating the trees value lead to obtaining very similar results. The differences between these methods stem from methodological shortages and therefore the necessity of accepting some simplified assumptions. The similar results, however, indicate the possibility of the interchangeable use of these compared methods and the probable use of the results obtained with one method to the analysis conducted with the use of the second method.

There are two problems appearing in relation with the conclusions described herein. These problems would require further research in order to be solved. Firstly, what period of time should be assumed as the average lifespan of particular tree species in urban development while determining the services provided by these trees. This factor significantly impacts the final result of the valuation with the benefit analysis method. Secondly – how to differentiate the value of provided services during the particular stages of tree development. Due to the lack of data in this area, a far reaching simplification was assumed for the needs of this research and no differentiations in the services value were made concerning the age of a tree. Answer to these two questions would allow to make one step towards discovering the real, exact value of trees growing in the urbanized areas.

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ECOSYSTEM SERVICES OF ABANDONED LAND IN A CITY. AN EXAMPLE FROM POZNAŃ

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USŁUGI EKOSYSTEMÓW TERENÓW ODŁOGOWANYCH W MIASTACH. PRZYKŁAD POZNANIA

STRESZCZENIE: Tereny odłogowane pojawiają się w wielu miastach na świecie. Ich liczba oraz charakterystyka zależna jest od warunków środowiskowych oraz społeczno-gospodarczych. W Poznaniu obszary nieużytkowane przez człowieka obejmują 10% powierzchni miasta, większość z nich stanowią tereny pokryte roślinnością, a co za tym idzie dostarczające usługi ekosystemowych. Ich powierzchnia jest porównywalna do obszaru zieleni urządzonej w Poznaniu i stanowi istotnym elementem ekosystemu miasta. Odłogi szczególnie efektywne dostarczają usług regulacyjnych. W niniejszej pracy zbadano skalę tych usług w zakresie zasilania wód podziemnych i retencji, oczyszczania powietrza oraz magazynowania węgla. Obszary te często zagrożone są przez nową zabudowę. Wykazywanie skali dostarczanych przez nie świadczeń może być wykorzystywane jako narzędzie pomocne w ochronie najcenniejszych z tych terenów.

SŁOWA KLUCZOWE: odłogi, roślinność spontaniczna, świadczenia ekosystemów

Introduction

Abandoned land constantly appears and disappears in cities. It is usually a part of almost every process of land use change, at least temporary. When land is unused by people the nature starts to use it for processes of vegetation growth. When land is unused for long periods of time natural succession usually tends to create ecologically valuable ecosystems. Such ecosystems could be an important part of green infrastructure in cities and provide variety of services for inhabitants of these cities.

It is important for researchers and policy makers to take into account areas of abandoned land and its ecological functions. They should know the extent of abandoned land in cities and its functions so protection of most valuable areas could be introduced. Decision makers in Poznań do not have data and knowledge about abandoned land in the city so this research was carried out to fulfil this gap. The aims of this study were to identify the area of abandoned land in the city and examine types and a scale of their ecosystem services.

Abandoned land

Abandoned land could be defined as land which is not in use in a direct and formal way by people[1]. This broad definition includes areas such as wasteland, ruderal urban forests, previous gardens and parks or brownfields. Depending on a state and an appearance the abandoned land in this study was grouped in two types: semi-natural with vegetation cover and built-up. These classes depend on a type of previous use, recultivation treatments and a period of not being used. For example, previously built-up area after recultivation planned by humans or self-made by nature could end up as a semi-natural area. Use of such a classification results from the aim of the study in which semi-natural areas play a crucial role.

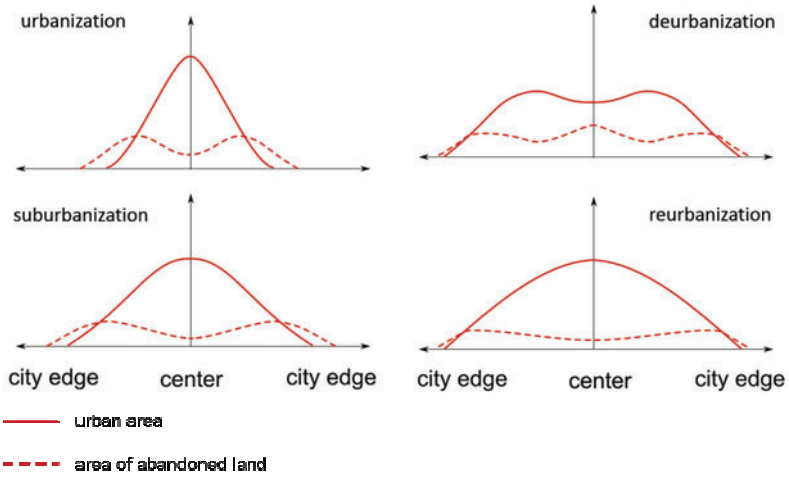
This definition of abandoned land includes also very small and only temporal areas, so two additional criteria were used. The first was a minimal area of two hectares so only sites big enough to be significant in context of the whole city was taken in consideration. The second condition was five years as a minimal period of not being in use which allows to study only long-term unused land.

[1] J. Zatonski*, Miejsce i rola odłogów miejskich w strukturze przestrzennej Poznania*, rozprawa doktorska, Poznań 2013.

Abandoned land in cities

Abandoned land are present in almost every city in the world[2]. But there are differences in their characteristics depending on an environment type and socio-economic drivers[3]. Two main reasons causing the appearing of abandoned land seems to be deindustrialization and changes in agricultural land use around cities. Changes in industry, technology and localization make old industrial buildings and sites unsuitable and they became abandoned brownfields. More and more people living around cities stop cultivating their agricultural land and urban sprawl leads to converting this land into residential areas so this land is not in use between time of cultivation stop and new development. During periods of cities growth most of abandoned land appears on city edges with progressing urbanization, during deurbanization more of abandoned land emerges closer to the city center (Figure 1).

Figure 1
Location and area of abandoned land in different stage of city life cycle 1



Source: own elaboration.

[2] J. Liu et al., *Study on spatial pattern of land-use change in China during 1995-2000*, "Science in China Series D: Earth Sciences" 2003 no. 46, t. 4, p. 373-384; Department for Communities and Local Government, Previously-Developed land that may be available for Development: England, London 2005, 2006, 2007; D. Bartlett, P. Quine, *Approaches to urban renewal in the US and UK*, Berkshire1987; A.O'M . Bowman, M.A. Pagano, *Urban vacant land in the United States*, Boston 1998.

[3] A. Pagano, A. O'M Bowman, *Vacant land in cities. An urban resource*, The Brookings Institution, Survey Series, Washington 2000, p. 8.

In spite the fact that abandoned land has a significant share in an area of some cities, they are often ignored in ecological studies[4]. There is also lack of understanding of „urban wilderness" which occurs on such areas as additional and valuable aspect of urban green[5].

Abandoned land in Poznań

During research aerial and satellite imagery analyses and ground truthing were used to identify abandoned land and their basic characteristics in city of Poznań. In result 208 abandoned sites was identified. They cover area of 25.3 km^2 which is around 10% of city. The median size of such site is 5.37 ha (Table 1).

The main type of abandoned land is semi-natural and it accounts for 66% of all abandoned land. Usually it is previously agricultural land located on edges of the city or around streams and in rivers valleys. Built-up abandoned land takes only 4% of the whole abandoned land area. Previously industrial, railway and military sites do not have a significant area in the city so their reclamation should not be very problematic. Mixed areas which have both anthropogenic structures and large areas of vegetation accounts for around 30% of abandoned land area. The most important example of mixed abandoned land are ponds in excavation pits left over by sand and clay mines and their surroundings in south-west of the city.

Vegetation on abandoned land covers 2373,9 ha, which represents 94% area of abandoned land and 9% area of the city. It is almost the same area as main-

Table 1

Types, amount and area of abandoned land in Poznań city

Type	Amount		Area	
	[number]	[%]	[ha]	[%]
Built-up	27	12.4%	104.04	4.2%
Mixed	56	25.8%	722.30	29.4%
Semi-natural	134	61.8%	1627.81	66.3%
Total	217	100.0%	2454.15	100.0%

Source: own elaboration.

[4] T. McPhearson, P. Kremer, Z.A. Hamstead, *Mapping ecosystem services in New York City. Applyinga social–ecological approach in urban vacant land*, "Ecosystem Services" 2013 no. 5, p. 11-26; E.G. King, R.J. Hobbs, *Identifying linkages among conceptual models of ecosystem degradation and restoration: towards an integrative framework*, "Restoration Ecology" 2006 no. 14(3), p. 369-378.

[5] J.H. Breuste, *Decision making, planning and design for the conservation of indigenous vegetation within urban development*, "Landscape and Urban Planning" 2004 no. 68, p. 439-452.

tained greenery which in Poznań covers an area of around 2250-2650 ha[6] (not counting urban forests). Trees and shrubs canopy on abandoned land have an area of 805 ha (33% of abandoned land). An analysis of aerial imagery from 1998 had shown that an area of trees and shrubs canopy had 440 ha during that time, so it almost doubled during next fourteen years. Natural succession in environment of Poznań usually leads to forming trees areas, so it can be expected that an area of canopy will grow in the future. Water bodies and wetlands account for 5% of abandoned land area and sealed grounds and buildings take only 1% of it.

Ecosystem services

Green areas in cities provide a wide variety of important ecosystem services[7]. But ecosystem services of vegetation on abandoned land differ from those from parks, allotment gardens and other maintained greenery in city. In most cases people do not benefit from direct provisioning services like energy, food or materials provision because spontaneous vegetation is not cultivated to provide them. Also cultural services are not easy to identify because people have mixed feeling about "wild nature" in the city and use it relatively rare and less intensive than the urban parks5. On other hand, on abandoned land occurs processes which are similar to natural areas and biodiversity is much higher than in urban parks. These conditions cause that such land provides regulation and supporting services on higher level than in well maintained greenery. This services include:

- Regulation: groundwater recharge and water retention, climate regulation, air purification, oxygen production, carbon sequestration, erosion regulation;
- Supporting: habitat provision, population and biodiversity maintaining, pollination.

In this study water retention, air purification and carbon sequestration were chosen for detailed research.

Ecosystem services can be quantified either as biophysical units of the service or the social value of the service, for example, monetary[8]. The first approach was used in this study.

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[6] B. Hoffmann et al., *Zieleń, Środowisko naturalne miasta Poznania,* part I, Poznań 1996, p. 123-139; Bank Danych Lokalnych, www.stat.gov.pl [10-09-2014].

[7] H. Akbari, *Shade trees reduce building energy use and CO_2 emissions from power plants*, "Environmental Pollution" 2002 no. 116(Suppl.), p. S119–S126; P.T. McPhearson et al., *Assessing the effects of the urban forest restoration effort of million trees, NYC on the Structure and Functioning of New York City,* "Ecosystems Cities and the Environment" 2010 no. 3(1), p. 1-21; D.J. Nowak, D.E. Crane, *Carbon storage and sequestration by urban trees in the USA*, "Environmental Pollution" 2002 no. 116, p. 381-389.

[8] F. Müller, L. Willemen, R. DeGroot, *Ecosystem services at the landscape scale: the need for integrative approaches*, "Landscape Online" 2011, p. 1-11.

Ecosystem services of abandoned land in Poznań

Abandoned land in Poznań has in most cases unsealed ground which allows infiltration of rainwater. Also areas with a concrete or asphalt layer on abandoned land due to not maintaining the rain drainage system cause that rainwater run-off is not getting to the city's central drainage system.

The average annual precipitation in Poznań is 508 mm[9]. So it is easy to calculate that on the whole area of abandoned land around 12,8 billion litres of water is falling which is not discharged into the drainage system.

This ecosystem service causes significant savings in a city's budget because intercepted rainwater does not have to be transported through the drainage system. Moreover thanks to water infiltration, groundwater is easier accessible by plants and reduces the need for watering them. Water retention is especially important in Poznań because it is one of the regions with the smallest amount of precipitation in Poland.

For determining a scale of air purification as well as carbon sequestration, literature research was undertaken. Based on parameters established for an area of trees and vegetation by other authors[10] there were calculated tones of intercepted pollution and carbon. Unfortunately, there is lack of such studies focused on spontaneous vegetation on abandoned land which probably having more vegetation layers, higher tree density and biodiversity has bigger potential for removing pollution and carbon from an atmosphere than maintained greenery.

In case of air purification especially removal of particles with diameter of 10 micrometres or less is important because the results of monitoring made by the

Table 2
Pollution and carbon spontaneous by vegetation on abandoned land

Elements	Parameters		Results	
	Trees	Vegetation	Trees [t]	Vegetation [t]
SO_2 removal	1.32 g/m^{2}yr	0.65 g/m^{2}yr	10.7	10.4
NO_2 removal	2.54 g/m^{2}yr	2.33 g/m^{2}yr	20.5	37.2
PM_{10} removal	2.73 g/m^{2}yr	1.12 g/m^{2}yr	22.1	17.9
O_3 removal	3.06 g/m^{2}yr	-	24.7	-
CO removal	0.58 g/m^{2}yr	-	4.7	-
Carbon sequestration	0.12 kgC/year/m^2	-	97	-
Carbon storage	9.25 kgC/m^2	0.18 kgC/m^2	7480.3	287.1

Source: D.J. Nowak, D.E. Crane, op. cit., p. 381-389; H. Jo, G. McPherson, *Carbon storage and flux in urban residential green-space*; "Journal of Environmental Management" 1995 no. 45, p. 109-133; H. Zimny, *Ekologia miasta*, Warszawa 2005; M. Czerwieniec, J. Lewińska, *Zieleń w mieście*, Kraków 2000.

[9] R. Farat, *Klimat Poznania. Środowisko naturalne miasta Poznania*, cz. I, Poznań1996, p. 123-139.
[10] D.J. Nowak, D.E. Crane, op. cit., p. 381-389; H. Jo, G. McPherson, *Carbon storage and flux in urban residential green-space*; "Journal of Environmental Management" 1995 no. 45, p. 109-133; H. Zimny, *Ekologia miasta*, Warszawa 2005; M. Czerwieniec, J. Lewińska, *Zieleń w mieście*, Kraków 2000.

Regional Inspectorate of Environmental Protection in Poznań shows that an acceptable level of this parameter (averaged over 24 hours) was exceeded 47 times from January to August 2014[11]. As for carbon, it is a major cause of global climate change so allowing it to be stored in plants, could be used for mitigation of this process.

Conclusion

Land is non-renewable resource and should be used in an efficient way. Meanwhile in cities large areas are permanently or temporarily not in use by man. On these areas ecological succession is ongoing which could lead to formation of ecologically valuable ecosystems. An area on abandoned land in Poznań is significant because it covers about 10% of the city. Vegetation on abandoned land in Poznań is an important part of the whole city ecosystem similar to maintained greenery. It has also crucial role in providing ecological services. Especially, regulation services as groundwater recharge and water retention, climate regulation, air purification, oxygen production, carbon removal and erosion regulation.

This study shows that vegetation on abandoned land by providing ecosystem services could be an important ally in reduction of local problems with groundwater resources and air pollution. It could also be used as a local tool for mitigation to a global climate change.

Unfortunately, areas of abandoned land with their valuable resources and services are disappearing from cities. There is need for more detailed research on this topic which should lead to developing tools to diagnose this area and provide reasons to preserve some of them.

[11] www.poznan.wios.gov.pl [10-09-2014].

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LAND COVER AND ECOSYSTEM SERVICES CHANGES IN AGRICULTURAL LANDSCAPES OF THE DĘBNICA RIVER CATCHMENT (WEST POMERANIA, POLAND)

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ZMIANY W POKRYCIU TERENU I USŁUGACH EKOSYSTEMOWYCH W KRAJOBRAZACH ROLNICZYCH ZLEWNI DĘBNICY (POMORZE ZACHODNIE, POLSKA)

STRESZCZENIE: Porównano usługi ekosystemowe tych samych krajobrazów rolniczych z okresu centralnie planowanej gospodarki upaństwowionej i gospodarki rynkowej. Określono je na podstawie bioróżnorodności krajobrazowej wynikającej z użytkowania i pokrycia terenu. Bioróżnorodność została określona na podstawie kompleksów roślinności rzeczywistej zdelimitowanych metodą symfitosocjologiczną, drogą kartowania terenowego. Kompleksy pozwoliły ocenić usługi z poziomu typów klasowych w hierarchicznej klasyfikacji CICES v4.3.

SŁOWA KLUCZOWE: krajobrazy rolnicze, bioróżnorodność, usługi ekosystemowe, pokrycie terenu, metoda symfitosocjologiczna, kompleks roślinności

Introduction

In 2014, the assessment of ecosystems and their services in the member states of the European Union will be completed. It is one of activities (Action 5) within the framework of the EU Biodiversity Strategy to 2020 (J. Maes et al.[1]). General tools were proposed, including Common International Classification of Ecosystem Services (R. Haines-Young and M. Potschin[2]), which make it possible to aggregate the obtained results on a Pan-European scale. To prepare this assessment, the data on geodiversity and biodiversity of geoecosystems and their functions are required. In 2011-2014, geodiversity and biodiversity of geoecosystems of the Dębnica River catchment and a reaction of geoecosystems to anthropopressure were studied. Some changes in land cover were found (J. Borysiak et al.[3]), which correspond to the general trend for Poland stated by D. Łowicki and A. Mizgajski[4]. These changes, visible also in agriculture (R. Kulikowski[5]), forestry and unused lands result, among others, from the political system transformation initiated in Poland on the end of 80. in 20th century. This paper presents some results from the study of the Dębnica River basin related to land cover, ecosystem biodiversity and ecosystem services. The application of the concept of real vegetation complex for the determination of changes in agricultural space will be shown and, based on this, also changes in the catalog of ecosystem services prepared according to the CICES v4.3 classification, currently tested in Europe.

Data and methods

Study area

The land cover of four agricultural landscapes of the Dębnica River drainage basin was diagnosed. This basin is a part of the first order drainage basin of

[1] J. Maes, A. Teller, M. Erhard et al., *Mapping and assessment of ecosystems and their services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020*, Luxembourg 2013.

[2] R. Haines-Young, M. Potschin, *Common international classification of ecosystem services (CICES): Consultation on version 4. Raport to the Europaean Environment Agency*, www.cices.eu [20-09-2013].

[3] J. Borysiak, M. Mazurek, Z. Zwoliński, *Concept of sustainable management involves landscape geodiversity of hydrogeomorphological units: the Dębnica River, Poland*, The 8th IAG/AIG International Conference on Geomorphology and Sustainability, Paris, France, August 27-31, 2013.

[4] D. Łowicki, A. Mizgajski, *Typology of physical-geographical regions in Poland in line with land-cover structure and its changes in the years 1990-2006*, „Geographia Polonica" 2003 no. 86, p. 255-266.

[5] R. Kulikowski, *Produkcja i towarowość rolnictwa w Polsce. Przemiany i zróżnicowania przestrzenne po II wojnie światowej*, „Prace Geograficzne Instytutu Geografii i Przestrzennego Zagospodarowania PAN" 2013 no. 241, p. 131.

Parsęta River. An analysis involved such spatial fragments for which land cover on the topographic map 1:10000 in 1980 was different than in 2014. The use of time criterion allowed to analyze land cover in two completely different periods of economic development of Poland, i.e., nationalized, centrally planned economy (1980) and market economy (2014). The modern pattern of Holocene and post-glacial landforms of the Dębnica River catchment is mainly shaped by typical lowland morphogenetic processes like: chemical denudation (which predominates over mechanical), erosion and accumulation produced by the runoff, incision in the upper reaches of rivers, alluvial sedimentation into floodplain terraces, bank erosion in the lower reaches of rivers, and degradation and aggradation caused by anthropopression (Z. Zwoliński et al.[6]). An effect of these processes is a high geodiversity (A. Kostrzewski et al.[7]) and, as a consequence, high biodiversity. In the areas with such features, a high differentiation of ecosystem services is expected.

The studied landscape units are situated in the villages of: Kołacz (WGS: N53°46'59.96" / E16°10'57.35"), Liniec (N53°45'19.81" / E16°18'19.9"), Łeknica (N53°46'11.75" / E16°17'9.04") and Uradz (N53°40'45.32" / E16°18'41.21"), and covered the area of: 159, 155, 111 and 80 hectares, respectively. According to J. Kondracki[8], they belong to the subprovince of South Baltic Lake District and a mesoregion of the Drawskie Lake District. They are situated in the marginal zone of the Pomeranian phase of Vistulian (Weichselian) glaciation (A. Karczewski[9]). The moraine plateau areas in the vicinity of Liniec and Łeknica sites are composed of glacial till, while in the Uradz site – of glacial gravel and silty sands or glacial gravel and silty sands lying on glacial till (W. Popielski[10]). In the Kołacz site, sands and gravels of kettle depressions, glacial gravel and silty sands, glacial till and fens prevail. The valleys of rivers in the Liniec site are covered by sands and slope deposits, while the valleys of rivers and depressions in Łeknica and Uradz sites – by humus sands and peats. Glacial till is strongly sandy, decalcified and weathered, with a high content of Scandinavian erratics in the upper parts of bedrock (W. Popielski[11]). The north-west area in the Uradz site is the valley of Dębnica River, a watercourse fed by groundwater, rain and snow (I. Dynowska[12]).

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[6] Z. Zwoliński, A. Kostrzewski, A. Stach, *Tło geograficzne współczesnej ewolucji rzeźby młodoglacjalnej*, in: L. Starkel, A. Kostrzewski, A. Kotarba, K. Krzemień (eds.), *Współczesne przemiany rzeźby Polski*, Kraków, 2008, p. 271-276.

[7] A. Kostrzewski, R. Kolander, J. Szpikowski, *Zintegrowany monitoring środowiska przyrodniczego*, in: *Raport o stanie środowiska przyrodniczego w województwie zachodniopomorskim 2006-2007*, „Biblioteka Monitoringu Środowiska" 2008, p. 198-222.

[8] J. Kondracki, *Geografia regionalna Polski*, Warszawa 1998, p. 440.

[9] A. Karczewski, *Morfogeneza strefy marginalnej fazy pomorskiej na obszarze lobu Parsęty w vistulianie (Pomorze Środkowe)*, Poznań 1989, p. 48.

[10] W. Popielski, *Szczegółowa mapa geologiczna Polski 1:50 000, arkusz 159-Barwice (N-33-81-D)*, Kielce 2001.

[11] W. Popielski, *Objaśnienia do Szczegółowej mapy geologicznej Polski 1:50 000. Arkusz Barwice (159)*, Warszawa 2005.

[12] I. Dynowska, *Typy reżimów rzecznych w Polsce*, „Zeszyty Naukowe Uniwersytetu Jagiellońskiego, Prace Geograficzne" 1971 no. 28, p. 155.

According to the climate regionalization by A. Woś[13], the studied landscape units are located in the Central Pomeranian Region.

Field mapping

In 2014, in the first stage of the site, the phytocoenotic diversity of landscape units of sites Kołacz, Liniec, Łeknica and Uradz was diagnosed by mapping in the field. Plant associations were identified following syntaxonomical survey of A. Brzeg and M. Wojterska[14], and W. Matuszkiewicz[15]. The result of diagnosis was used to make symphytosociological *relevés* in the real vegetation complexes according to the method of R. Tüxen[16]. These complexes were homogenous regarding one (areally dominant) potential natural vegetation and, also, the same (areally dominant) way of land use and land cover. Potential natural vegetation was determined according to R. Tüxen (after A. Richling and J. Solon[17]). The complex position in the hierarchical structure of landscape was given by J. M. Matuszkiewicz[18] – it is a geosystem of the next higher rank than ecosystem, the type of biocoenosis. To each plant association of the complex, syngenesis according to the classification of J. B. Faliński[19] was assigned. Also, symphytosociological *relevés* made in the villages of Pustkowie (N53°45'33.67"/E16°30'12.6") and Przybkowo (N53°43'45.26"/E16°30'34.09") were used for the result interpretation. Ecosystem services were assigned to the delimited types of the real vegetation complex, following the classification CICES v4.3. Each service from the class type level was credited with one score.

[13] A. Woś, *Zarys stosunków klimatycznych w rejonie górnego odcinka zlewni Parsęty*, in: A. Kostrzewski (ed.), *Zintegrowany monitoring środowiska przyrodniczego. Stacja Bazowa Storkowo*, „Biblioteka Monitoringu Środowiska", Warszawa 1994, p. 79-96.

[14] A. Brzeg, M. Wojterska, *Zespoły roślinne Wielkopolski, ich stan poznania i zagrożenie*, in: M. Wojterska (ed.), *Szata roślinna Wielkopolski i Pojezierza Południowopomorskiego*, Poznań 2001, p. 39-110.

[15] W. Matuszkiewicz, *Przewodnik do oznaczania zbiorowisk roślinnych Polski*, Warszawa 2011, p. 536.

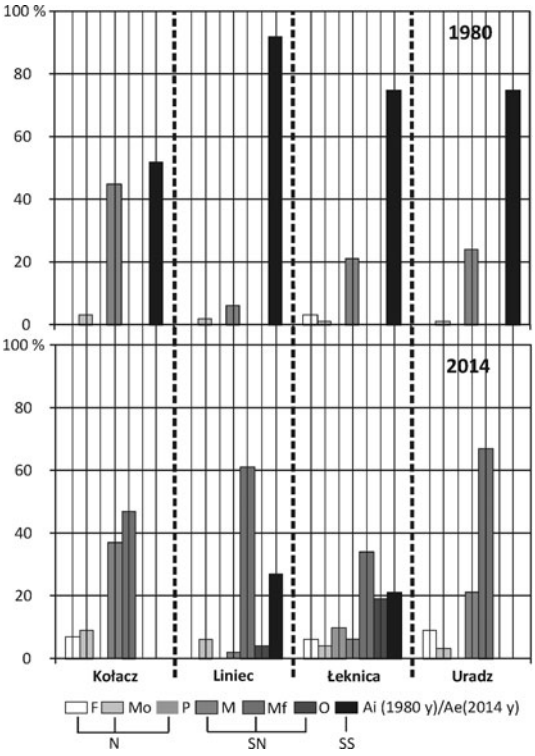
[16] R. Tüxen, *Zür Homogenität von Sigmassoziationen, ihrer syntaxonomischen Ordnung und ihrer Verwendung in der Vegetations Kartierung*, „Doc. Phytosoc., N.S." 1977 no. 1, p. 321-327.

[17] A. Richling, J. Solon, *Ekologia krajobrazu*, Warszawa 2011, p. 464.

[18] J. M. Matuszkiewicz, *Landscape phytocomplexe and vegetation landscape real and typological landscape units of vegetation*, „Doc. Phytosoc. N. S." 1979 no. 4, p. 663-672.

[19] J. B. Faliński, *Zbiorowiska autogeniczne i antropogeniczne. Próba określenia i klasyfikacji*, „Ekologia Polska B" 1969 no. 15, p. 173-182.

Figure 1
Structural changes in agricultural landscapes in the Dębnica River catchment (West Pomerania, Poland)



1980, 2014 – case study years; vegetation complex type in analyzed sites: Ae – arable land in extensive cultivation, Ai – arable land probably in intensive cultivation, F – forest, M – meadow, Mf – mowed fallow, Mo – mosaic of natural phytocoenoses (forest, shrub, tall herb fringe), O – orchard in sod, P – pond; syngenesis of vegetation complex: N – natural, SN – seminatural, SS – synanthropic segetal;

locality of sites (name of village): K – Kołacz, L – Liniec, Ł – Łeknica, U – Uradz;

Source: own elaboration.

Results

Land cover changes

In the analyzed agricultural landscapes, substantial changes in land cover in relation to 1980 were observed (Figure 1). In Kołacz site, arable land disappeared. It was replaced by mowed fallow land (47%) and in considerable part (5%) – forest biotopes. Also, the area of meadows and pastures decreased from 47% to 37%, while 10% of the transformed area is occupied by the tall herb fringe-shrub-forest complex. In Liniec site, the area of arable land decreased by

65%, mainly in favour of mowed fallow land. The contribution of meadows decreased from 6% to 2%, and they were replaced by the mosaic of forest and shrub patches, and tall herb fringe communities. In Łeknica site, a pond of 11 hectares was constructed at the cost of the half of meadow area, 21% of meadows was replaced either by tall herb fringe-shrub-forest formation or forest, and 25% of arable land was transformed into a fruit orchard in sod. In Uradz site, arable land also disappeared; 89% of its area changed into mowed fallow land. However, in the valley of the Dębnica River almost the whole complex of meadows (89%) survived. Along with the changes in land cover, an intensity of the synanthropization process decreased in all analyzed landscapes. It was assumed that in 1980, when arable land was managed by the state farms, an intensive farming was practiced.

Agrochemical treatments were used that suppressed the growth of weeds. It is presumed that at that time, only synanthropic vegetation of herbicidal fallow occurred. In 2014, mostly, semi-natural vegetation of mowed fallow land was found, as well as fruit orchards in sod, with the mowed strips between the rows of trees and with no traces of herbicides within the tree and shrub rows. In the large areas of former meadows and pastures, the secondary biocoenotic succession took place. It resulted in the replacement of semi-natural vegetation by natural vegetation. In the remaining arable land, abundance of weeds and very well developed phytocoenoses of segetal synanthropic associations were found, what proves extensive farming.

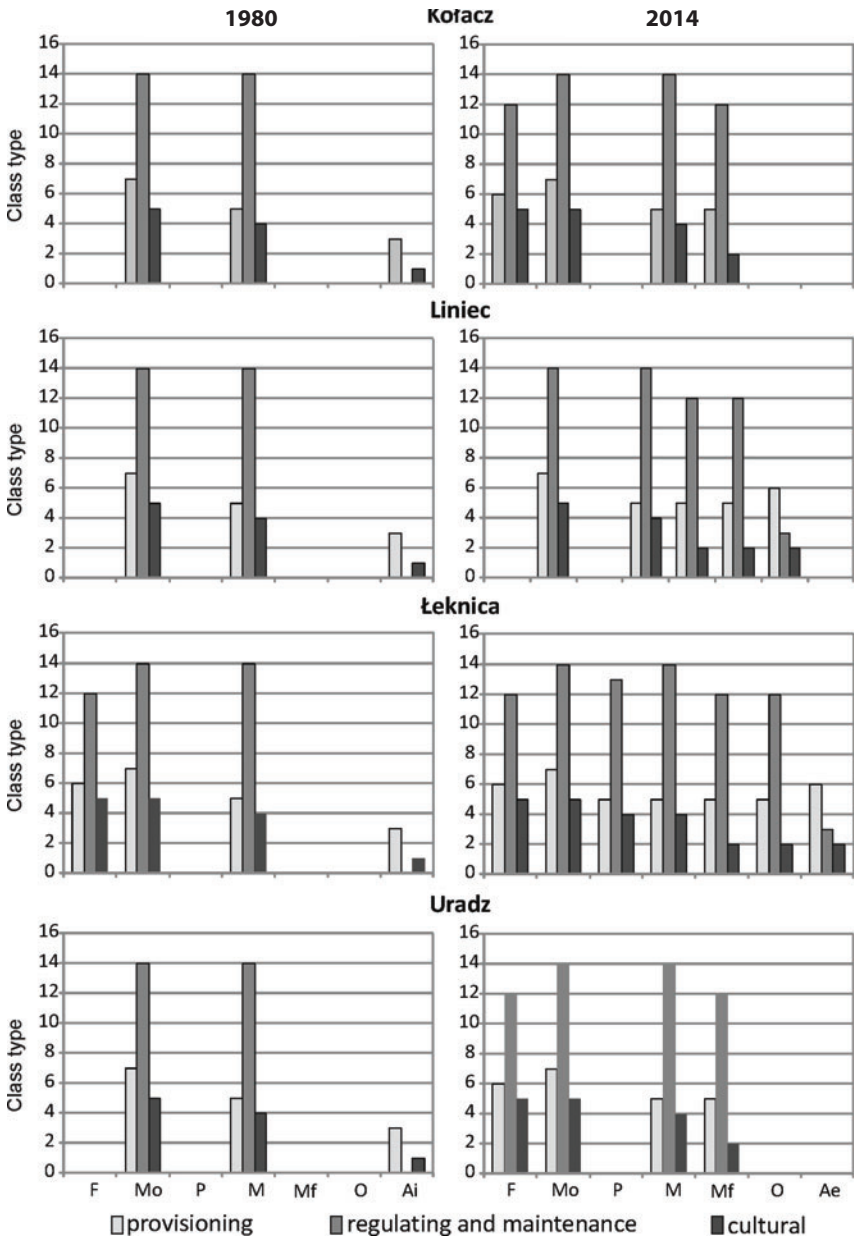
To show the renaturalization degree of the analyzed agricultural landscapes, the phytocoenotic structure and syngenesis of new substitute complexes of real vegetation were presented (Table 1). The four new complexes – water and rush vegetation of the constructed pond (P), forest (F) and tall herb fringe-shrub-forest (Mo), were documented. Also, the *relevés* taken in the preserved meadow complexes (M) were included. Next column shows the segetal complex of extensively used arable land, while the last column – the same type of arable land complex (Ae) traditionally cultivated for over 65 years (personal information from a farmer). The phytocoenotic structure of the Łeknica complex (Ae) compared to this type of complex from Pustkowie (Ae) may be an evidence for extensive farming in Łeknica. Table does not include new complexes of mowed fallow land and fruit orchards. Vegetation of such units has undetermined phytocoenotic relationships and consists mainly of native species from *Molinio-Arrhenatheretea* and *Artemisietea*. Mowing, and sometimes also grazing (e.g. goat herds in Liniec site), justifies classification of this vegetation to the semi-natural type.

Ecosystem services changes

Table 2 presents comparison of ecosystem services for the seven types of real vegetation complexes that, in 2014, occupied the land of the four studied landscape sites. The last column in the table shows services related to the complex type connected with the intensively cultivated arable land replaced by new types. In 2011-2014, this type was observed only in the area of large-scale agricultural

Figure 2

Changes in ecosystem services of agricultural landscapes in the Dębnica River catchment (West Pomerania, Poland)



1980, 2014 – case study years; vegetation complex type in analyzed sites: Ae – arable land in extensive cultivation, Ai – arable land probably in intensive cultivation, F – forest, M – meadow, Mf – mowed fallow, Mo – mosaic of natural phytocoenoses (forest, shrub, tall herb fringe), O – orchard in sod, P – pond; syngenesis of vegetation complex: N – natural, SN – seminatural, SS – synanthropic segetal; locality of complex, name of village: K – Kołacz, L – Liniec, Ł – Łeknica, U – Uradz

Source: own elaboration.

Table 1

Phytocoenotic structure of vegetation complexes in changed agricultural landscapes (the Dębnica river catchment, West Pomerania, Poland)

Specification		Investigated sites							
		Łeknica	Kołacz	Uradz	Uradz	Kołacz	Uradz	Łeknica	Pust-kowie
Vegetation complex		P	F		Mo	M		Ae	
Area of sigmassociation (ha)		0,2	0,8	1,1	0,7	0,5	0,5	0,9	0,8
Share of natural phytocoenoses (% N)		100	98	100	100	10	25	-	-
Share of seminatural phytocoenoses (% SN)		-	2	-	-	90	75	-	-
Share of segetal (weet) phytocoenoses (% SS)		-	-	-	-	-	-	95	95
Share of ruderal phytocoenoses (% SR)		-	-	-	-	-	-	5	5
Number of associations	Syn	10	8	5	12	10	12	4	6
Associations									
Salicetum auritae Jonas 1935 em. Oberd. 1964	N	2 O	.	.	.	.	.	.	.
Glycerietum maximae (Allorge 1922) Hueck 1931	N	2 /	.	.	.	.	.	.	.
Phragmitetum communis (W. Koch 1926) Schmale 1939	N	1 /	.	.	.	.	.	.	.
Caricetum elatae W. Koch 1926	N	2 .	.	.	.	+ .	.	.	.
Caricetum paniculatae Wangerin 1916 ex v. Rochow 1951	N	1 .	.	.	.	+ .	1 .	.	.
Hottonietum palustris R. Tx. 1937 ex Pfeiffer 1941	N	1 .	.	.	.	.	.	.	.
Junco-Molinietum (R. Tx. 1937) Preising in R. Tx. et Preising 1951 em. Pass. 1964	N	1 .	.	.	.	.	.	.	.
Lemnetum minoris Soó 1927	N	1 .	.	.	.	.	.	.	.
Potametum natantis Soó 1927 ex Podbielkowski et Tomaszewicz 1978	N	1 .	.	.	.	.	.	.	.
Sagittario-Sparganietum emersi R. Tx. 1953	N	1 .	.	.	.	.	.	.	.
Calamagrostio arundinaceae-Quercetum petraeae (Hart. 1934) Scam. et Pass. 1959	N	.	5 O	.	.	.	.	.	.
Agrostio-Populetum tremulae Pass. in Pass. et Hofm. 1968	N	.	1 .	.	.	.	.	.	.
Armerio elongatae-Festucetum ovinae R. Knapp 1944 ex Celiński 1953	SN	.	+ .	.	.	.	.	.	.
Calamagrostietum epigeios Juraszek 1928	N	.	+ .	.	.	.	.	.	.
Euonymo-Prunetum spinosae (Hueck 1931) Pass. in Pass. et Hofmann 1968	N	.	+ .	.	.	.	.	.	.
Sieglingio-Agrostietum capillaris Balc. et Brzeg 1978	SN	.	+ .	.	.	.	.	.	.
Rubetum idaei Malinowski et Dziubałtowski 1914 em. Oberd. 1973	N	.	+ .	+ .	.	.	.	.	.
Torilidetum japonicae Lohmeyer in Oberd. et al. 1979 ex Görs et Th. Müller 1969	N	.	+ .	+ .	.	.	.	.	.
Deschampsio flexuosae-Fagetum Schroder 1938	N	.	.	5 O	.	.	.	.	.
Stellario-Carpinetum Oberd. 1957	N	.	.	1 /	.	.	.	.	.
Agrimonio-Vicietum cassubicae Pass. 1967 nom. invers.	N	.	.	+ .	.	.	.	.	.

Fraxino-Alnetum W. Mat. 1952	N	.	.	.	5 O	.	.	.	.
Aegopodio-Sambucetum Doing 1962 em. Wojt. 1990	N	.	.	.	2 .	.	.	.	.
Carici elongatae-Alnetum W. Koch 1926 ex R. Tx. 1931	N	.	.	.	1 O	.	.	.	.
Cardamino-Chrysosplenietum alternifolii Maas 1959	N	.	.	.	+ .	.	.	.	.
Euonymo-Coryletum Pass. in Pass. et Hofmann 1968	N	.	.	.	+ .	.	.	.	.
Prunello vulgaris-Plantaginetum brachystachyae Faliński 1961 ex 1963	SN	.	.	.	+ .	.	.	.	.
Stachyo sylvaticae-Impatientetum noli-tangere (Pass. 1967) Hilbig 1972	N	.	.	.	+ .	.	.	.	.
Urtico-Calystegietum Görs et Th. Müller 1969	N	.	.	.	+ .	.	.	.	.
Epilobio hirsuti-Convolvuletum Hilbig, Heinrich et Niemann 1972	N	.	.	.	+ .	+ .	.	.	.
Eupatorietum cannabini R. Tx. 1937	N	.	.	.	+ .	.	+ .	.	.
Filipendulo-Geranietum palustris (Scherrer 1923) W. Koch 1926	N	.	.	.	+ .	.	2 O	.	.
Scirpetum silvatici Ralski 1931	N	.	.	.	+ .	2 O	2 O	.	.
Angelico-Cirsietum oleracei R. Tx. 1937 em. 1947	SN	.	.	.	.	5 O	4 O	.	.
Stellario palustris-Deschampsietum cespitosae Freitag 1957	SN	.	.	.	.	2 O	2 O	.	.
Caricetum acutiformis Eggler 1933	N	.	.	.	.	1 .	+ .	.	.
Lysimachio vulgaris-Filipenduletum Bal.-Tulačkova 1978	N	.	.	.	.	+ .	1 .	.	.
Phalaridetum arundinaceae Libbert 1931	N	.	.	.	.	+ .	1 /	.	.
Potentilletum anserinae Rapaics 1927 em. Pass. 1964	SN	.	.	.	.	+ .	+ .	.	.
Caricetum gracilis Almquist 1929	N	.	.	.	.	.	1 .	.	.
Peucedano-Calamagrostietum canescentis Weber 1978	N	.	.	.	.	.	1 /	.	.
Digitarietum ischaemi R. Tx. et Preising in R. Tx. 1950 ex R. Tx. 1954	SS	.	.	.	.	.	.	2 O	4 O
Setario-Lycopsietum arvensis Pass. 1959	SS	.	.	.	.	.	.	3 O	2 O
Convolvulo arvensis-Agropyretum repentis Felfoldy (1942) 1943	SR	.	.	.	.	.	.	2 /	2 /
Papaveretum argemones Kruseman et Vlieger 1939	SS	.	.	.	.	.	.	2 O	1 .
Echinochloo-Setarietum pumilae Felfoldy 1942 corr. Mucina 1993	SS	.	.	.	.	.	.	.	2 O
Sclerantho-Arnoseridetum minimae R. Tx. 1937	SS	.	.	.	.	.	.	.	1 .

Vegetation complex: Ae – arable land in extensive cultivation, F – forest, M – meadow, Mo – mosaic of natural phytocoenoses (forest, shrub, tall herb fringe), P – pond; Syn – syngenesis of association: N – autogenous natural, SN – anthropogenic seminatural, SS – synanthropic segetal (weed communities), SR – synanthropic ruderal; pattern of association patch in vegetation complex: O – over great surface, / – in long, narrow linear form, . – singular or dispersed in irregular form; quantity acc. to Braun-Blanquet scale: + – one patch of phytocoenose or a few ones; 1 – <5%, 2 – 5-25%, 3 – 25-50%, 4 – 50-75%, 5 – 75-100%

Table 2
Ecosystem services of vegetation complex types (Dębnica River catchment)

Section	Division	Group	Class	Class type	Type of vegetation complex							
					F	Mo	P	M	Mf	O	Ae	Ai
					Syngenesis of vegetation complex							
					N			SN			SS	
Provisioning	Nutrition	Biomass	Cultivated crops	*Land ecosystems:* cereals – buckwheat, mustard, rye	0	0	0	0	0	0	1	1
				Land ecosystems: fruits – apple, black and red currant, pear, plum	0	0	0	0	0	1	0	0
			Reared animals and their outputs	*Land ecosystems:* insects – bees (honey)	1	1	1	1	1	1	1	1
				Land ecosystems: mammals – goads (meat, milk, cheese)	0	0	0	0	1	0	0	0
			Wild plants and their outputs	*Land ecosystems*: blackberry, elderberry, hawthorn, hazel, raspberry, rose, sorrel, mushrooms	1	1	0	0	0	0	0	0
			Wild animals and their outputs	*Land ecosystems*: molluscs – pomatia; game – boar, deer, fallow deer, hare, mallard, pheasant, red deer	1	1	1	1	1	1	1	0
				Freshwater ecosystem: fish – crucian carp, eel, pike, roach, ruffe, tench	0	0	1	0	0	0	0	0
	Materials	Biomass	Fibres and other materials from plants and animals for direct use or processing	*Land ecosystems*: resin, wood	1	1	0	0	0	0	0	0
			Materials from plants, algae and animals for agricultural use	*Land ecosystems:* green fodder – clover; grasslands – hay for fodder	0	0	0	1	1	1	0	0
				Land ecosystems: arable lands – straw (bedding for cattle)	0	0	0	0	0	0	1	1
			Genetic materials from all biota	*Land and freshwater ecosystems*: medicinal herbs	1	1	1	1	1	1	1	0
		Water	Surface water for non-drinking purposes	*Freshwater ecosystems*: irrigation, livestock consumption	0	1	1	1	0	0	0	0
	Energy	Biomass-based energy sources	Plant-based resources	*Land ecosystems*: firewood for energy production	1	1	0	0	0	0	0	0
				Land ecosystems: straw for energy production	0	0	0	0	0	0	1	0
				Total for provisioning section	6	7	5	5	5	5	6	3

Regulating and maintenance	Mediation of waste, toxic and other nuisances	Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems	*Land and freshwater ecosystems*: bio-physicochemical filtration/sequestration/storage/accumulation of pollutants in soil/bottom sediments	1	1	1	1	1	1	0	0
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	*Land ecosystems*: erosion and denudation protection	1	1	0	1	1	1	0	0
			Buffering and attenuation of mass flows	*Freshwater ecosystems*: transport and storage of sediment by watercourses, storage of sediments by ponds	0	1	1	1	0	0	0	0
		Liquid flows	Hydrological cycle and water flow maintenance	*Land and freshwater ecosystems*: capacity of maintaining baseline flows for water supply and discharge – river channel and pond retention, soil retention	1	1	1	1	1	1	0	0
			Flood protection	*Land and freshwater ecosystems*: flood protection by vegetation cover and landscape retention	1	1	1	1	1	1	0	0
		Gaseous /air flows	Ventilation and transpiration	*Land and freshwater ecosystems*: change in temperature and humidity	1	1	1	1	1	1	0	0
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene - pool protection	Pollination and seed dispersal	*Land and freshwater ecosystems*: pollination, seed bank, seed dispersal	1	1	1	1	1	1	1	0
			Maintaining nursery populations and habitats	*Land and freshwater ecosystems*: astatic ponds, balks, roadside shrubs and trees, heaps of erratic stones, network of watercourses	1	1	1	1	1	1	0	0
		Pest and disease control	Pest control	*Land ecosystems*: extensive agriculture, multifunctional forest, feeding grounds for birds	1	1	1	1	1	1	1	0
		Soil formation and composition	Weathering processes	*Land ecosystems*: maintenance of bio-geochemical conditions of soils including fertility, improvement of nutrient storage and soil structure, slowing down the processes of physical and chemical weathering (overgrowing of arable lands and grasslands – secondary biocenotic succession)	1	1	1	1	1	1	0	0

			Decomposition and fixing processes	*Land ecosystems*: Maintenance of bio-geochemical conditions of soils including fertility, improvement of nutrient storage and soil structure, slowing down the processes of physical and chemical weathering (overgrowing of arable lands and grasslands – secondary biocenotic succession)	1	1	1	1	1	1	0	0
		Water conditions	Chemical condition of freshwaters	*Freshwater ecosystems*: maintenance of chemical composition of freshwater column and sediment to ensure favourable living conditions – overgrowing of arable lands and grasslands (secondary biocenotic succession) in the catchments of watercourses and ponds	0	1	1	1	0	0	0	0
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	*Land and freshwater ecosystems*: Global climate regulation by greenhouse gas sequestration by ecosystems and their biota	1	1	1	1	1	1	1	0
			Micro and regional climate regulation	*Land and freshwater ecosystems*: Modifying of topo-, micro- and regional climate patterns caused biocenotic secondary succession	1	1	1	1	1	1	0	0
	Total for regulating and maintenance section				12	14	13	14	12	12	3	0
Cultural	Physical and intellectual interactions with biota, ecosystems and landscapes	Physical and experiential interactions	Experiential use of plants, animals and landscapes in different environmental settings	*Land and freshwater ecosystems*: Experiential use of traditional agricultural landscapes rich in natural biocenotic structures, bird watching	1	1	1	1	1	1	1	0
			Physical use of landscapes in different environmental settings	*Land and freshwater ecosystems*: angling, boating, hiking, hunting, jogging, walking	1	1	1	1	1	1	0	0
		Intellectual and representative interactions	Scientific	*Land and freshwater ecosystems:* Regional Directorate for Environmental Protection in Szczecin – master plan for PLH390039 Czaplinek Lakes; A. Mickiewicz University in Poznań – Changes of ecosystem services in landscapes modified by man, geoecosystems and economic studies	1	1	1	1	1	1	1	1
			Educational	*Land and freshwater ecosystems*: Połczyn Forest District: educational activities; thematic village	1	1	0	0	0	0	0	0

			Aesthetic	*Land and freshwater ecosystems:* harmonious natural and seminatural landscapes, advanced regenerative processes of natural vegetation	1	1	1	1	1	1	1	0
	Spiritual, symbolic and other interactions with biota, ecosystems, landscapes	Other cultural outputs	Existence	*Land and freshwater ecosystems*: enjoyment provided by wildlife	1	1	1	1	0	0	0	0
			Bequest	*Land and freshwater ecosystems*: willingness to preserve plants, animals, ecoystems, landscapes for the experience and use of future generations	1	1	1	1	0	0	0	0
				Total for cultural section	5	5	4	4	2	2	3	1
				Total number of scores	24	27	23	24	20	20	12	4

Ae – arable land in extensive cultivation, Ai – arable land in intensive cultivation, F – forest, M – meadow, Mf – mowed fallow (former arable land), Mo – mosaic of natural phytocoenoses (of forest, shrub, tall herb fringe patch), O – orchard in turf, P – pond; syngenesis of vegetation complex: N – autogenous natural, SN – anthropogenic seminatural, SS – anthropogenic synanthropic segetal (weed plant communities)

cooperatives, as, for instance, in the village of Przybkowo. The total number of scores for ecosystem services of all types of complexes (Table 2) from the section 'provisioning' is similar and stays within the range 5-7. The total sum within each type comprises the same or completely different services from the class type level. Similar situation concerns more less evened score for the services from the 'regulating and maintenance' section (12-14 scores). An exception is a low score for the segetal vegetation complex connected with arable land (Ae and Ai). In the section 'cultural', the number of scores for the mowed fallow land complex (Mf) and fruit orchards in sod (O) is equal, but much lower than for the forest, mosaic and pond-related complexes (F, Mo, P and M).

Appropriately to the character of changes in land cover, also ecosystem services changed in all tested landscape units (Figure 2). In each one, the general number of services in all sections increased. In Łeknica site, it is an increase of 84%, in Liniec site – 79%, while in Kołacz and Uradz sites – 72%. The highest increase (86% and 92%) was noted in the section 'regulating and maintenance', which results from the very high decrease in the synanthropization level.

Concluding remarks

In the preparation of the list of ecosystem services and, earlier, in the assessment of landscape biodiversity, the concept of real vegetation complex was used. Previously, J. Solon[20] indicated the possibility of using such spatial unit of biosphere organisation in studies of the relationship between land cover and biodiversity, as well as an analysis of landscape changes in time. Delimitation of complexes based on field mapping, made it possible to provide ecosystem services from the class type level, while the presented catalog of services reflects the real state and can be the source of reliable information for the determination of environmental management directions.

The presented changes that took place in 1980-2014 are largely an effect of transition from nationalized, centrally planned economy (1989) to market economy and, also, the realization of agri-environmental schemes. According to A. Sadłowski[21], the period of industrial intensification of farming was finished in 1989. The cause of changes in land cover was a low economic effectiveness of cultivating the land of a low agricultural usefulness. After 1989, sandy, highly skeletal, of poor fertility and with low underground water table arable land has been covered by spontaneously developed vegetation due to the lack of ploughing. Nowadays, this vegetation is mainly mowed and has been largely included in the agri-environmental schemes (personal information from its users). Complex-

[20] J. Solon, *Ocena różnorodności krajobrazu na podstawie analizy struktury przestrzennej roślinności*, „Prace Geograficzne Instytutu Geografii i Przestrzennego Zagospodarowania PAN" 2002 no. 185, p. 232.

[21] A. Sadłowski, *Płatności obszarowe jako instrument polityki ochrony środowiska*, "Journal of Agribusiness and Rural Development" 2011 no. 4(22), p. 145-151.

es of segetal synanthropic vegetation, connected with intensively cultivated arable land, were replaced by multifunctional mosaic of agricultural landscape. Spontaneous reafforestation took place on the poorest, sandy fallow land and on permanent grasslands with long-stagnant water. The disappearance of open landscapes of fallow land and permanent grasslands due to giving up cultivation and regeneration of natural forest vegetation was many times reported (e.g. M. Hunziker[22], B. Barabasz-Krasny[23], K. Falińska[24], M. Gellrich et al.[25], J. M. Matuszkiewicz et al.[26]). Apart from reafforestation, also a homogenization of landscape with the contribution of natural and semi-natural complexes took place. It is the reverse process to the anthropogenic fragmentation of space (J. Solon[27]). Such situation is connected with the decrease in synanthropization level and increase in natural biodiversity. It was proved, for instance, as the result of investigation of spontaneous succession on the abandoned field in Białowieża (W. Adamowski and A. Bomanowska[28]), as well as on the post-agricultural land in the Wielkopolski National Park (S. Balcerkiewicz and G. Pawlak[29]). During 36 years in Białowieża and 25 years in the Wielkopolski NP, the majority of anthropophytes subsided and was replaced by native species, while weed plant communities was replaced by juvenile forest phytocoenoses. K. Hedlund et al.[30] documented an increase in biodiversity during the early secondary succession on the former arable land, based on the studies in five European countries.

An increase from 72 to 84% in ecosystem services at the class type level took place, depending on the section. Present-day, the transformed agricultural landscapes have two basic functions: one of them – food production, is continued. The other is protection of environment and it is strongly connected with the increase in biodiversity. This increase results from elimination of agroecosystems with

[22] M. Hunziker, *The spontaneous reafforestration in abandoned agricultural lands: perception and aesthetic assessment by locals and tourists*, "Landscape and Urban Planning" 1995 no. 31, s. 399-410.

[23] B. Barabasz-Krasny, *Sukcesja roślinności na łąkach, pastwiskach i nieużytkach porolnych Pogórza Przemyskiego*, "Fragm. Flor. Geobot. Polonica, Suppl." 2002 no. 4, p. 3-81.

[24] K. Falińska, *Alternative pathways of succession: species turnover patterns in meadows abandoned for 30 years*, "Phytocoenosis 15 (N. S.), Archiv. Geobot." 2003 no. 9, p. 104.

[25] M. Gellrich, P. Baur, B. Koch, N. E. Zimmermann, *Agricultural land abandonment and natural forest re-growth in the Swiss mountains: A spatially explicit economic analysis*, "Agriculture, Ecosystems and Environment" 2007 no. 118, p. 93-108.

[26] J. M. Matuszkiewicz, A. Kowalska, J. Solon, *Long-term evolution models of post-agricultural forests*, „Prace Geograficzne Instytutu Geografii i Zagospodarowania Przestrzennego PAN" 2013 no. 240, p. 312.

[27] J. Solon, *Ocena różnorodności krajobrazu* ..., op. cit.

[28] W. Adamowski, A. Bomanowska, *Forest return on an abandoned field secondary succession under monitored conditions*, "Folia Biologica et Oecologica" 2010 no. 7, p. 49-73.

[29] S. Balcerkiewicz, G. Pawlak, *Antropofity na tle dynamiki roślinności – studium na podstawie długoterminowego eksperymentu na powierzchni stałej*, "Acta Botanica Silesiaca" 2011 no. 6, s. 63-80.

[30] K. Hedlund, I. Santa Regina, W. H. Van der Putten et al., *Plant species diversity, plant biomass and responses of the soil community on abandoned land across Europe: idiosyncracy or above-belowground time lags*, "Oikos" 2003 no. 10, p. 45-58.

synanthropic vegetation. The dependence of ecosystem services on the biodiversity state is widely stressed (J. Borysiak[31], J. Maes et al.[32]). W. Dembek[33] reported that in the past decade, realization of common agricultural policy in the European Union was of essential significance for the improvement of environmental conditions of rural areas. The aim of this policy is implementation of multifunctional agriculture. An instrument, which will allow to keep both the new and preserved natural and semi-natural complexes of real vegetation and their ecosystem services, are the agri-environmental and climate schemes, realized since 2014 (Project[34]). It implies a remuneration system for farmers for providing noncommercial environmental services. The role of a farmer as a provider of public goods was clearly emphasized in the EU Biodiversity Strategy to 2020[35].

[31] J. Borysiak, *Ecosystem services of extensive wet grasslands. Wielkopolska Region (Poland) case study*, „Ekonomia i Środowisko" 2012 no. 42, p. 136-152.
[32] J. Maes, A. Teller, M. Erhard et al., *Mapping and assessment of ecosystems and their services* ... op. cit.
[33] W. Dembek, *Problemy ochrony polskiej przyrody w kontekście wspólnej polityki rolnej*, „Woda-Środowisko-Obszary Wiejskie" 2012 no. 12(4), p. 109-121.
[34] *Projekt Programu Rozwoju Obszarów Wiejskich na lata 2014-2020 (PROW 2014-2020)*, www.minrol.gov.pl [20-09-2014].
[35] *The EU Biodiversity Strategy to 2020*, Luxembourg: Publications Office of the European Union, 2011, www.ec.europa.eu [20-09-2014].

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ECOSYSTEM SERVICES HOT SPOT MAPPING: PROTECTED AREAS IN THE LOWER SILESIA PROVINCE

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ANALIZA ZRÓŻNICOWANIA PRZESTRZENNEGO WYBRANYCH USŁUG EKOSYSTEMÓW NA TLE OBSZARÓW CHRONIONYCH W WOJEWÓDZTWIE DOLNOŚLĄSKIM

STRESZCZENIE: Niezbędna jest poprawa wiedzy na temat ekosystemów i oferowanych przez nie usług w krajach należących do Unii Europejskiej, aby osiągnąć główne cele zapisane w Strategii ochrony różnorodności biologicznej do 2020 roku. Z tego powodu państwa członkowskie, we współpracy z Komisją Europejską, są zobowiązane zidentyfikować i ocenić stan ekosystemów i ich usług. Istnieją różne podejścia do mapowania usług ekosystemów, z których jednym jest analiza hot spot. Jest ona dobrym narzędziem do identyfikacji obszarów, które nie są chronione, lecz są ekologicznie cenne i dostarczają wielu usług ekosystemów. W badaniu przeprowadzono analizę czterech potencjałów usług ekosystemów: globalnej regulacji klimatu, kontroli erozji, moderacji ekstremalnych zjawisk i dostarczania wody pitnej. Większość z punktów hot spot dla wybranych usług ekosystemów województwa dolnośląskiego była zlokalizowana w obrębie obszarów chronionych, zwłaszcza tych objętych ochroną w formie Natura 2000.

SŁOWA KLUCZOWE: usługi ekosystemów, kartowanie za pomocą narzędzi GIS, wojewodztwo dolnośląskie

Introduction

The concept of ecosystem service has recently gained a lot of academic attention[1]. There have been many research initiatives concerning the classification[2], mapping[3] and valuation of ecosystem services[4]. The Millennium Ecosystem Assessment (MEA) was the first and the biggest research project concerning this topic. MA (2005) provided the most commonly recognized definition of ecosystem services, which is *benefits that human obtain from nature*, and categorization of services into: supporting, regulating, provisioning and cultural[5]. Although this division and distinction between ecosystem functions, services and products are still under discussion[6], it is commonly understood that in order to include ecosystem services into decision making processes the systematization is necessary. The ecosystem service concept provides new approach to translate the importance of natural capital and its contribution to improving human well-being into economic value. This very anthropogenic perspective may be implemented into environmental policy documents and spatial planning[7]. Ecosystem services has already been included in the European Union Biodiversity Strategy to 2020, the main aim of which is to maintain and restore ecosystems and their services[8]. In order to achieve this it is necessary to improve knowledge on ecosystems and services they deliver in countries belonging to the European Union[9]. Therefore, Member States, in cooperation with the European Commission, are obliged to identify and assess the state of ecosystems and their services and measure the economic value of these services[10]. Under the action 5 of the Biodiversity Strategy each country should map ecosystem services by 2014. In order to facilitate this process European Commission has run several projects among which MAES[11] (Mapping and Assessment of Ecosystems and their Services) presents availabili-

[1] R. Costanza, I. Kubiszewski, *The authorship structure of "ecosystem services" as a transdisciplinary field of scholarship*, "Ecosystem Services" 2012 no. 1, p. 16-25.
[2] R. S. de Groot et al., *A typology for the classification, description and valuation of ecosystem functions, goods and services,* "Ecological Economics" 2002 no. 41(3), p. 393-408.
[3] B. Burkhard et al., *Mapping and modelling ecosystem services for science, policy and practice*. "Ecosystem Services" 2013 no. 4, p. 1-3.
[4] J. P. Schägner et al., *Mapping ecosystem services' values: Current practice and future prospects.* "Ecosystem Services" 2013 no. 4, p. 33-46.
[5] *MEA, Millennium Ecosystem Assessment, Ecosystems and Human Well- Being: Synthesis*, Washington DC 2005.
[6] K. J. Wallace, *Classification of ecosystem services: Problems and solutions*, "Biological Conservation" 2007 no. 139, p. 235-246.
[7] B. Raszka, M. Hełdak, *Świadczenia ekosystemów w polityce przestrzennej gmin powiatu wrocławskiego*, Wrocław 2013.
[8] *The EU Biodiversity Strategy to 2020*, Luxemburg 2011.
[9] R. Brouwer et al., *A synthesis of approaches to assess and value ecosystem services in the EU in the context of TEEB Final Report* 2013.
[10] *The EU Biodiversity Strategy to 2020*, Luxemburg 2011.
[11] J. Maes et al., *Mapping ecosystem services for policy support and decision making in the European Union,* "Ecosystem Services" 2012 no. 1(1), p. 31-39.

ty of data necessary to set indicators on national level. MAES is based in the Common Classification of Ecosystem Services (CICES v4.3).

Even before the European Union's initiatives, mapping ecosystem services has been a topic of academic research in Europe[12] and outside Europe[13]. In Poland the case study mapping attempts have mostly been done for small-scale, detailed unit areas. That is why we decided to conduct a study for the whole Lower Silesia province which is struggling in achieving balance between nature conservation and socio-economic development. Even though there are publications on spatial distribution on natural resources and the state of the environment[14], these studies have seldom presented distribution of ecosystem services[15].

The aim of the paper is to contrast existing protected areas which are environmentally valuable according to traditional preservation rules with the areas where provision of the selected ecosystem services is the greatest according to the current research standards on ecosystem service hotspot mapping. In order to achieve that we developed the comprehensive method for mapping ecosystem services which could be applied in the national ecosystem assessment process. We selected four ecosystem services, each of which is spatially presented and evaluated using appropriate indicators. The services we consider are global climate regulation, moderation of extreme events, erosion control, and fresh water provision. According to the Common International Classification of Ecosystem Services vol. 4.3 these ES could be divided into two section: provisioning and regulating. Fresh water provision belongs to ecosystem service class ground water for drinking, whereas the rest of selected ES belong to the following classes: global climate regulation by reduction of greenhouse gas concentrations, flood protection, and mass stabilization and control of erosion rates. The choice of ecosystem services is governed by literature overview and the possibility for them to be quantified. The research results show spatial distribution and overlaid of individual ecosystem service, on the basis of which the aggregated ecosystem service map is produced. The Lower Silesia region is the study area selected for this research as it is faced with common for the whole country spatial problems such as excessing soil sealing, poor water relations balance and expansion of built-up areas. On the other hand, Lower Silesia is the region characterized by one of the best environmental conditions and a lot of Nature 2000 areas in Poland.

[12] L. C. Braat, *ECOSER 4th Volume: Special issue on mapping and modelling ecosystem services*, "Ecosystem Services" 2013 no. 4.
[13] M. Petter et al., *A methodology to map ecosystem functions to support ecosystem*, "Ecology and Society" 2013 no. 18(1).
[14] Chief Inspectorate for Environmental Protection, *Report on the state of the environment in Poland 2008*, Warsaw 2010.
[15] A. Mizgajski, M. Stępniewska, *Ecosystem services assessment for Poland – challenges and possible solutions,* "Economics and Environment" 2012 no. 2 (42), p. 54-73.

Study area

The case study region Lower Silesia province (LSp) is one of the main 16 administrative divisions (viovodships) in Poland. It is located in the southwest part of the country (Figure 1). The total population of the region is almost three millions. The biggest urban centre and the capital of a province is the city of Wroclaw. Wroclaw metropolitan area has got around 1 million inhabitants what makes it the fifth biggest city in Poland. Constantly expanding suburbanization processes impose greater impact on the protected environmentally valuable areas located in human settlement proximity.

The Lower Silesia region has got one of the best environmental conditions in the country. The growing season here is the longest in Poland (above 220 days) and winters are much milder. There is a temperate climate with an average annual temperature of 7,7°C and an average annual precipitation of 595 mm. The region is very diverse in landscape forms. The east and northern parts of the province is covered with lowlands whereas in south-west there are Sudeten Foreland and part of the Sudetes mountain range. The Odra River is a main supplier of fresh waters for the region. At the same the river basin is at high risk of flooding. The greatest of flood happened in 1997 when almost half of the province was affected. The region is covered with relatively good quality soils in Poland. The ration of good quality soils to rather bed soils is positive. Because of its unique environmental resources there are several forms of protection introduced to the region (two national parks, 12 landscape parks and 20 protected landscape areas), which covers less than 20 percent of the province. However, the region is dense with forests (around 30 percent of the area) and agricultural lands (50 percent of the area).

The Lower Silesia attracts a lot of tourists every year. Most of the tourist influx is directed to the city of Wroclaw, but still many people visit less built-up areas. Most attractive natural place are Sudetes Mountains and Sudeten Foreland.

Materials and methods

There are different approaches to map ecosystem services. In MAES second technical report[16] three main approaches were presented:

- Ecosystem services mapping using available indicators,
- Ecosystem services mapping linking different indicators with land use data,
- Model-based approaches to map ecosystem services.

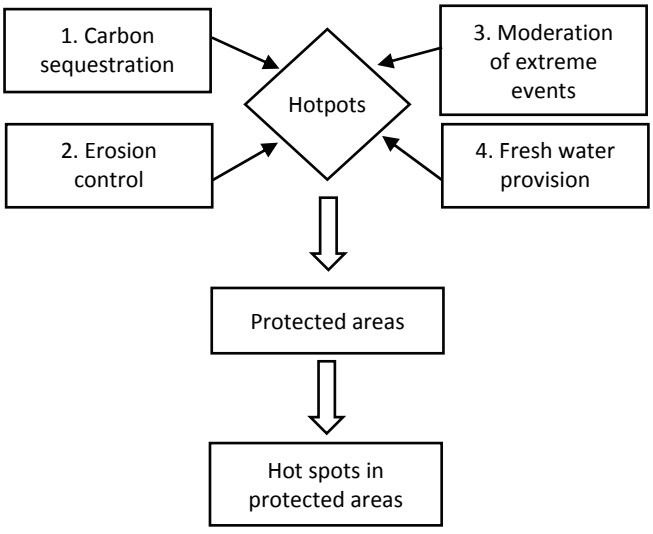
The first approach is perceived as the simplest way to map ecosystem services since it requires the usage of available indicators and presenting their values

[16] MAES, *Mapping and assessment of ecosystems and their services. Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020*, European Commission, 2nd technical report – Final, February 2014.

Figure 1
The Lower Silesia province and its location in Poland

Source: own elaboration.

Figure 2
Method for estimating ecosystem service potential in protected areas



Source: own elaboration.

spatially. Second approach combines indicators with land use data and the last one encompasses modelling biophysical processes instead. The hotspot mapping for Lower Silesia province involved first two ways to visualize ecosystem service potential and capacity. First of all, the hotspot of global climate regulation and erosion control were identified. Then the moderation of extreme events – flood protection was added and the last ES fresh water provision was mapped using 0-1 when underground water springs were identified (Figure 2).

The quality of the ES maps increase with the use of primary data and representative sampling rather than secondary data taken from look-up tables, expert knowledge and casual relationships[17]. However, the hotspot analysis was carried out using secondary data sources for the case study area being the Lower Silesia province. Types of data source consisted of biophysical, topographical, hydrological, and land-cover data available at different resolutions. Although 100 m resolution Corine Land Cover (CLC) raster data served as a basis, the erosion control map's one kilometre resolution was finally adapted. Maps were produced using ArcGIS 10 software and were not verified in the field due to the fact that was not the aim of the research.

The analysis of the spatial distribution of ecosystem services was conducted on the basis of land cover classes distinguished in the Corine Land Cover. Then, the areas with the highest total value of ecosystem service level indicators were compared with valuable natural areas in the Lower Silesia which are subject to various forms of protection. On the basis of that the areas have been identified where a high level of services provided ecosystems overlap with areas designated as environmentally valuable.

Climate regulation service is defined as the influence of ecosystems on climate[18]. In this study we assumed that carbon stock potential was based on the relationships between land use and carbon stock. There are different approaches to map global climate regulation, most often applied are carbon storage layer[19], mean f-evapotranspiration value and mean emissivity index[20] or carbon sequestration[21]. For the purpose of this study erosion control is defined as contrary to soil erosion. PESERA – The Pan-European Soil Erosion Risk Assessment – is the map produced by the Joint Research Centre under European Commission. It is a

[17] M. J. Martínez-Harms, P. Balvanera, *Methods for mapping ecosystem service supply: a review*, "International Journal of Biodiversity Science, Ecosystem Services & Management" 2012 no. 8(1-2), p. 17-25.

[18] L.C. Braat, R. de Groot, *The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy*, "Ecosystem Services" 2012 no. 1(1), p. 4-15.

[19] H.K. Gibbs, *Major world ecosystem complexes ranked by carbon in live vegetation: an updated database using the GLC2000 land cover product.* Oak Ridge (TN), Oak 2006.

[20] N. Schwarz, A. Bauer, D. Haase, *Assessing climate impacts of planning policies. An estimation for the urban region of Leipzig (Germany),* "Environmental Impact Assessment Review" 2011 no. 31(2), p. 97-111.

[21] G.E. Ausseil et al., *Assessment of multiple ecosystem services in New Zealand at the catchment scale*, "Environmental Modelling & Software" 2013 no. 43, p. 37-48.

model that quantifies soil erosion by water and assess its risk across Europe[22]. PESERA may replace such methods as Universal Soil Loss Equation (USLE) which is very often use for mapping that ES. Moderation of extreme events type of ecosystem service is mapped by presenting areas of potential flood prevention characteristics – wetlands. Flood protection was chosen considering the yearly flooding in the region due to its topographic and hydrological conditions. The Lower Silesia Province experienced catastrophic flooding in 1997. Fresh water provision ecosystem service for the purpose of this study is limited to underground fresh water sources. This ES is diversely defined in the literature. One may find that clean water provision is measured by nitrate leaching[23].

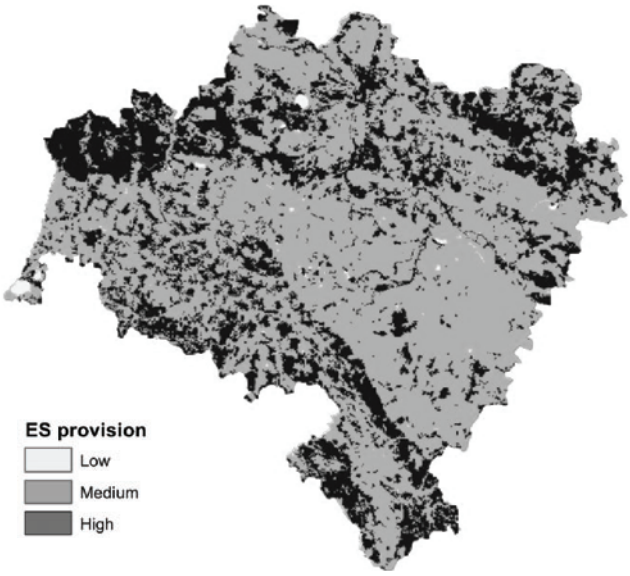
Results

The hot spot analysis of global climate regulation proves considerable ecosystem service potential for the region (Figure 3). All the high values for this ES provision constitute hot spot, the greatest number of which are located in the north-west part of the province, within Nature 2000 site of Bory Dolnośląskie. It is scientifically suggested that forests and peatlands are carbon sinks[24] which is also proven by the results for the first out of four ES potential. Moreover, high carbon stock potential is correlated with the erosion control ecosystem service and therefore most of the hot spot of climate regulation are overlaid by erosion control ES potential (Figure 4). However, erosion control is influenced by such factors as topography, land use and other. The results of hot spot analysis shows that the highest provision of this ES is located in the southern parts of the province as well as in the south-west, middle-east parts.

The hot spots of moderation of extreme events ecosystem service potential aare mainly located in the north part of the province whereas the hot spots for the fresh water provision occur in the south, mountain areas (Figure 5). This may be explained by the topography of the region which is flat in northern side. There are a lot of wetland which retain water in dry seasons and accumulate the excess during wet season. Wetlands located in the closest proximity of the rivers play the greatest role in flood prevention. Apart from wetlands, flood plains protect the built-up areas from the natural catastrophes. The analysis of the land use, however, reveals the housing development increasing at that sites which hinders the ecosystem services and the benefits they bring to human well-being. In this research we considered provision of fresh water as ecosystem service only from the underground water sources, though it is acknowledged surface resources also play important role.

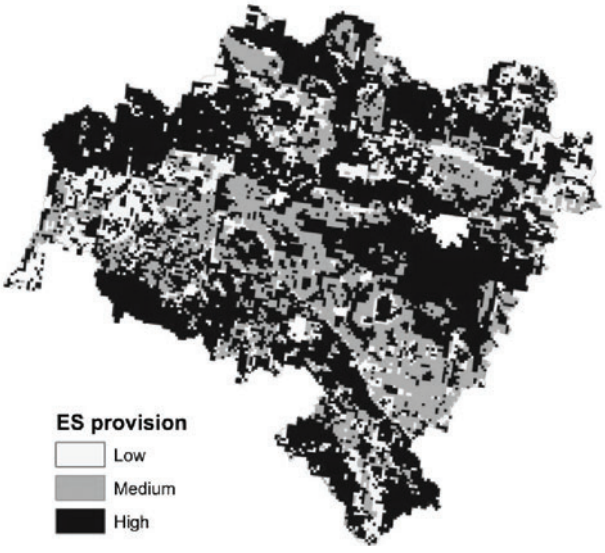
[22] www.eusoils.jrc.ec.europa.eu [01-09-2014].
[23] G.E. Ausseil et al., op. cit., p. 37-48.
[24] UK National Ecosystem Assessment, *The UK National ecosystem assessment: synthesis of the key findings*, Cambridge 2011.

Figure 3
Hot spots of global climate regulation ecosystem service potential



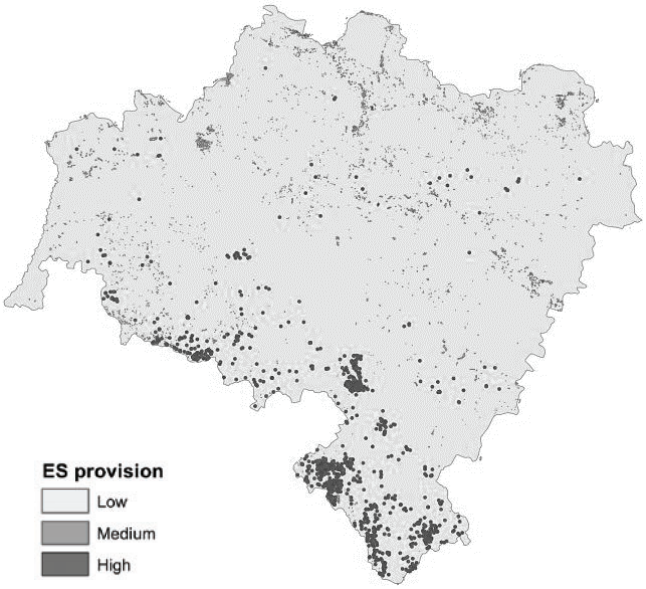
Source: own elaboration.

Figure 4
Hot spots of erosion control ecosystem service potential



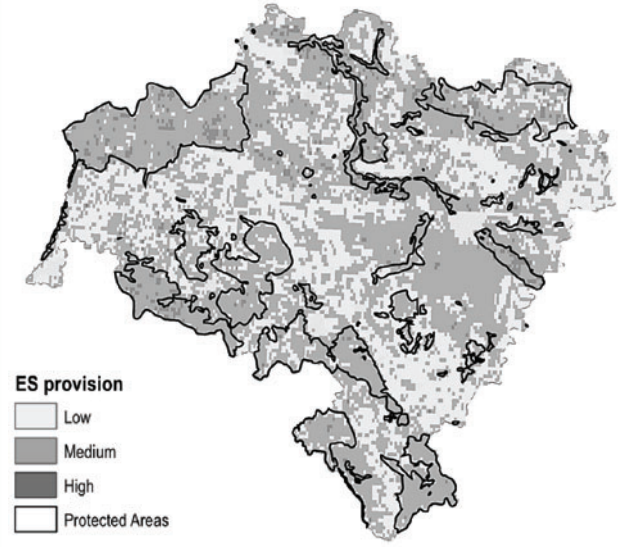
Source: own elaboration.

Figure 5
Hot spots of moderation of extreme events and fresh water provision ecosystem service potential



Source: own elaboration.

Figure 6
Hot spots of the selected ecosystem services potential and boarders of the protected areas in Lower Silesia province



Source: own elaboration.

Figure 6 presents hot spots of the selected ecosystem services potential and boarders of the protected areas (Nature 2000, national, landscape and preservation parks). Out of 17681 polygons 712 are classified as hot spots. The analysis shows that only about 12 percent of hot spots is located within national, landscape and reservation parks whereas Nature 2000 sites host about 60 percent of all the hot spots. The greatest amount of hot spots outside protected areas occur in the central north and north-east side of the Lower Silesia Province. These are also topographically the lowest parts of the region. Then cold spots are concerned, about 30 percent of them is situated within boarders of protected areas. Although cold spots are usually agricultural lands and mountain areas, places proving medium amount and quality of the selected ecosystem services are often of the same use.

Conclusions

The hot spot analysis over the one kilometre resolution data enable us to identify hot spots of ecosystem services potential that are not protected. Ecosystem service hot spot is a good tool for spatial analyses which brings new perspective to the ecosystem service mapping. Mapping ecosystem services gives also a broader perspective for protected areas' management. If ecosystem services are overlapping on a given area there is a high probability of ES trade-offs[25]. The range of ES hotspot may vary according to spatial resolution, scale and types of ecosystem services[26].

According to Seppelt et al. (2011) the use of secondary data for ecosystem service mapping and no results validation are more common in the research papers concerning that topic than the use of primary data and results being validated. It is, however, without a doubt that the reliable and comprehensive ecosystem service assessments requires biophysical measurement, modelling and monitoring of ecosystem functions[27]. Although such assessment may be time-consuming and cost-generating, it seems to be necessary in order to achieve reliable and satisfactory for decision making. Nevertheless, ecosystem service mapping still faces a lot of challenges and one of the most important of them is to set standards on the level of detail and resolution that is acceptable for comprehensive and not misleading maps[28] for all the stakeholders.

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[25] B. Locatelli, P. Imbach, S. Wunder, Synergies and trade-offs between ecosystem services in Costa Rica, "Environmental Conservation" 2013 no. 41(01), p. 27-36.

[26] M. Kandziora, B. Burkhard, F. Müller, *Mapping provisioning ecosystem services at the local scale using data of varying spatial and temporal resolution*, "Ecosystem Services" 2013 no. 4, p. 47-59.

[27] R. Seppelt et al., *A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead*, "Journal of Applied Ecology" 2011 no. 48(3), p. 630-636.

[28] J. Hauck et al., *Maps have an air of authority. Potential benefits and challenges of ecosystem service maps at different levels of decision making*, "Ecosystem Services" 2013 no. 4, p. 25-32.

Jakub Kronenberg • Marek Giergiczny

COSTS AND BENEFITS OF CREATING AND MAINTAINING A STORK VILLAGE: CASE STUDY OF KŁOPOT (CYBINKA COMMUNE)

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KOSZTY I KORZYŚCI UTWORZENIA I DZIAŁALNOŚCI BOCIANIEJ WIOSKI NA PRZYKŁADZIE BOCIANIEJ WSI KŁOPOT (GMINA CYBINKA)

STRESZCZENIE: Bocianimi wsiami nazywa się miejsca kolonijnego gniazdowania bocianów białych. Takie miejsca stanowią atrakcję turystyczną, ponieważ jest to rzadkie zjawisko. Chroni się je nie tylko ze względu na możliwości rekreacji, ale także szereg innych kulturowych usług ekosystemów. W niniejszym artykule skoncentrowano się na wycenie ekonomicznej bocianiej wioski Kłopot nad Odrą, ze względu na dostarczane przez nią korzyści rekreacyjne. Posługując się metodą kosztu podróży, ustaliliśmy że wartość rekreacyjna Kłopotu wyniosła w latach 2002-2013 odpowiednio 1 671 183 PLN lub 3 369 321 PLN – uwzględniając lub nie uwzględniając koszt alternatywny czasu spędzonego przez turystów w podróży. Biorąc pod uwagę dodatkowe, relatywnie mniejsze korzyści uzyskiwane dzięki turystyce przez mieszkańców Kłopotu, a także – przede wszystkim – koszty utworzenia i utrzymania bocianiej wioski pochodzące ze środków publicznych, ustalono, że społeczna korzyść netto związana z funkcjonowaniem tej wioski w latach 2002-2013 wyniosła 1 197 554 PLN lub 2 895 692 PLN, odpowiednio uwzględniając i nie uwzględniając koszt alternatywny czasu spędzonego przez turystów w podróży.

SŁOWA KLUCZOWE: analiza kosztów i korzyści, efektywność ekonomiczna ochrony środowiska, ekonomiczna wycena usług ekosystemów, ochrona ptaków, turystyka ornitologiczna

Introduction

Cost–benefit analysis (CBA) is typically pursued when decision makers seek economic rationale for the decisions they are about to make. The basic logic of this approach is to compare the costs and benefits of a project in question, and to carry out this project only when benefits outweigh costs. CBA is widely used in environmental and health-care fields, where decisions are often particularly complex and involve important trade-offs.[1]

Our study treats CBA as an intellectual exercise, as there are few trade-offs involved when creating a stork village and there are other important motivations for this decision, rather than economic rationality. Stork villages attract tourists because of colonial nesting of white storks (*Ciconia ciconia*), a species of a particularly high cultural importance.[2] Therefore, a decision to create a stork village primarily depends on natural circumstances (whether there is a stork colony), and – secondly – on the willingness of the local stakeholders to carry out conservation activities and brand this colony as a tourist attraction. Only the latter may involve additional economic considerations that fit into the CBA logic, such as the costs of conservation activities and the related economic benefits.

The objective of this article is to test the economic efficiency of innovative nature protection measures, based on our case study of Kłopot, a stork village in the Odra River valley in Cybinka Commune in the west of Poland. It is one of the largest white stork colonies in Poland and probably also in Europe. The study area includes ca. 50 small farms located in the river valley, an area partly used as pastures, meadows and rarely as arable fields. The stork village "brand" was introduced to Kłopot in 2001 by the League for Nature Protection (LPN, *Liga Ochrony Przyrody*), a prominent Polish NGO, and investment started in 2002. Kłopot is a unique stork village in that it hosts a White Stork Museum (opened in 2003 and managed by the LPN), probably one of the two of its kind in the world (the other being in Kölked village in Hungary). Adjacent to the Museum is a hostel, also run by the LPN.

Kłopot is associated with a network of European Stork Villages coordinated by EuroNatur (although it is not a formal member). Local authorities and inhabitants of European Stork Villages are obliged to take active measures to protect storks, aiming "to enhance the living conditions of the white stork, such as preserving or rewilding large open wet meadows or erecting artificial stork nests" and to increase environmental awareness of inhabitants and visitors.[3] All of these activities translate into costs incurred by those who maintain a stork village.

Benefits related to stork villages are reflected in the broad satisfaction of their existence and in a more utilitarian ability to visit them by individual tour-

[1] R.J. Brent, *Applied Cost-benefit Analysis*, Cheltenham, UK and Northampton, MA, USA 2006.
[2] J. Kronenberg et al., *Znaczenie bociana białego Ciconia ciconia dla społeczeństwa: analiza z perspektywy koncepcji usług ekosystemów*, „Chrońmy Przyrodę Ojczystą" 2013 no. 69, p. 3-27.
[3] N. Wiesehomeier, G. Willinger, K. Grund, *European Stork Villages: where storks are honorary citizens*, Radolfzell 2014, p. 2.

ists. We approximate the latter category with the results of a travel cost valuation study, a method which is widely used to estimate the value of sites visited for recreational purposes. Additional benefits include the abovementioned economic opportunities related to the presence of tourists in stork villages (opportunity to sell goods and services).

Methods

We used a single-site travel cost model (TCM), based on data from an on-site sample of recreational birdwatchers visiting Klopot in 2011 and 2013. We used a single visitor as our unit of observation. We estimated a negative-binomial count-data TCM. We paid special attention to counteract potential biases introduced by on-site sampling: endogenous stratification (over sampling frequent visitors) and truncation (only observing visitors making at least one trip during the season).

The surveys were carried out from April to September and questionnaires were available to tourists in the White Stork Museum in Klopot, where local employees prompted the tourists to take part in the study. Every year about 1000 tourists visit Klopot. 119 complete questionnaires were collected in 2011 and 172 in 2013. In 2011 we used the same questionnaire to study the recreational value of another stork village, Żywkowo, and we encourage the interested readers to read more about the questionnaire and the specificities of the TCM that we used in an article that reports the results of that study.[4]

Here, we focus on the CBA, following a standard approach of seeking the net social benefit of a project. Both costs and benefits were calculated for 12 years: 2002-2013, i.e. ex post – since investment in the stork village was initiated until last year. The costs and benefits are discussed from an international perspective, taking into account that the village was also visited by foreigners and that foreign donors provided funds for its creation and maintenance. All amounts are expressed in 2013 prices, calculated with the use of the real, risk-free interest rate (our proxy of a social discount rate). We calculated the real, risk-free interest rate by subtracting the core inflation rate of the National Bank of Poland from the average yields of 10yr government bonds in each year.

The TCM-estimated recreational consumer surplus constitutes the most important benefit category. The other benefits accrue to the local community as a result of the inflow of tourists. We studied them in more detail, interviewing the more entrepreneurial inhabitants of Kłopot (shop owner, bee keeper, representatives of the LPN) about how much tourists contribute to their revenues.

Costs were calculated based on how much various external donors contributed to the establishment of the White Stork Museum and to creating the stork

[4] M. Czajkowski et al., *The economic recreational value of a white stork nesting colony. A case of 'stork village' in Poland*, "Tourism Management" 2014 no. 40, p. 352-360.

village "brand" for Kłopot. These grants were mainly used to ensure the presence of the storks' breeding colony in Kłopot (conservation expenses) and to create the necessary infrastructure, both for storks (such as nest platforms) and for tourists (information boards etc.).

Unlike in some other CBA projects, we did not include the opportunity costs related to potential other land use options in the village (such as intensive agriculture). The main reason for this was that we would then also have to include various costs (including external costs) related to such activities, making this extension far broader than the core topic of our study.

Finally, other less tangible costs and benefits are only mentioned in passing where we found it impossible to calculate their value in monetary terms.

Results

Recreational benefits (consumer surplus calculated with TCM)

The expected number of trips taken by visitor n is given by: $\lambda_n = \exp(\beta_{TC} TC_n)$ which serves as our travel cost recreation demand function where TC_n represents individual n's cost of reaching the site. The trip cost was defined in two variants: with and without the opportunity cost of time; in both cases assuming a round trip. The average cost per kilometer was estimated at 0.45 PLN; however, when calculating cost per person we took a travelling party size into account. The value of time depended on visitor's origin and was assumed to be 8 PLN/h for Polish visitors and 16 PLN/h for foreigners (in both cases the value of time was assumed to be equal to 1/3 of an average hourly wage rate, which is a common practice in TCM studies). The average vehicle speed was assumed to be 60 km/h, and the mean distance traveled was 120 km (one way), (Table 1). The estimation results of two models are shown in Table 2 (assuming the opportunity cost of time to be zero) and Table 3 (assuming the opportunity cost of time to be one-third of an hourly wage). As expected, the coefficient of a trip cost was negative and statistically significant in both models.

In Table 4 we report welfare estimates along with sensitivity analysis over opportunity cost of time. Using zero cost of time instead of the 1/3 wage resulted in welfare estimates (consumer surplus associated with average respondents' visits) that are 50% lower than when the opportunity cost of time was taken into consideration: 186 PLN vs. 375 PLN; both welfare measures are expressed in 2013 prices. These results are very similar to those of another Polish stork village, Żywkowo in the north-east of Poland.[5] As Kłopot is visited by approximately 1000 tourists per year, this gives the net annual recreational benefit of 186 000 PLN (without value of time) or 375 000 PLN (with value of time).

[5] Ibidem.

Table 1
Summary statistics of the basic explanatory variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Visit	291	1.872852	2.032745	1	21
Km	291	119.8282	156.6736	3	768
Cost	291	47.93127	62.66944	1.2	307.2
Cost1	291	92.0312	127.6177	2.16	768
Male	291	.3436426	.4757417	0	1
Age	291	42.48797	13.96902	15	80

Source: the authors' own elaboration.

Table 2
Estimation results of the individual travel cost model excluding the opportunity cost of travel time

Visit	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Cost	-.0053748	.0021756	-2.47	0.013	-.0096389	-.0011108
Cons	-20.25328	166.2862	-0.12	0.903	-346.1682	305.6617
Lnalpha	21.11985	166.2861			-304.7949	347.0346
Alpha	1.49e+09	2.47e+11			4.3e-133	5.2e+150

Truncation point: 0
Dispersion = mean
Log likelihood = -362.58645
LR chi2(2) = 8.40
Prob > chi2 = 0.0150
Pseudo R2 = 0.0114
Likelihood-ratio test of alpha=0:
chibar2(01) = 139.28
Prob>=chibar2 = 0.000

Source: the authors' own elaboration.

Assuming that these benefits are relatively constant over time, we can calculate the recreational value of Kłopot since tourists started to visit this place in 2003. In the first year about 600 people came, and since 2004 the village has attracted about 1000 tourists annually. Taking into account the real, risk-free interest rate (our proxy of a social discount rate), we conclude that the total recreational value of the village has been 1 671 183 PLN not including the value of time, and 3 369 321 PLN including the value of travel time.

Table 3
Estimation results of the individual travel cost model including the opportunity cost of travel time

Visit	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
cost1	-.0026661	.001113	-2.40	0.017	-.0048476	-.0004847
cons	-21.8118	150.1269	-0.15	0.884	-316.0552	272.4316
lnalpha	22.66891	150.1266			-271.5739	316.9117
alpha	7.00e+09	1.05e+12			1.1e-118	4.3e+137

Truncation point: 0
Dispersion = mean
Log likelihood = -362.67787
LR chi2(2) = 8.21
Prob > chi2 = 0.0165
Pseudo R2 = 0.0112
Likelihood-ratio test of alpha = 0
chibar2(01) = 139.58
Prob>=chibar2 = 0.000

Source: the authors' own elaboration.

Table 4
Welfare estimates associated with visiting the stork village (consumer surplus per person per trip), [PLN]

Visit	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Excluding the opportunity cost of travel time						
nl_1	-186.0523	75.30889	-2.47	0.013	-333.655	-38.44958
Including the opportunity cost of travel time						
nl_1	-375.0731	156.5805	-2.40	0.017	-681.9652	-68.18096

Source: the authors' own elaboration.

Profits from tourism

The inhabitants obtained a new opportunity to earn money with the inflow of tourists, such as increased revenue of the local shop or revenues of other inhabitants who manage to sell their products or services to the LPN or directly to tourists. Occasionally, especially during bigger events organized by the LPN, the inhabitants could sell their produce and, in some instances, provide catering services. Assuming the average profit margin to be 25% of the revenue, the minimum net benefits from tourism for the inhabitants of Kłopot were 23 386 PLN over the period of 2002-2013 (2013 prices, discounted with the real, risk-free interest rate – our proxy of a social discount rate).

Costs of creating and maintaining the stork village

As a stork village is meant to serve public purposes, most expenses related to its creation and maintenance were paid from grants provided by various donors. These included both large international organizations (GEF/UNDP), important Polish funds (Regional and National Funds for Environmental Protection and Water Management), smaller organizations (Ciconia Stiftung, ProNatura), regional and local authorities, as well as private companies and individuals. External grants were used to fund all larger expenses related to the stork village, and often individual donors were approached when smaller needs emerged.

Altogether the various grants amounted to 497 015 PLN (2013 prices, discounted with the real, risk-free interest rate – our proxy of a social discount rate). Additional, current expenses were covered by the proceeds from educational services and accommodation offered by the Museum and the hostel.

Adapting the old school building for new purposes was particularly costly in the beginning and most costs were covered from the initial grants in 2003. Additional facilities had to be created, such as the storkwatching tower, hostel furniture, exhibits for the museum, bicycles for rental and other equipment (binoculars, computers etc.). White stork conservation activities included renovation of nests and nest platforms. Finally, the activity of a stork village requires education and promotion, which appeared as the annual Stork Day, youth exchange, information boards, posters, postcards etc. No costs of acquiring land were involved as the building and the land where the White Stork Museum, the hostel and the office are located are owned by Cybinka commune and are leased to the LPN free of charge.

In addition to the above costs incurred by the LPN, we were only able to identify negligible private costs incurred by one household which provided catering services and for some time offered accommodation. Also, private costs may be related to the fact that storks sometimes destroy (over time) roofs, either because of their heavy nests or because of their excrements. However, these problems can be prevented by proper maintenance of those nests which is included in the costs incurred by the LPN.

Net benefit of creating and running a stork village

In light of the above estimations, we can calculate the net social benefit of running and creating the stork village in Kłopot to be 1 197 554 PLN when using the lower (and less realistic) TCM estimate, and 2 895 692 PLN when using the upper (more realistic) TCM estimate. Note that these are mostly the broad public benefits that contribute to this result, which justifies the use of public funds for the creation and running of the stork village.

Discussion and conclusions

Based on an analogy to many other economically successful bird conservation undertakings which translated into local development opportunities,[6] LPN representatives saw similar opportunities in Kłopot. From the very beginning of this project, they suggested that the inhabitants of the village should undertake stork conservation activities (including the preservation of the storks' habitat) to attract tourists and thus generate economic benefits. Also, from the very beginning they ensured that the inhabitants have opportunities to earn money by providing catering services and selling their produce to tourists.[7] Their expectations only partly came true – there are fewer tourists and fewer income opportunities than the LPN expected.

The monetary benefits gained directly by the inhabitants do not compensate for the costs incurred by the LPN when establishing and maintaining the necessary infrastructure. However, these costs were paid with public funds (mostly from institutional donors) and they well reflected the broader interests of conservation. Public benefits estimated with the TCM indicate that establishing a stork village in Kłopot proved perfectly reasonable also in economic terms. Furthermore, white stork is a species that plays a prominent role in Polish culture[8] and nature conservation has broader objectives than just making profit.

Most environmental conservation projects are motivated by a broader – ethical and political – rationale, and our CBA only serves as an intellectual exercise. We need to keep in mind the different limitations of this approach: CBA is a typical economic tool, based on numerous assumptions characteristic of neoclassical economics, such as rational behavior of economic agents, ethical individualism, and a monistic utilitarian approach. Thus, critics suggest that CBA should be developed further and "acknowledge the multiple dimensions of human well-being, the plural forms of value articulation, the complex nature of ecosystems, the distributional biases of markets and the fairness implications of spatio-temporal framing"[9].

Indeed, our analysis revealed further, non-monetary benefits related to the stork village status of Kłopot. These include changes in environmental awareness of inhabitants and their positive attitude towards environmental conservation. This is partly motivated by financial benefits that they receive, but it is also a broader appreciation stemming from the fact that they see people coming from far away to see "their" storks. In terms of public benefits, this helps to shape the identity of the village. The identity – or rather an image – of the village also helps to raise further funds for environmental conservation or development of tour-

[6] C.f. D. Molloy, p. Thomas, P. Morling, *RSPB reserves and local economies*, Sandy 2011.
[7] L. Jerzak, P. Czechowski, *Rozwój turystyki przyrodniczej na przykładzie bocianiej wioski Kłopot*, „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu" 2009 no. 50, p. 241-245.
[8] J. Kronenberg et al., op. cit.
[9] G. Wegner, U. Pascual, *Cost-benefit analysis in the context of ecosystem services for human well-being: A multidisciplinary critique*, "Global Environmental Change" 2011 no. 21, p. 492-504.

ism. Also, the village is an important site of ecological education for schools in the region.

The direct benefits related to running a stork village gained by the inhabitants can be larger, as demonstrated by an example of yet another stork village in Poland – Pentowo – which is run and managed as a business enterprise. Indeed, there are many opportunities to make stork villages more attractive to tourists, in line with the concept of sustainable tourism, so that those who visit this site have more opportunities to spend time and money there.[10] Thus, the management models of stork villages and other undertakings based on sustainable use of natural resources require further research.

This research was funded within the Polish National Science Centre grant N N112 292339. Helpful comments from Anna Bartczak are gratefully acknowledged.

[10] J. Dziankowska et al., *Sustainable development strategy for the stork village Kłopot*, Łódź 2011.

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FACTORS MODIFYING WILLINGNESS TO INCUR EXPENSES FOR THE BENEFIT OF THE WIELKOPOLSKI NATIONAL PARK

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CZYNNIKI RÓŻNICUJĄCE SKŁONNOŚĆ RESPONDENTÓW DO PONOSZENIA KOSZTÓW NA RZECZ WIELKOPOLSKIEGO PARKU NARODOWEGO

STRESZCZENIE: Celem niniejszej pracy było określenie inklinacji mieszkańców do ponoszenia opłat za możliwość korzystania z Wielkopolskiego Parku Narodowego. Materiały źródłowe do realizacji postawionego problemu pozyskano podczas badań w formie wywiadu standaryzowanego, przeprowadzonego w latach 2012-2013 wśród mieszkańców miejscowości położonych w obrębie gmin, w których zlokalizowany jest WPN oraz mieszkańców Poznania bezpośrednio sąsiadujących z tymi gminami. W pracy zastosowano model logitowy. Z otrzymanych rezultatów wynika, że na wielkość deklarowanej kwoty za możliwość korzystania z WPN mają wpływ następujące zmienne: wiek respondenta, poparcie wydatków ekologicznych oraz przynależność do organizacji ekologicznych.

SŁOWA KLUCZOWE: wycena dóbr środowiskowych, metoda wyceny warunkowej, metoda logitowa

Introduction

Environmental protection is focused first of all on human needs. Its objective is not to counteract the economic progress of the society, but to prevent and minimise negative effects of this activity. Requirements of protection of environmental value result from many reasons; however, all of them may be included in the sustainable development policy. Due to the fact that it is in the best interest of the society to appropriately utilise environmental resources, it is crucial to ensure sustainability of the environment and its elements. At the same time, as a result of an insufficient awareness of interrelations between economy, the society and the environment the implementation process of sustainable development has been slow. Actions aiming at the protection of nature surrounding us following the principle of sustainable development are multifaceted and one of its forms is to establish surface nature conservation forms such as e.g. national parks.

The reason for the establishment of the National Park of Wielkopolska in 1957 was to protect postglacial landscapes and semi-natural forests located in that area. Ideal conditions for recreation and leisure, as well as the immediate vicinity of a large municipal centre have resulted in an enhanced activity of tourists and individuals interested in settling in the vicinity of the park. Anthropopressure may lead to overexploitation of the natural environment and eventually to its degradation. Threats resulting from the recreation use of protection areas are likely to become more serious as a result of increasing human activity and mobility.

It is believed that environmental resources are priceless; however, since they are limited, it is necessary to instill in the general public the awareness of their great importance for the economy and the extensive effect on the overall quality of life. The best method to present these interdependencies in the most convincing manner is to allocate money value to environmental resources. This process aims not only at enhancing the public awareness, but also at estimating the value assumed for the environment and other public goods, typically not subjected to their market appraisal. Determination of the money value contributes to the promotion of green lifestyles, it facilitates more effective management of expenditure on environmental protection, e.g. as a result of determination of the potential environmental impact of investments on individual elements of the environment as perceived from the human point of view.

However, it still needs to be remembered that a reliable appraisal requires in-depth knowledge and faces significant obstacles, resulting mainly from the general belief that money may not fully reflect the comprehensive value of environmental goods. Moreover, we also need to consider the fact that estimation of environmental value is developed thanks to the creation of new appraisal techniques, including additional socio-economic conditions connected with nature conservations forms.

The first surveys concerning consumer preferences were conducted in the 1940's. They concerned consumer purchases in studies conducted by the US Federal Reserve System[1]. The first surveys presenting consumer preferences in relation to environmental goods were carried out by Bowen 1943[2], and Ciriacy – Wantrup 1947[3].

In Poland the first publications focusing on the economic value of the natural environment concerned forested areas[4]. They were studies by employees of the Forest Research Institute in Warsaw, discussing appraisal of non-economic functions of forests. Among authors investigationg this problem we need to mention Marszałek[5], Klocek[6] and Gołoś[7].

In turn, the contingent valuation method was applied for the first time in studies concerning protection of the Baltic Sea against excessive discharge of such substances as nitrates and phosphates. Recorded results showed how much Poles would be willing to pay to protect the Baltic and its beaches against negative effects of eutrophication[8]. More recent research using the contingent valuation method has concerned e.g. willingness to pay for cleaner water in rivers and for consumer use or willingness to pay for improved protection of the Białowieża Forest[9].

The aim of this study was to determine the willingness of inhabitants to pay fees for the use of the National Park of Wielkopolska (NPW).

The scope of study and methods

The scope of this study included an analysis of the material collected from 1400 respondents during standardised interviews and mail questionnaires.

The questionnaire consisted of three parts. In the first part questions concerned general information on NPW (the knowledge, frequency of visits, the im-

[1] F.T. Juster, *Consumer buying intentions and purchase probability: an experiment in survey design,* "Journal of the American Statistical Association" 1966 no. 61, p. 658-696.
[2] H.R. Bowen, *The interpretation of voting In the allocation of economic resources,* "Quarterly Journal of Economics" 1943 no. 58, p. 27-48.
[3] S.V. Ciriacy–Wantrup, *Capital returns from soil-conservation practice,"*A Journal of Farm Economics" 1947 no. 29, p. 1181-1196.
[4] A. Zydroń, K. Szoszkiewicz, *Wartość środowiska a gotowość społeczeństwa do zapłacenia za to dobro,"* Annual Set The Environment Protection" 2013 no. 15, p. 2874-2886.
[5] T. Marszałek, *Szacowanie pozagospodarczej wartości lasów, parków narodowych i rezerwatów przyrody,* „Sylwan" 1976 no. 3, p. 33-45.
[6] A. Klocek, *Pozaprodukcyjne funkcje lasu – dobra publiczne gospodarki leśnej,* „Sylwan" 1999 no. 11, p. 5-20.
[7] P. Gołos, *Wycena wartości ekonomicznej rekreacyjnej funkcji lasu na przykładzie Leśnego Kompleksu Promocyjnego Gostynińsko-Włocławskiego,* rozprawa doktorska, Warszawa 1998.
[8] F.T. Juster, *Consumer buying intentions and purchase probability: an experiment in survey design,* "Journal of the American Statistical Association" 1966 no. 61, p. 658-696.
[9] M. Czajkowski, *Nośniki wartości dóbr środowiskowych,* rozprawa doktorska, Warszawa 2008, p. 302.

portance of NPW for visitors, preferred forest type), while the second part comprised questions related to the willingness of respondents to incur costs for the sake of the environment (voluntary allocation of funds for the possibility to use the NPW value or possible compensation for a lack of such a possibility, alternatively if the respondents declared no amount they would pay, whether they would be provide volunteer work for NPW). In turn, the third part included socio-economic characteristics of respondents (their sex, age, profession, net income per family member, education, place of residence). Results were verified and in this way questionnaires containing no answers to key questions were eliminated. Finally an ordered, verified matrix was prepared with answers of the respondents, comprising results of 577 interviews. Based on the answers of the respondents the following variables were identified, as described in Table 1.

Table 1
Dependent variables which explain the declared amount of money for the use of NPW

Explanatory variable	Unit	Symbol	Theoretical assumption
Frequency of visits in the National Park of Wielkopolska	0 – never, 1 – once a year, 2 – several times a year, 3 – once a month, 4 – once a week, 5 – more frequently	x_1	+
Knowledge on the National Park of Wielkopolska	0 – practically almost none, 1 – poor, 2 – moderate, 3 – good, 4 – very good	x_2	+
Willingness to work for the sake of the National Park of Wielkopolska	1 – 1 day, 2 – 2 days, 3 – 5 days, 4 – 7 days, 5 – more days	x_3	+
Age	1 – below 18 years, 2 – 18-25 years, 3 – 26-40 years, 4 – 41-60 years, 5 – over 60 years	x_4	+
Residence in terms of population size	1 – village, 2 – town up to 20 thousand inhabitants, 3 – town – from 21 thousand to 100 thousand, 4 – city over 100 thousand	x_5	+-
Mean net income per person	1 – up to 100 PLN 2 – 100-200 PLN 3 – 200-500 PLN 4 – 500 PLN – 1000 PLN 5 – 1000-2500 PLN 6 – over 2500 PLN	x_6	+-
Education	1 – elementary, 2 – vocational, 3 – secondary, 4 – higher	x_7	+-
Opinion on financial requirements of environmental protection	1 – moderate, 2 – I am for it, 3 – I am all for it, -1 – I am against, -2 – I am strongly against it	x_8	+
Affiliation to environmental organisations	1 – I am not a member, 2 – I used to be a member, 3 – I am a passive member of environmental organisations, 4 – I am an active member of environmental organisations	x_9	+
Distance from NPW	[km]	x_{10}	-

(-) – negative effect on the the declared amount of money
(+) – positive effect on the the declared amount of money

Source: own elaboration.

Logit model

When selecting explanatory variables the theoretical assumptions were as follows: the amount of the declared fee for the possibility to use NPW will be positively affected by: frequency of visits to the National Park of Wielkopolska, knowledge on the National Park of Wielkopolska, willingness to offer days of volunteer work for the National Park of Wielkopolska, age, financial requirements of environmental protection and affiliation to environmental organisations. In turn, a negative effect on the explanatory variable was expected in the case of distance from NPW. Additionally it was stated that the population size of the place of residence, education and mean net income per person should not influence the declared amount for the possibility to use NPW.

The outlined objective was analysed using the logit method[10], which makes it possible to describe dependencies between frequencies of individual variants of the explained variable and selected explanatory variables. For the purpose of analysis of the amount declared for the possibility to use NPW a model was constructed, in which values of the explained variable (y) were presented in the nominal scale, i.e. 0 denotes the answer of 0 PLN, 1/7 – 10 PLN, 2/7 – 25 PLN, 3/7 – 50 PLN, 4/7 – 100 PLN, 5/7 – 200 PLN, 6/7 – 300 PLN and 7/7 – 400 PLN. It was assumed that variation in the declared amounts for the possibility to use NPW may be expressed by the equation:

$$y = \frac{\exp\left(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_{10} x_{10}\right)}{1 + \exp\left(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_{10} x_{10}\right)} \quad (1)$$

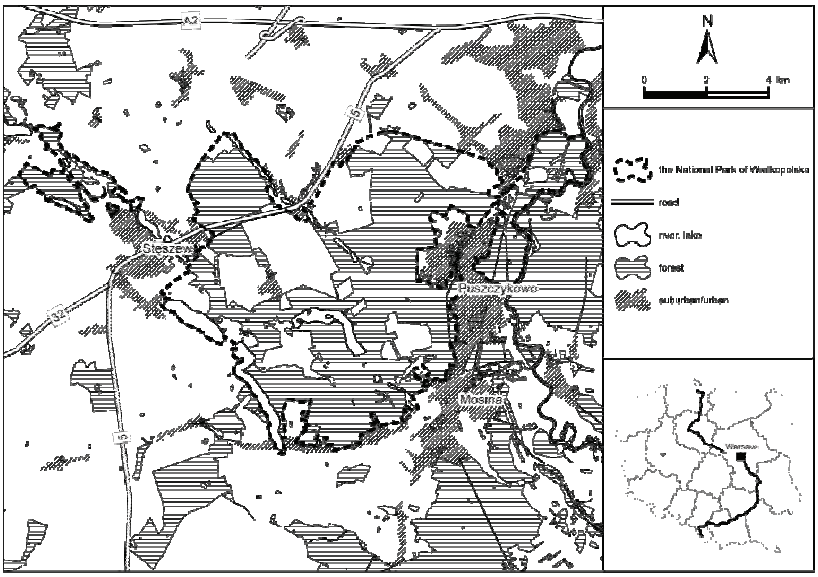
where: β_0, β_1, ..., β_{10} are unknown regression coefficients, which were determined using the maximum likelihood method. In this analysis the calculations were performed using the *Statistica* 10.0 programme.

Characteristic of the study area

Source materials for the realisation of the presented problem were collected in the course of standardised interviews performed in the years 2012-2013 with inhabitants of towns located in communes, within which NPW is situated and with the inhabitants of Poznań, neighbouring these communes. The Park is located at a distance of approx. 15 km south from the centre of Poznań (Figure 1). NPW was established in 1957 in order to protect various forms of post-glacial landscape and the most natural plant communities, as well as associated animal species. At present the area of NPW is 7 584 ha, while including the protection zone it is 14 840 ha. It is estimated that over 1 million tourists visit the National Park of Wielkopolska annually. The Park comprises approximately 85 km hiking trails, 100 km cycling paths and 30 km horse-riding trails.

[10] A. Markowska, T. Żylicz, *Costing an international public good: The case of the Baltic sea,* "Ecological Economics" 1999 no. 30, p. 301-316.

Figure 1
Location of the study area – the National Park of Wielkopolska



Source: own elaboration.

Results and discussion

A logit model was constructed in order to predict the declared amount of money to be paid for the use of NPW and to indicate which of the analysed factors will have a significant effect on this variable. Table 2 presents results of this modelling.

Analyses showed that the declared amount of money for the use of NPW depends on the following variables: age of respondents, their opinion on financial requirements of environmental protection and affiliation to environmental organisations. A positive effect on the investigated phenomenon was connected with the age of respondents (older individuals declared higher amounts), while a negative effect was found for the other two factors. In the case of respondents acknowledging the necessity to allocate large amounts of money for environmental protection, the personally declared amount of money for the use of the Park was very low. They acknowledged that environmental protection requires high outlays, but it is not the local community using the NPW services that should be burdened with additional costs. This may result from the fact that local communities on the one hand believe that they are interested in ecology and that nature is a value by itself, while on the other hand they do not suffer consequences of their actions and at the same time they feel excused from responsibility for a given problem[11].

[11] J. Herink, *Odpowiedzialność ekologiczna a komunikacja marketingowa,* "Annual Set The Environment Protection" 2013 no. 15, p. 2799-2810.

Table 2
Regression coefficients in the model describing the declared amount of money for the use of NPW

Explanatory variable	Symbol	Assessed regression coefficient	Empirical level of significance
Constant	-	0.686	0.241
Frequency of visits in the National Park of Wielkopolska	x_1	-0.099	0.198
Knowledge on the National Park of Wielkopolska	x_2	-0.146	0.188
Willingness to work for the sake of the National Park of Wielkopolska	x_3	-0.023	0.723
Age	x_4	0.418	< 0.001
Residence in terms of population size	x_5	-0.112	0.149
Mean net income per person	x_6	-0.108	0.069
Education	x_7	0.157	0.132
Opinion on financial requirements of environmental protection	x_8	-0.449	< 0.001
Affiliation to environmental organisations	x_9	-0.394	0.023
Distance from NPW	x_{10}	-0.393	0.063

Source: own elaboration.

Studies conducted by Mitchell, Carson[12] and Nowacki[13]showed that the amount declared for the use of the environment value depend on income, education, profession, the composition of the group of visitors, demographic and psychographic factors. Moreover, this amount to a considerable extent is dependent on the features of the attraction itself, such as quality of services and infrastructure.

When analysing the assessed regression coefficients it was stated that similar opinions were expressed by members of environmental organisations. They also declared low amounts of money to be paid for the use of NPW. A similar problem was investigated in their study by Królikowska, Królikowski[14], who examined the introduction of fees for discharge of precipitation and snowmelt water. It was not a simple problem, as evidenced by the fact that very few municipal sewage and utility companies decided to introduce fees for precipitation water discharge.

[12] R.C. Mitchell, R.R. Carson, *Using surveys to value public goods: the contingent valuation method resources for the future*, Washington DC 1989; N.A. Powe, K.G. Willis, op. cit.; K. Kawagoe, N. Fukunaga, op. cit.
[13] M. Nowacki, *Skłonność do zapłaty a cena wstępu do atrakcji turystycznej*, „Zeszyty Naukowe Uniwersytetu Szczecińskiego" 1999 no. 568, „Ekonomiczne Problemy Turystyki" no. 13.
[14] J. Królikowska, A. Królikowski, *Opłaty za odprowadzanie wód opadowych – potrzeby i możliwości,* "Annual Set The Environment Protection" 2013 t. 15, p. 1143-1152.

When analysing values of empirical significance levels presented in Table 2 for the mean net income per family member and the distance from NPW a trend may be observed for the negative effect on the investigated explanatory variable. It is highly likely that willingness to support NPW decreases with an increase in income in the general public. Similarly, we have concluded that with an increase in the distance of the place of residence from NPW the willingness to pay for the benefit of NPW decreases. Such conclusions were also reached as a result of other mathematical analyses, i.e. canonical analysis of correspondence[15].

In the case of other investigated sociological characteristics, such as the frequency of visits to NPW, knowledge on the National Park of Wielkopolska, willingness to offer volunteer work for NPW and education, no interdependencies were found with the declared amount to be paid for the use of the National Park of Wielkopolska.

Following the opinion of Czajkowski[16] it may be stated that the contingent valuation method based on responses of the interviewees, who declared their action in a hypothetical situation, facilitates considerable flexibility and valuation of goods, for which there is no market and which may not be appraised otherwise. This method makes it possible to assess the significance of individual characteristics of protected areas and verify willingness to pay for them.

Conclusions

1. The declared amount of money for the use of NPW depends positively on the age of the respondents, while it is negatively dependent on their opinion on the financial requirements of environmental protection and affiliation to environmental organisations.
2. Mean net income per family member and the distance from NPW show a trend towards a negative effect on the amount of money declared for the use of NPW.
3. No interdependence was found between the amount of money declared for the use of NPW and the frequency of visits to NPW by the respondents, their education, knowledge on the National Park of Wielkopolska and their willingness to provide volunteer work for the Park.

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[15] A. Zydroń, K. Szoszkiewicz, *Wartość środowiska a gotowość społeczeństwa do zapłacenia za to dobro,* "Annual Set The Environment Protection" 2013 no. 15, p. 2874-2886.
[16] M. Czajkowski, *Nośniki wartości dóbr środowiskowych,* rozprawa doktorska, Warszawa 2008.

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LOSSES IN SURFACE WATER ECOSYSTEM SERVICES CAUSED BY WASTE WATER DISCHARGE

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STRATY W ŚWIADCZENIACH EKOSYSTEMÓW WÓD POWIERZCHNIOWYCH SPOWODOWANE EMISJĄ ŚCIEKÓW

STRESZCZENIE: Zanieczyszczenia przedostające się do wód powierzchniowych powodują pogorszenie się jakości wody oraz zaburzenia w funkcjonowaniu ekosystemów wodnych i powiązanych z nimi ekosystemów lądowych. Skutki odczuwane są także przez ludność i gospodarkę narodową. Straty ponoszone przez ludność oraz poszczególne sektory gospodarki w związku z emisją ścieków są bardzo zróżnicowane. Na ich wielkość ma wpływ przede wszystkim sposób wykorzystania zanieczyszczonej wody. Straty te można podzielić na dwie podstawowe grupy: straty ponoszone przez użytkowników zanieczyszczonych wód oraz starty związane z funkcjonowaniem ekosystemów wodnych. Koszty, które muszą ponieść korzystający z zasobów wodnych, są jednocześnie stratami wynikającymi z ograniczonej możliwości świadczenia usług przez dany ekosystem wodny.
W artykule przedstawiono starty w świadczeniach ekosystemów wodnych spowodowane zrzutami ścieków oraz sposoby ich szacowania.

SŁOWA KLUCZOWE: świadczenia ekosystemów, wody powierzchniowe, odprowadzanie ścieków, szacowanie strat

Introduction

The natural environment is a place where humans exist. It is therefore a source for fulfilling their needs. With the development of science and technology, these needs started exceeding the basic physiological, hygienic and survival requirements. The development of economies and consumer society caused an increase in the requirement for natural resources. Currently, all types of ecosystems are being utilised. It can be said that the ecosystems provide a kind of a service. Due to this fact, a new concept was created, linking the natural environment and the way of utilizing it, called the concept of ecosystem services.

Common International Classification of Ecosystem Services (CICES) defines "as the contributions that ecosystems make to human well-being. These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people. A fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them"[1].

Initial works on the concept of ecosystem services and their economic value date back to the mid-1960s and early 1970s[2]. Interest in this issue has increased in the 90s[3].

An important date in the development of the concept of ecosystem services was year 1997 and the publishing of an article by Costanza, in which he presents 17 types of ecosystem services and assesses their economic value in a global scale[4].

The important moment in the development of the concept of ecosystem services was the publication in 2005 Millennium Ecosystem Assessment (MEA), a work involving over 1300 scientists. One of the key results of the MA was the

[1] *Common International Classification of Ecosystem Services (CICES)*: Consultation on Version 4, August-December 2013, Report to the European Environment Agency, Revised January 2013, p. I.

[2] R.T. King, *Wildlife and man*, "Conservationist" 1966 no. 20(6), p. 8-11; D.R. Helliwell, *Valuation of wildlife resources*, "Regional Studies" 1969 no. 3, p. 41-49; E.P. Odum, H.T. Odum, *Natural areas as necessary components of man's total environment*, Transactions of the 37th North American Wildlife and Natural Resources Conference, March 12-15, Washington D.C. 1972, vol. 37, p. 178-189.

[3] D.W. Pearce, *Economic values and the natural world*, London 1993; D. Pimentel, C. Wilson, *Economic and environmental benefits of biodiversity*, "Bioscience" 1997 no. 47(11), p. 747-758; R.S. de Groot, *Functions of nature. Evaluation of nature in environmental planning, management and decision making*, Groningen 1992; R.S. de Groot, *Environmental functions and the economic value of natural ecosystems*, in: A.M. Jansson (ed.), *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, "International Society for Ecological Economics" 1994, p. 151-168; K.E. Limburg, C. Folke, *The ecology of ecosystem services: introduction to the special issue*, "Ecological Economics" 1999 no. 29, p. 179-182; M.A. Wilson, S.R. Carpenter, *Economic valuation of freshwater ecosystem services in the United States 1971-1997*, "Ecological Applications" 1999 no. 9(3), p. 772-783.

[4] R. Costanza et al., *The value of the world's ecosystem services and natural capital*, "Nature" 1997, p. 387-253.

finding that globally 15 of the 24 ecosystem services investigated are in a state of decline, and this is likely to have a large and negative impact on future human welfare[5].

Research into ecosystem services has flourished considerably since the publication of the MA, notably the ongoing Economics of Ecosystems and Biodiversity (TEEB) project which is making a compelling case for promoting conservation, by estimating the economic benefits of ecosystems to human welfare and the economic cost to society of ecosystem decline[6]. The TEEB study identified a set of 22 ecosystem services[7].

In MEA 2005, ecosystem services are divided into four groups: provisioning services, regulating services, supporting services and cultural services[8]. CICES proposes the following classification: provisioning services, regulating and maintenance, cultural services[9].

As a part of a project, partially funded by the European Union, studies were conducted which assessed the connection between ecosystems of larger areas and their capacity and possibilities of delivering environmental services and resources. New maps have been designed for Europe, which illustrate the possibilities of ecosystems for delivering resources and services in the next 20-30[10].

A very significant issue of the discussed concept is the economic pricing of the environmental resources and services of the ecosystems, as well as losses in these services, resulting from their lower quality. One of the most important ecosystems determining the life on Earth is the aquatic ecosystem. Aquatic ecosystems provide services to society, but also make it possible for many terrestrial ecosystems to provide their own services.

The aim of this article is to present the services of surface water ecosystems and the way in which losses in these services are shaped in connection with water resource pollution.

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[5] B. Fisher, R. Kerry Turner, P. Morling, *Defining and classifying ecosystem services for decision making*, "Ecological Economics" 2009 no. 68, p. 643.

[6] D. de Groot, *Protecting natural capital for human wellbeing and sustainable development*, Science for Environment Policy, DG Environment News Alert, Special ISSUE Ecosystem Services, May 2010, p. 1.

[7] TEEB, *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundation*, Earthscan, Cambridge 2010.

[8] MEA, *Ecosystems and Human Well-being: Current State and Trends*, vol. 1, Findings of the Condition and Trends, Working Group of the Millennium Ecosystem Assessment. Island Press Washington, Covelo, London 2005, p. 917.

[9] *Common International Classification*…, op. cit.

[10] *Mapping Europe's potential to provide ecosystem goods and services,* Science for Environment Policy, DG Environment News Alert, Special ISSUE Ecosystem Services, May 2010.

Surface water ecosystems' services

It is estimated, that wetlands occupy over 1,280 million hectares of landmass. These areas include surface waters, such as rivers and lakes as well as swamps and coastal waters (up to 6 m) but also anthropogenic forms such as reservoirs and rice fields[11].

The services of the surface water ecosystems can be discussed in any of the four categories mentioned earlier (Table 1). The most important from the perspective of human existence is the provisioning function. However, the ensuring of this service is often dependent on the regulatory function, which is the ability of waters to self-purification.

Table 1
Types of services of surface water ecosystems

Categories of ecosystem services	Ecosystem services
Provisioning Services	Water (quantity and quality) for consumptive use (for drinking, domestic use, and agriculture and industrial use) Water for non-consumptive use (for generating power and transport/navigation) Aquatic organisms for food and medicines
Regulatory Services	Maintenance of water quality (natural filtration and water treatment) Buffering of flood flows, erosion control through water /land interactions and flood control infrastructure
Cultural Services	Recreation (river rafting, kayaking, hiking and fishing as a sport) Tourism (river viewing) Existence values (personal satisfaction from free flowing rivers)
Supporting Services	Role in nutrient cycling (role in maintenance of floodplain fertility), primary production Predator/prey relationships and ecosystem resilience

Source: *Ecosystems and Human Well-being: Policy Responses, Chapter 7: Freshwater Ecosystem Services,* www.unep.org [07-09-2014].

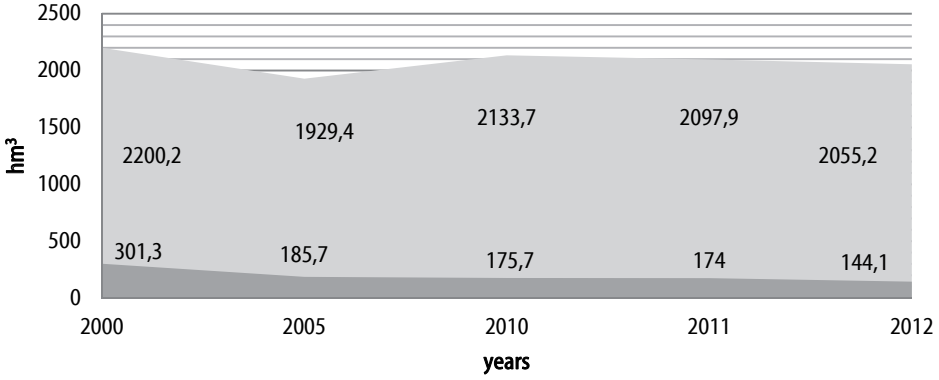
The possibility of using the services presented in table 1 by the society is dependent on water quality. In years 2000 – 2012 the amount of industrial and municipal sewage discharged into the waters without prior purification was in constant decline (Figure 1). In 2012 the amount was equal only 48% of the sewage discharged in Poland in 2000.

In Poland in 2012 untreated waste was also disposed via the sewage system. 28 hm^3 of waste was disposed of this way, which was 2.2% of all waste disposed of via sewage network[12].

However, from the perspective of losses in aquatic ecosystems, it is not only the amount of waste that is important, but also – and most importantly – the load

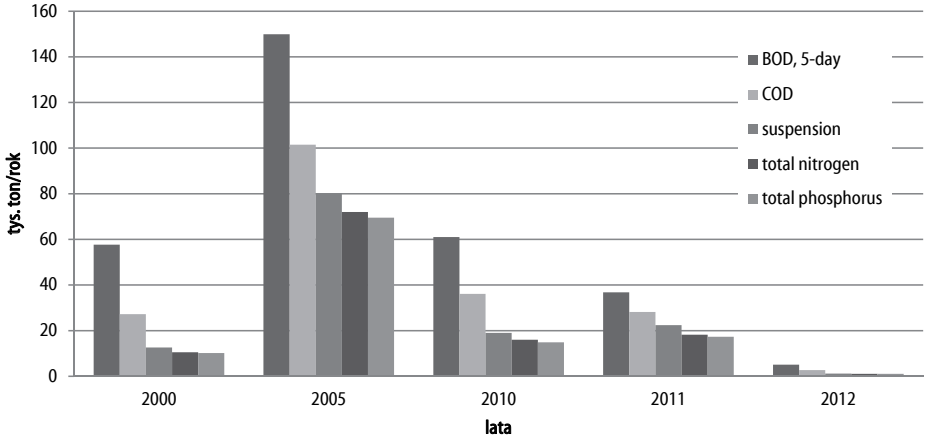
[11] MEA, *Ecosystems and Human Well-being: Wetlands and Water Synthesis*, Millennium Ecosystem Assessment, Washington D.C. 2005.
[12] *Ochrona Środowiska 2013*, op. cit.

Figure 1
Industrial and municipal sewage discharged into the waters in Poland in years 2000-2012



Source: own interpretation based on: *Ochrona Środowiska 2013*, Warszawa 2013.

Figure 2
Loads of pollutants discharged in treated waste in Poland in years 2000-2012



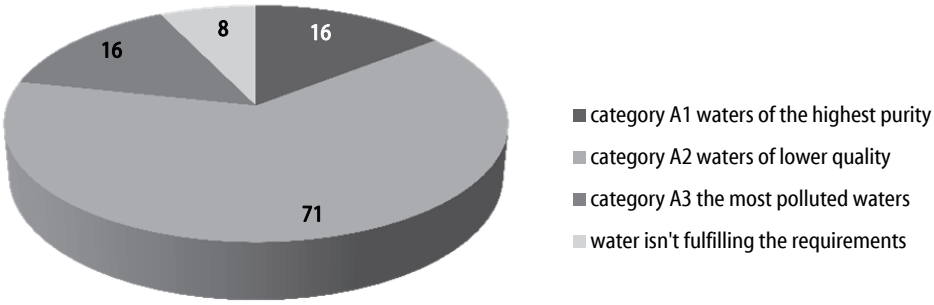
Source: own interpretation based on: *Ochrona Środowiska 2013*, op. cit.

discharged together with the waste. Figure 2 presents pollutant loads from treated waste in Poland in years 2000-2012.

Waste discharged into surface waters are a mixture of municipal and industrial waste. Based on the data published in the CSO (Central Statistical Office) statistical yearbooks[13] we can conclude that the untreated communal waste contribute to approximately 80%, and industrial to approximately 20% of the

[13] Based on average amounts in years 2000-2012 from: *Ochrona Środowiska,* op. cit.

Figure 3
The number of measurement points for water quality in the categories of water quality in year 2012



Source: *Ochrona środowiska 2013...,* op. cit.

amount of waste disposed of directly into surface waters without prior treatment. The analysis of statistical data has also shown that the largest amount of untreated waste comes from the food industry (excluding mining, which disposes mainly saline mine waters, in which the content of chlorides and sulphates is measured). An often used index of waste pollution is the 5 days biochemical oxygen demand (BOD5). Having the general amount of waste and wanting to determine approximate pollutant load amounts for BOD5 in the waste discharged into waters, it can be assumed that the concentration of pollutants in municipal waste is 333mg·dm-3, whereas in case of industrial waste it reaches 1000 mg·dm-3. While the composition of municipal waste is fairly constant, the concentration of pollutants in industrial waste is highly varied, which is why the assumption made above is just an approximation.

As it was mentioned before, the most analysed functions of ecosystems are the provisional functions, the most important of which is providing drinkable water. According to the laws in Poland and the European Union, drinking water is examined in three categories A1, A2 and A3[14]. The results of the analyses of water quality in relation to the category of drinking water are presented in figure 3.

Surface waters, which are or can be used as a source of drinking water, are divided into three categories: A1, A2 and A3. The A1 category includes waters of the highest purity, requiring only basic physical treatment through filtration and disinfection. The A2 category includes waters of lower quality, requiring multistage physical and chemical treatment, especially the occurrence of oxidation, coagulation, flocculation, decantation, filtration and disinfection**.** The A3 category

[14] Regulation of the Minister of Environment on the day of 27 November 2002 regarding the requirements, which should be fulfilled by surface waters used for providing people with water for consumption ("Journal of Laws" No 204, item. 1728).

includes the most polluted waters, requiring highly efficient physical and chemical treatment[15].

Disposal of waste into waters makes these water impossible to be used as sources of drinking water or increases the cost of benefiting from such service. In Poland, according to data of the Main Inspectorate for Environmental Protection on the basis of the results of the National Environmental Monitoring, in 2012 only in 16 locations, out of 111 water supplies, the quality of water was that of A1 category, which meant it could be used for drinking water provisioning with no additional cost. In 8 locations, the water did not fall into any of the mentioned categories.

Discharge of waste into surface waters, especially those not treated or treated insufficiently, causes losses in the possibility of utilising the water aquatic ecosystem services. Ecosystem services and these losses can be estimated, based on the six major economic valuation techniques when market valuations do not adequately capture social value:

- Avoided Cost,
- Replacement Cost,
- Factor Income,
- Travel Cost,
- Hedonic Pricing,
- Contingent Valuation [16].

Monetary values for fresh water (rivers, lakes) ecosystems service are presented in table 2.

Table 2

Monetary values for fresh water (rivers, lakes) ecosystems service per biome [values in Int.$/ha/year,2007 price levels]

Ecosystem services		Monetary values
Provisioning services	food	106
	water	1808
Regulating services	waste treatment	187
Cultural services	recreation	2166

Source: R. de Groot et al., *Global estimates of the value of ecosystems and their services in monetary units,* "Ecosystem Services" 2012 no. 1, p. 50-61.

In table 2 are presented monetary values based on The Ecosystem Service Valuation Database (ESVD). The ESVD is a relational database, which links information on the publication, with the value estimates and the case study locations.

[15] Ibidem.

[16] S.C. Farber, R. Costanza, M.A. Wilson, *Economic and ecological concepts for valuing ecosystem Services*, SPECIAL ISSUE: The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives, "Ecological Economics" 2002 no. 41, p. 375-392.

De Grot presenting valuation of fresh water ecosystems services used 665 values from ESVD. The geographic distribution of the valuation data included in the database shows a distribution over the continents: 28% from Asia, 26% from Africa, 14% from Europe, 12% from Latin America and the Caribbean, 12% from North America, and 8% from Oceania[17].

Loss estimates in aquatic ecosystem services

Each person who benefits from the values and resources of surface water ecosystems, perceives the losses connected with the inability or limited ability to benefit from the ecosystem services differently. The size of these losses will vary depending on the section of the economy utilizing the polluted water resources. Taking this into account, the loss criterion caused by water pollution is divided into the following groups:

- Losses resulting from providing people with water,
- Losses in industry,
- Losses in agriculture and silviculture,
- Losses in fishery economics,
- Losses in aquatic constructions,
- Losses connected with sport and leisure,
- Losses connected with widespread using of water,
- Losses resulting from the decreasing ability of waters to self-purify,
- Losses resulting from the destruction of nature and landscape[18].

In order to estimate the losses in aquatic ecosystem services existing methods of pricing environmental resources and services can be used, which include the direct and indirect estimate methods, and calculations utilising item indicators.

One of the frequently used methods is the indicator method. This method utilizes determined unit costs connected with additional actions related to utilizing water resources or estimates the incurred losses in relation to a natural unit i.e. one m^3 of polluted water, one kg of pollutant load. Such indicators are suggested by Miłaszewski[19], Famielec[20], Małecki[21].

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[17] R. de Groot et al., op. cit.

[18] A. Symonowicz, *Straty wynikające z zanieczyszczenia zasobów wodnych i niewłaściwej nimi gospodarki*, in: *Ekonomiczne problemy ochrony środowiska*, Materiały Sesji Rady Zarządu Głównego Ligi Ochrony Przyrody, Warszawa 1983, p. 53-56.

[19] R. Miłaszewski, *Pertes economiques resultant de la pollution des eaux de surface*, „Ekonomia i Środowisko" 2013 no. 2(45), p. 37; R. Miłaszewski, K. Rauba, *Koszty środowiskowe spowodowane zanieczyszczeniem wód powierzchniowych*, Materials from Nationwide Symposium „Hydroprezentacje IX 2006, Śląska Rada NOT-FSNT, Katowice 2006.

[20] J. Famielec (ed.), *Straty gospodarcze spowodowane zanieczyszczeniem środowiska naturalnego w Polsce w warunkach transformacji gospodarczej,* cz. 1, Kraków 2001.

[21] P. Małecki, *Straty ekologiczne powodowane zasoleniem Wisły w regionie krakowskim*, rozprawa doktorska, Kraków 2002.

As mentioned earlier, an important provisioning service of aquatic ecosystems is providing people with drinking water. Due to using category A2 and A3 waters for drinking purposes, waters not fulfilling the requirements of any category, units providing the service of supplying drinking water have to bear additional cost of water purification. These costs can be understood as losses related to the waters' limited ability to fulfil its provisioning function. A loss would be the cost of removing pollutants to a concentration respective to A1 category. These losses can be determined based on unit costs of water purification using specific methods of pollutant reduction.

Another provisioning function of aquatic ecosystems is providing us with aquatic organisms. Fishing losses can be observed, when the quality of the water makes it unable for fish to inhabit a certain area, or there is a decrease in the fish mass. The loss in this service can be identified as loss of income based on the difference between the amount of fish caught in good quality waters and waters polluted by waste, in which the concentration of pollutants makes it impossible for fish to live. Unit indicators related to such losses are described in other texts[22].

The indicator method can also be used in relations to estimating the losses resulting from a limited regulatory function of an aquatic ecosystem, which is self-purification. The costs connected with the decrease in water's ability to self-purify are resulting from discharging additional loads of pollutants into water-dwellings and watercourses. Self-purification of water can only occur up to a certain borderline amount of pollutants. The losses are therefore generated by insufficiently treated or completely untreated waste. In order to estimate such losses, it can be assumed that the losses connected to the introduction of an additional load of pollutants into the surface waters corresponds to the costs required to reduce it. The average cost of removing of 1 kg of pollutant load by a water treatment facility can be assumed as a unit loss indicator[23].

Another of the ecosystem services are also the cultural services, which mainly are connected to tourism. In this case, the losses depend on the function of a given water-dwelling or watercourse (whether it is a bathing location, or used for sailing or recreational fishing). The losses will be resulting from the decrease in the number of tourists using a given resource. The losses in this service can be determined through analyzing current data In order to establish how many tourists have resigned from coming to a given water-dwelling due to its increasing pollution and multiplying that number by the amount of money each tourist would have spent. The losses connected with tourism will occur for example, when the waters, due to the waste being discharged into them, cannot fulfil the conditions of bathing waters anymore. The losses can also be observed, when the quality of water will not allow for the existence of fish, which in turn will make it impossible for the waters to serve their recreational function i.e. fishing[24].

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[22] *Straty gospodarcze spowodowane...,* op. cit.

[23] E. Rauba, *Metoda określania opłat za usługi wodne*, rozprawa doktorska, Warszawa 2006.

[24] R. Miłaszewski, *Zastosowanie modeli decyzyjnych w programowaniu inwestycji ochrony wód*, „Materiały Badawcze, Seria: Gospodarka Wodna i Ochrona Wód" 1993 no. 15.

Małgorzata Rauba

THE INFLUENCE OF THE QUALITY OF FLOWING WATERS ON FRESHWATER ECOSYSTEM SERVICES ON THE EXAMPLE OF THE LEŚNA PRAWA RIVER

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WPŁYW JAKOŚCI WÓD PŁYNĄCYCH NA ŚWIADCZENIA EKOSYSTEMÓW WODNYCH NA PRZYKŁADZIE RZEKI LEŚNA PRAWA

STRESZCZENIE: Ekosystemy mogą spełniać swoje funkcje pod warunkiem utrzymania odpowiedniej jakości ich komponentów. Ekosystemy powiązane są ze sobą siecią silnych zależności i powiązań. Istotną rolę odgrywają zwłaszcza ekosystemy wodne. Zanieczyszczenie wód powoduje zmiany nie tylko w samym zbiorniku lub cieku, lecz także w otaczających go ekosystemach lądowych, w tym także leśnych.

W artykule zaprezentowano wpływ zmian jakości wód rzecznych na świadczenia ekosystemu wodnego na przykładzie rzeki Leśna Prawa przepływającej przez obszar Puszczy Białowieskiej. Walory przyrodnicze Puszczy Białowieskiej są niepowtarzalne. Bogactwo fauny i flory, unikatowe na skalę światową sprawia, że z jej walorów korzystają nie tylko okoliczni mieszkańcy ale także turyści z całego świata. Niewiele osób jednak zdaje sobie sprawę z wartości świadczeń ekosystemów i z tego jak maleją wraz z postępem procesów niszczenia ekosystemów. Świadomość ich utraty jest często niezauważana lub bagatelizowana przez lokalne władze.

W artykule przedstawiono wyniki badań jakości wód rzeki Leśna Prawa. Zła jakość wód wpływa nie tylko na utratę korzyści płynących z usług podstawowych rzeki, ale również z kulturowych.

SŁOWA KLUCZOWE: świadczenia ekosystemów, jakość wód powierzchniowych, rzeka Leśna Prawa

Introduction

Ecosystem services refer to the benefits which the society or economy can obtain from the environment. The environment then becomes an important partner for the authorities on various levels regarding the decision-making process for planned investments[1]. The proper management of such services should therefore be in accordance with the rules of balanced development, achieving mutual benefits, for the environment as well as for the economy[2].

Contemporary literature divides ecosystem services into four categories:

1. Provisioning –these are all the products obtained from the environment (food and fibres, fuel, genetic resource, biochemical substances, natural medicine and pharmaceutics, food additives, decorative materials).
2. Regulating – encompassing all the benefits obtained from regulation the processes occurring in ecosystems (maintaining proper air quality, climate regulation, water regulation, erosion control, water and sewage treatment, biological control, pollination).
3. Cultural – focusing on the non-material benefits resulting from the contact of humans with nature such as: spiritual enrichment, reflection, recreation, aesthetic experiences.
4. Supporting – necessary for the functioning of all other elements of the ecosystem, ensuring living space for plants and animals, and also maintaining their diversity. It differs from services in the fact that its influence on people is indirect and occurs in a very long period of time, whereas changes in the other categories have a direct and short-term effect on people. An example of such a basic service can be the production of atmospheric oxygen, or the circulation of nutrients[3].

The two last services are especially important in areas of unique natural values which at the same time are a source of income to the local community. Despite the fact that the idea of ecosystem services in the world had its beginnings in the 1960s, its use in Poland has begun quite recently. The low awareness of our governing bodies of the cooperation of the economy, environment and society, which is the basis for balanced development, causes not only significant financial losses, but also losses in the natural environment. One of the elements of the environment, especially sensitive to changes and pollution are aquatic ecosystems. The main source of water pollution is human activities. Among the anthropogenic sources, the most important are: unregulated water-waste economy (point sources), surface and groundwater runoff from agricultural areas (area sources–

[1] J. Kronenberg, T. Bergier, K. Maliszewska, *Usługi ekosystemów jako warunek zrównoważonego rozwoju miast – przyroda w mieście w działaniach Fundacji Sendzimira*, in: M. Kosmala (ed.), *Miasta wracają nad wodę*, Toruń 2011, p. 279-285.

[2] J. Kostecka, *Edukacyjne znaczenie pojęcia świadczenie ekosystemów dla ochrony awifauny miast*, „Inżynieria ekologiczna" 2010 no. 22, p. 34-42.

[3] MEA, *Ecosystems and Human Well-being*, A Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment, 2003, p. 49-70.

crop protection chemicals, animal excrement), atmospheric pollution (dry and wet deposition)[4]. While it can be hard to assess the losses in the environment and the spreading of pollutants from area and atmospheric sources, point sources are fairly easy to locate and remove, on condition that appropriate repair systems are planned and introduced.

The quality of the Leśna Prawa river and the ecosystem services

The values of the Białowieża Forest are known all over the world. First of all it is the only complex of lowland forests in Europe, which has preserved its natural character. It is a refuge for many rare species of fungi, plants and animals[5]. The loss of any element of this ecosystem would infringe on the biotic and abiotic environment of the Forest. The area of the Białowieża Forest is covered by a thick network of watercourses. One of them includes the Leśna Prawa river, which is a right tributary of the Bug river. A large part of the Leśna Prawa river, along with its source, lie in the territory of Poland (approx. 33 km), the remaining part (approx.30 km) lies on the Belarussian side. The river flows through the town of Hajnówka, and further down into the area of the Białowieża Forest. The river bed up to the border with Belarus is characterised by shallow depths (from 0.5 to 1.5 m) and widths (from 0.5 to 6 m). The municipal character of the river, the discharging of treated waste from the municipal waste treatment facility, the vicinity of agricultural areas and its lowland character, result in an almost complete lack of flow (0.5 m^3/s) and mixing of waters causing the river waters to be of low quality.

In order to assess the influence of water quality of the Leśna Prawa river on the possibility of providing services by this ecosystem, studies were conducted in 2012 on water samples from 6 locations. The first location was set outside the town of Hajnówka to determine the influence of a rural habitat, including the water-waste economy. The remaining 5 locations were in the area of the Białowieża Forest. The water was analysed for concentration levels of ammonia nitrogen, nitrate nitrogen, total phosphorus and the content of dissolved oxygen. The studies were conducted in spring: May, June, July and autumn: October, November, December.

As the research shows, the low quality of waters is mostly caused by an increased concentration of biogenic compounds–phosphorus compounds, ammonia nitrogen, and a low amount of dissolved oxygen. According to the Water Framework Directive, the quality of surface waters in Member States of the European Union should reach a good level until 2015. The improvement needs to be both in the chemical and ecological state. The ecological state includes the quality

[4] A. Jarosiewicz, *Proces samooczyszczania w ekosystemach rzecznych*, „Słupskie Prace Biologiczne" 2007 no. 4, p. 27-41.

[5] G. Rąkowski, *Przyrodnicze i kulturowe walory Puszczy Białowieskiej*, „Ochrona Środowiska i Zasobów Naturalnych" 2010 no. 42, p. 276.

of structure and functioning of the surface water ecosystems, classified through analyses using biological, physiochemical and hydromorphological factors6. The decision whether a given watercourse falls into the good, average or bad category is based on the results of individual analyses mentioned above, the rule being that the awarded class corresponds to the lowest result value. The classification of physiochemical elements is based on assigning to each analysed indicator to a class through comparing their characteristic values with borderline values. There are two classes:

- class I refers to a very good condition,
- class II refers to a good condition,
- not fulfilling the requirements of class II refers to a physiochemical state below good[7].

River waters can potentially provide all four types of ecosystem services. However, this is conditioned by the quality of the waters. As mentioned earlier, an ecosystem which is too polluted has limited possibilities for potential uses. The waters, which physiochemical parameters do not fall into any of the classes i.e. did not reach a good condition, lose the possibility to provide the majority of ecosystem services. The conducted analyses of the selected pollutants in the Leśna Prawa river show that the waters of this river are below a good physiochemical condition. It is especially visible in the first measurement location outside the town of Hajnówka, in village Sacharewo. All of the studied parameters exceeded the values attributed to the very good and good conditions of waters (Figure 1, 2, 3). In the remaining research locations the concentration of the analysed compounds did not exceed class II of water purity, which is an indicator of the ability of the river waters to self-purify, provided the pollution from the rural area is eliminated. Therefore the possibilities of utilizing the waters of the Leśna Prawa river are very limited.

One of the most important aquatic ecosystem services are the resource services. Potentially, every water course could provide such services. However, currently many surface waters cannot provide such service due to their bad quality. The Leśna Prawa river has no drinking water intake stations. This article however assesses the potential possibility of the analysed river to fulfil the drinking water provision function.

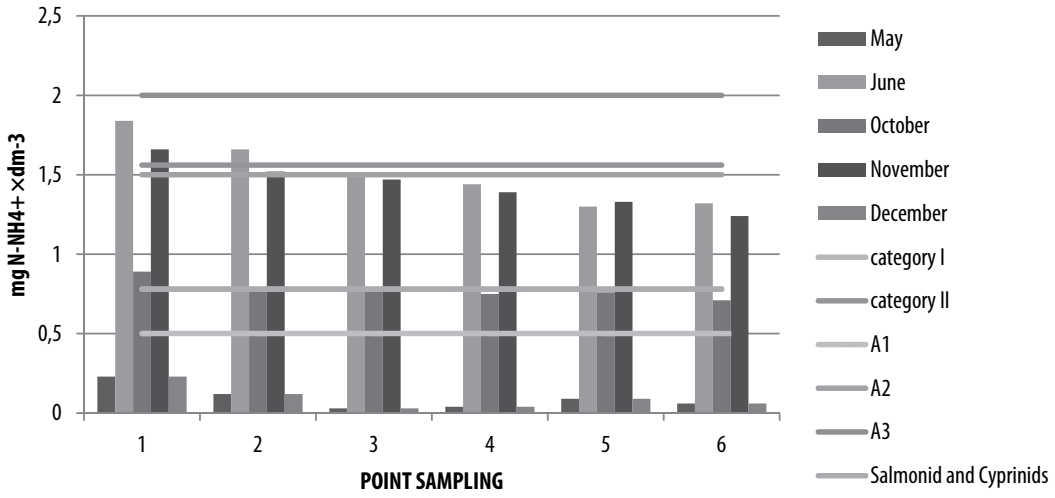
For these ecosystems its mainly the function of providing drinking water. In the case of surface waters used to provide people with water for consumption there are 3 categories of usefulness, which are:

- category A1 – waters requiring only basic physical treatment through filtration and disinfection,

[6] Dyrektywa 2000/60/WE Parlamentu Europejskiego I Rady z dnia 23 października 2000 r. ustanawiająca ramy wspólnotowego działania w dziedzinie polityki wodnej.

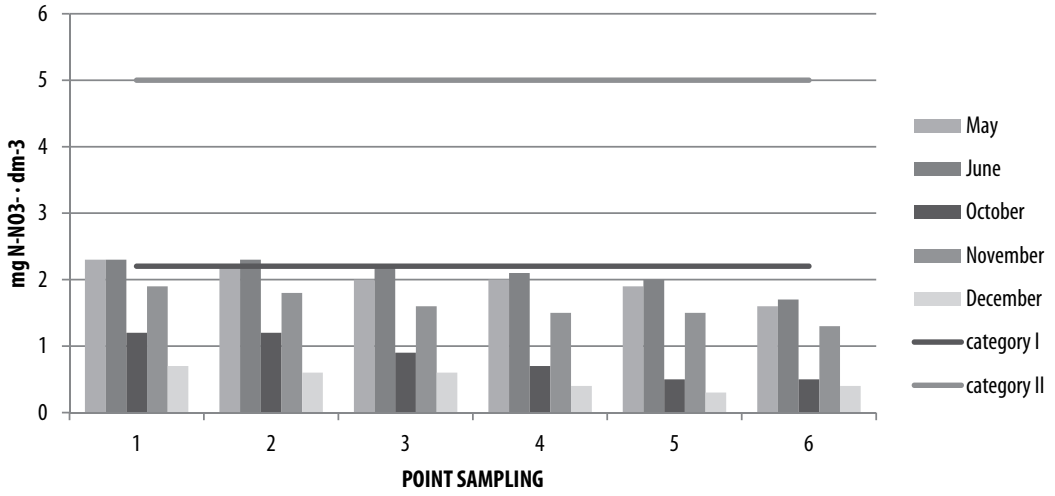
[7] Rozporządzenie Ministra Środowiska z dnia 9 listopada 2011 r. w sprawie sposobu klasyfikacji stanu jednolitych części wód powierzchniowych oraz środowiskowych norm jakości dla substancji priorytetowych.

Figure 1
Concentration of ammonia nitrogen in the waters of the Leśna Prawa river



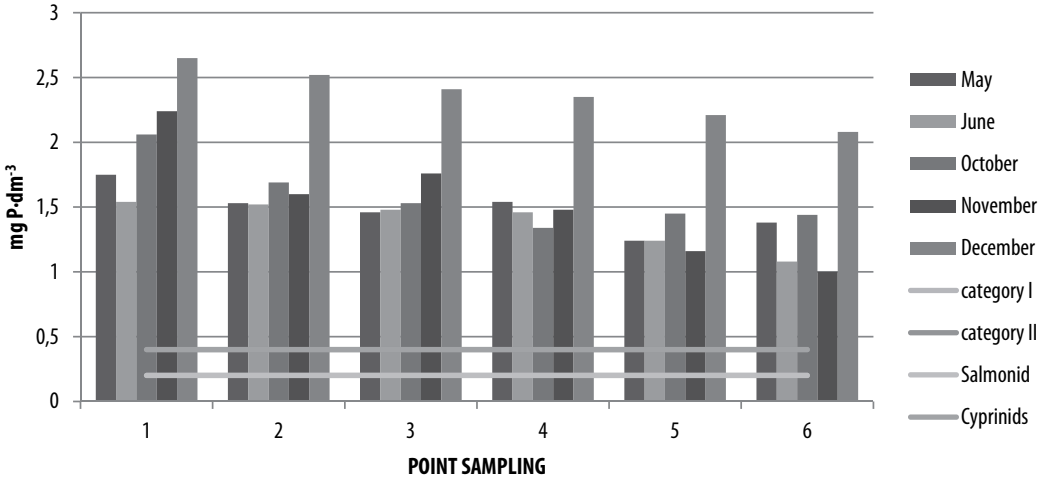
Source: own interpretation based on B. Mikucki „Analiza chemiczno-hydrologiczna rzeki leśnej na przykładzie Leśnej Prawej", Praca dyplomowa inżynierska, Hajnówka 2013.

Figure 2
The concentration of nitrate nitrogen in the waters of the Leśna Prawa river



Source: own interpretation based on B. Mikucki „Analiza chemiczno-hydrologiczna rzeki leśnej na przykładzie Leśnej Prawej", Praca dyplomowa inżynierska, Hajnówka 2013.

Figure 3
The concentration of total phosphorus in the waters of the Leśna Prawa river



Source: own interpretation based on B. Mikucki *Analiza chemiczno-hydrologiczna rzeki leśnej na przykładzie Leśnej Prawej*, Praca dyplomowa inżynierska, Hajnówka 2013.

- category A2 – waters requiring typical physical and chemical treatment, especially initial oxidation, coagulation, flocculation, decantation, filtration and disinfection (chlorination),
- category A3 – waters requiring highly effective physical and chemical treatment, especially oxidation, coagulation, flocculation, decantation, filtration, adsorption on active carbon, disinfection (ozonisation, chlorination)[8].

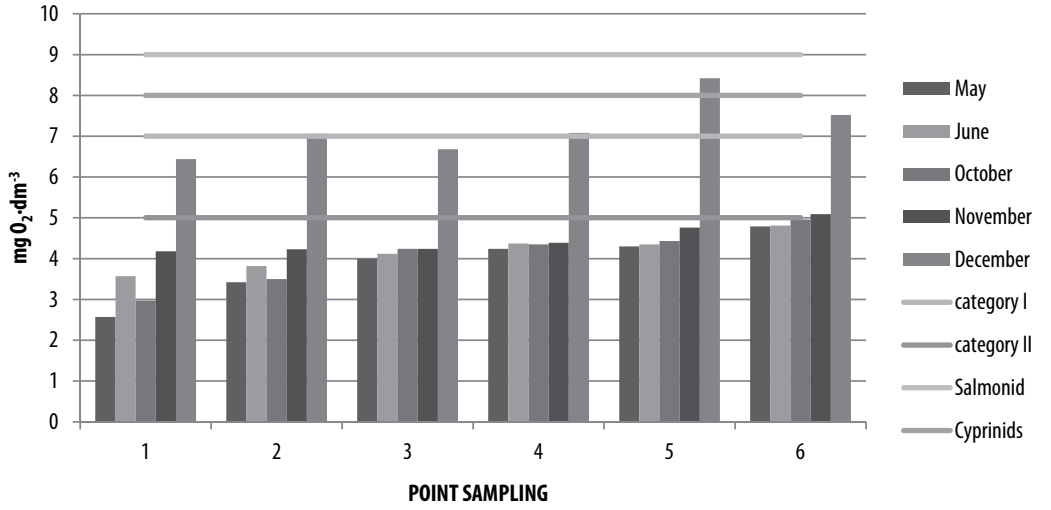
The studies of the Leśna Prawa river show that the amount of nitrate nitrogen in all analysed locations was within the A1 range (recommended 25 $mg \cdot dm^{-3}$), while the amount of ammonia nitrogen in most analysed locations was within the A2 category. Meanwhile, the amount of dissolved oxygen was within the A3 category. It can be stated, that the waters of the analysed river potentially do not meet the requirements of directly fulfilling the provisioning service.

The river also does not provide appropriate environment for fish. None of the analysed parameters of water pollution did not fulfil the requirements necessary for neither salmonidae nor cyprinidae to live in. The ecosystem of the Leśna Prawa river cannot, therefore, provide yet another provisioning service, namely the possibility of obtaining fish resource.

Due to the nature values of the area through which the river flows, cultural services are an extremely important element of the ecosystem services.

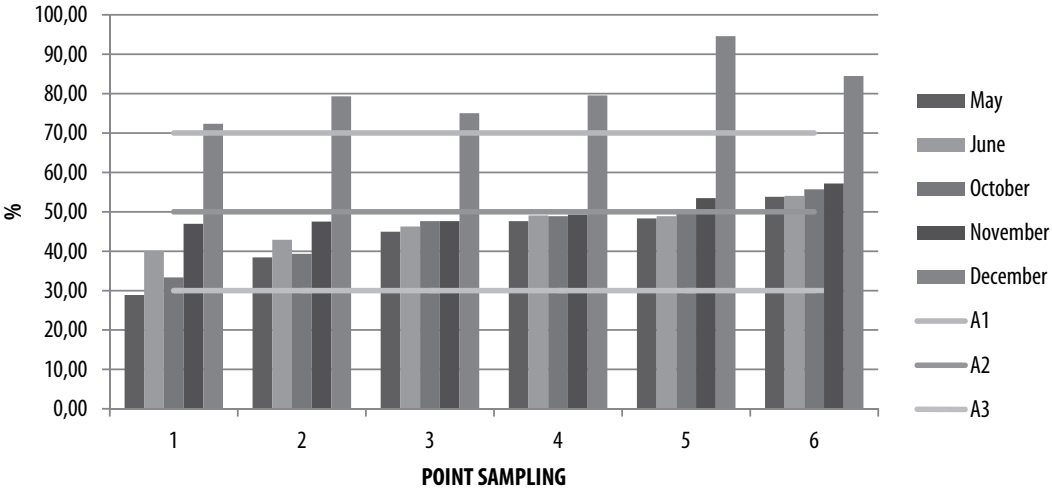
[8] Rozporządzeniem Ministra Środowiska z dnia 27 listopada 2002 r. w sprawie wymagań, jakim powinny odpowiadać wody powierzchniowe wykorzystywane do zaopatrzenia ludności w wodę przeznaczoną do spożycia (Dz.U. 2002 nr 204 poz. 1728).

Figure 4
The concentration of dissolved oxygen in the waters of the Leśna Prawa river



Source: own interpretation based on B. Mikucki „Analiza chemiczno-hydrologiczna rzeki leśnej na przykładzie Leśnej Prawej", Praca dyplomowa inżynierska, Hajnówka 2013.

Figure 5
Level of oxygen saturation of the waters of the Leśna Prawa river



Source: own interpretation based on B. Mikucki „Analiza chemiczno-hydrologiczna rzeki leśnej na przykładzie Leśnej Prawej", Praca dyplomowa inżynierska, Hajnówka 2013.

The Leśna Prawa River provides cultural services to the local community based on intangible benefits like recreation, aesthetic experiences and communing with nature. A bike path Hajnówka – Orzeszkowo – Hajnówka (blue 42 km), Nordic walking path around Sacharewo (red 11 km) and a narrow gauge railway line run through the river valley. The loss of such service would directly affect the village of Sacharewo especially, through which the river flows. In the time of research on water quality, the bad state of the waters could be stated even organoleptically. The water had a smell of raw sewage and lacked clarity. A survey conducted by direct interview the people of Sacharewo, clearly showed that the water quality of the Leśna Prawa river adversely affects providing cultural services. All persons of the respondents agreed that the quality of the waters of the Leśna Prawa River influences on their esthetic feelings (13 persons), 10 people do not use the waters of the river for recreational purposes (3 persons had no opinion).

Such conditions did not allow the people of Hajnówka and Sacharewo to use the area in the vicinity of the river for recreational purposes or family leisure time. The above mentioned tourist paths also run through the town. The bad condition of the river waters diminished the attractiveness of the area and was partly responsible for the limited ability of providing cultural services by the river. The potential of the analysed river in the direction of such ecosystem services cannot be fully utilised as well. The bad water quality causes the decline in the attractiveness of the area to people wanting to admire natural landscapes, or to fishermen. Kayak tourism or bathing are not possible either.The transboundary nature of the river makes that loss of cultural services affect not only the people of the Polish side, but also Belarusian. Poor water quality in terms of chemical indicators was confirmed by Regional Inspectorate of Environmental Protection in Białystok in profile Topiło near the border with Belarus. It can make the cultural benefits consisting in the use of the river for tourism purposes (kayak trail Kamieniuki-Brześć) will be also limited.

The conducted analysis of the river's waters show that, also in areas of high natural values, they do not fulfil the conditions which would allow to take full benefit of the ecosystem services.

INFORMATION

INFORMACJE

Sprawozdanie Zarządu Polskiego (d. Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych z działalności w kadencji: 21 września 2010 roku – 12 października 2014 roku

Do zwołania Walnego Zebrania Sprawozdawczo-Wyborczego na koniec czteroletniej kadencji obliguje Zarząd Statut *Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych* (§ 23, pkt. 3): *„Zwyczajne Walne Zebranie zwołuje Zarząd raz w roku jako sprawozdawcze i co cztery lata jako sprawozdawczo-wyborcze, zawiadamiając członków w każdy skuteczny sposób o jego terminie, miejscu i proponowanym porządku obrad, co najmniej na 14 dni przed terminem Walnego Zebrania"* (§ 23, pkt. 3).

Spełniony został statutowy wymóg poinformowania wszystkich członków Stowarzyszenia poprzez wysłanie w dniu 3 września 2014 roku do wszystkich członków Stowarzyszenia listu zawierającego informacje o terminie i miejscu oraz szczegółowe propozycje programu Walnego Zebrania Sprawozdawczo-Wyborczego w Łodzi. Dodatkowo informacja ta została zamieszczona na stronie internetowej Stowarzyszenia.

Zgodnie z wymogiem Statutu Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych, w połowie bieżącej kadencji odbyło Walne Zebranie Sprawozdawcze we Wrocławiu. W 2013 roku zorganizowano Walne Zebranie Sprawozdawcze w Białymstoku, stosując się do zalecenia KRS o konieczności zwoływania Walnego Zebrania corocznie. Wybór Uniwersytetu Ekonomicznego we Wrocławiu oraz Uniwersytetu w Białymstoku na miejsce Walnego Zebrania nie był przypadkowy, zadecydowały o tym względy merytoryczne i uznanie dla osiągnięć naukowych pracowników obu uczelni oraz innych uczelni oraz instytucji województwa dolnośląskiego i podlaskiego.

Prezentowane sprawozdanie dotyczy czteroletniej (2010-2014) działalności Zarządu, przy szczegółowym przedstawieniu osiągnięć za okres ostatniego roku (2013/2014).

W bieżącej kadencji 2010-2014 w skład Zarządu wchodziły następujące osoby:
1. dr hab. prof. AGH Leszek Preisner – przewodniczący,
2. prof. dr hab. Adam Budnikowski – wiceprzewodniczący,
3. prof. dr hab. Bogusław Fiedor – wiceprzewodniczący,
4. dr hab., prof. UŁ Małgorzata Burchard-Dziubińska – sekretarz,
5. dr hab. inż. Tadeusz Pindór – skarbnik,
6. dr inż. Elżbieta Broniewicz,
7. prof. dr hab. Kazimierz Górka,
8. dr hab., prof. UEW Andrzej Graczyk,
9. prof. dr hab. Elżbieta Lorek,
10. prof. dr hab. inż. Rafał Miłaszewski.

W skład Komisji Rewizyjnej (2010-2014) wchodziły następujące osoby:
1. prof. dr hab. inż. Ryszard Janikowski – przewodniczący,
2. dr hab. inż., prof. PB Joanna Ejdys – wiceprzewodnicząca,

3. dr hab., prof. USz Barbara Kryk – wiceprzewodnicząca,
4. dr inż. Joanna Czerna-Grygiel,
5. dr hab., prof. SGH Piotr Jeżowski,
6. dr Karol Kociszewski,
7. prof. dr hab. Johannes (Joost) Platje.

Najważniejszym wydarzeniem było niewątpliwie zatwierdzenie 9 lipca 2014 roku przez Sąd Rejonowy dla Krakowa-Śródmieścia zmiany nazwy z: Europejskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych na nową nazwę: Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych oraz dokonanie odpowiedniego wpisu w Krajowym Rejestrze Sądowym w Krakowie. Bardzo dziękuję wszystkim Członkom naszego Stowarzyszenia za cierpliwość i wyrozumiałość w stosunku do długiego okresu dokonywania tych zmian. Szczególnie dziękuję dr hab. inż. Tadeuszowi Pindórowi, poprzedniemu przewodniczącemu ESESiZN za codzienną pomoc w pokonywaniu trudności związanych z procesem zmiany nazwy Stowarzyszenia. Obecnie obowiązującą nazwą jest Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych. Dokonaliśmy niezbędnych zmian w odpowiednich urzędach i instytucjach. Dokonamy kolejnych po Walnym Zebraniu Sprawozdawczo-Wyborczym w Łodzi, gdy ukonstytuuje się nowo wybrany Zarząd i Komisja Rewizyjna.

Według stanu na dzień 30 września 2014 roku Stowarzyszenie liczyło 165 członków. W okresie sprawozdawczym, od 21 września 2010 do 12 października 2014 roku przyjęto 34 osób. W tym samym okresie decyzją Zarządu skreślono 13 członków, w tym: 7 osób na ich prośbę, a dodatkowo ze względu na niechęć tych osób do uiszczenia zaległych wieloletnich składek członkowskich.

Wśród Członków Stowarzyszenia nadal dominują pracownicy wyższych uczelni, z najsilniejszą reprezentacją pracowników uczelni: Warszawy (41), Krakowa (35), Białegostoku (23), Wrocławia (22), oraz Katowic, Łodzi, Olsztyna, Opola, Bydgoszczy, Jeleniej Góry, Szczecina, Poznania i Lublina.

W okresie objętym niniejszym sprawozdaniem Zarząd odbył łącznie trzynaście zebrań, w tym:

- w 2010 roku – we Wrocławiu (21 września),
- w 2011 roku – w Opolu (11 kwietnia), w Białymstoku (27 czerwca) i w Krakowie (26 września),
- w 2012 roku – w Opolu (11 kwietnia), w Białymstoku (27 września) i we Wrocławiu (5 grudnia),
- w 2013 roku – we Wrocławiu (8 grudnia 2012), w Głogowie (8 maja) i w Białowieży (4 grudnia),
- w 2014 roku – w Łodzi (13 października).

Spełniony został tym samym wymóg Statutu, dotyczący odbywania co najmniej trzy razy w roku zebrań Zarządu. W praktyce członkowie Zarządu spotykali się częściej, głównie przy okazji uczestnictwa w różnych konferencjach.

Informacja o finansowej sytuacji Stowarzyszenia jest zawarta w oddzielnym sprawozdaniu finansowym, które przedstawi dr hab. inż. Tadeusz Pindór, skarbnik PSEŚiZN.

W kadencji 2010-2014 Stowarzyszenie rozwinęło łączność wewnętrzną i zewnętrzną, poprzez prowadzenie strony internetowej. Strona ta posiada adres: http://home.agh.edu.pl/~psesizn/.

Strona internetowa od sześciu lat jest administrowana przez dr inż. Mariusza Trelę, adiunkta w Katedrze Ekonomii, Finansów i Zarządzania Środowiskiem Wydziału Zarządzania AGH w Krakowie.

Kontynuując wspaniałe tradycje wcześniejszej działalności, Stowarzyszenie współorganizowało wiele konferencji naukowych.

2010

1. Stowarzyszenie zostało zaproszone do objęcia patronatem Seminarium Naukowego na temat: ***Turystyka i rekreacja w kreowaniu lokalnej przedsiębiorczości***, zorganizowanego przez Państwową Wyższą Szkołę Zawodową w Tarnobrzegu w dniu 27 maja 2010 roku w Baranowie Sandomierskim.
2. Katedra Ekonomii Ekologicznej Uniwersytetu Ekonomicznego we Wrocławiu, kolejny raz, zaproponowała Stowarzyszeniu współorganizację Konferencji Naukowej na temat: ***Rozwój zrównoważony a kryzys globalny***, w dniach 21-22 września 2010 roku.

2011

1. V Międzynarodową Konferencję z cyklu: ***Globalizacja a środowisko***, zorganizowaną przez Instytut Międzynarodowych Stosunków Gospodarczych Szkoły Głównej Handlowej w Warszawie w dniach 7-8 kwietnia 2011 roku.
2. 11th International Conference on: ***Current Issues of Sustainable Development – Governance and Institutional Change***, zorganizowaną przez Wydział Ekonomiczny Uniwersytetu Opolskiego w dniach 10-12 kwietnia 2011 roku.
3. VIII Międzynarodową Konferencję Naukową z cyklu: ***Uwarunkowania i mechanizmy zrównoważonego rozwoju i gospodarki opartej na wiedzy***, zorganizowaną przez Katedrę Zrównoważonego Rozwoju i Gospodarki Opartej na Wiedzy Wyższej Szkoły Ekonomicznej w Białymstoku w dniach 27-29 czerwca 2011 roku.
4. Konferencję Naukową na temat: Badania naukowe i działalność dydaktyczna w zakresie *ekonomii środowiska i zasobów naturalnych*, połączoną z Pierwszym Zjazdem Katedr i Zakładów prowadzących badania naukowe i dydaktykę w zakresie *ekonomii środowiska i zrównoważonego rozwoju*, zorganizowane przez Katedrę Ekonomii, Finansów i Zarządzania Środowiskiem Wydziału Zarządzania Akademii Górniczo-Hutniczej w Krakowie w dniu 26 września 2011 roku.

2012

1. W dniach 18-20 marca 2012 roku Stowarzyszenie współorganizowało z Wydziałem Ekonomicznym Uniwersytetu Opolskiego 12th International Conference on: ***Current Issues of Sustainable Development – Governance and Institutional Change***.
2. W okresie 4-6 czerwca 2012 roku Stowarzyszenie objęło patronat nad II Konferencją Naukową na temat: ***Trendy i wyzwania zrównoważonego rozwoju w XXI wieku***, zorganizowaną przez Wydział Nauk Ekonomicznych i Zarządzania Uniwersytetu Szczecińskiego.

3. W dniach 11-12 października 2012 roku w Supraślu obchodzono Jubileusz XX-lecia Fundacji Ekonomistów Środowiska i Zasobów Naturalnych, organizacyjnie połączony z konferencją na temat: ***Ekonomia i środowisko – przyszłość teorii i badań na bazie 20-letnich doświadczeń***. W czasie Konferencji prof. Leszek Preisner zaprezentował dorobek dwudziestoletniej działalności naszego Stowarzyszenia. Tekst wystąpienia został opublikowany w czasopiśmie „Ekonomia i Środowisko", nr 3(43)2012.
4. W dniach 6-7 grudnia 2012 roku Katedra Ekonomii Ekologicznej Uniwersytetu Ekonomicznego we Wrocławiu zaprosiła Stowarzyszenie do współorganizacji Konferencji Naukowej na temat: ***Zasobooszczędne gospodarowanie***.

2013

1. Konferencję Naukową na temat: ***Trendy, wyzwania i dylematy zrównoważonego rozwoju*** współorganizowaną w Międzyzdrojach 27-29 maja 2013 roku z Wydziałem Nauk Ekonomicznych i Zarządzania Uniwersytetu Szczecińskiego.
2. II Seminarium Sekcji Ekonomiki Użytkowania i Ochrony Wód ESEŚiZN na temat: ***Ekonomiczne problemy gospodarki wodnej***, współorganizowane z Państwową Wyższą Szkołą Zawodową w Głogowie w dniach 8-9 maja 2013 roku.
3. W dniu 15 listopada 2013 roku Leszek Preisner uczestniczył w uroczystej Gali Finałowej Konkursu ***Eko-liderzy*** 20-lecia Wojewódzkiego Funduszu Ochrony Środowiska i Gospodarki Wodnej w Krakowie.

2014

1. Stowarzyszenie zostało zaproszone jak partner III Ogólnopolskiej Konferencji Naukowej EkoServ na temat: ***Świadczenia ekosystemów jako przedmiot badań transdyscyplinarnych***, organizowanej przez Zakład Geografii Kompleksowej, Uniwersytet im. Adama Mickiewicza w Poznaniu.
2. W dniach 13-15 października 2014 roku, odbędzie się konferencja naukowa na temat: ***Środowisko przyrodnicze a rozwój***, współorganizowana ze Stowarzyszeniem przez prof. Małgorzatę Burchard-Dziubińską z Wydziału Ekonomiczno-Socjologicznego Uniwersytetu Łódzkiego, w trakcie której zorganizowane zostanie Walne Zebranie Sprawozdawczo-Wyborczym Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych.

Do innych form aktywności członków Stowarzyszenia zaliczyć niewątpliwie należy:

- wyrażanie przez członków Stowarzyszenia opinii w ważnych kwestiach dotyczących wdrażania w Polsce zasad rozwoju zrównoważonego i trwałego,
- udział członków Stowarzyszenia w organach doradczych i opiniotwórczych,
- opracowanie ekspertyz dotyczących ochrony środowiska.

Stowarzyszenie, w ramach współpracy z Fundacją Ekonomistów Środowiska i Zasobów Naturalnych w Białymstoku, zaangażowane jest w działalność wydawniczą, realizowaną w trzech formach, a mianowicie:

- Biblioteka „Ekonomia i Środowisko", której problematyka skupiona jest na wydawaniu materiałów konferencyjnych, a jej redaktorem jest prof. dr hab. Kazimierz Górka – łącznie wydano 35 zeszyty.
- Czasopismo (kwartalnik) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych pod nazwą „Ekonomia i Środowisko", którego redaktorem naczelnym jest dr inż.

Elżbieta Broniewicz – wydano 49 zeszytów, z tego 12 w okresie sprawozdawczym. Aktualnie tytuł ten ma przyznane 8 punktów na liście czasopism Ministerstwa Nauki i Szkolnictwa Wyższego.

- Książki i inne materiały, publikowane przez Wydawnictwo Ekonomia i Środowisko, prowadzone przez Fundację Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych w Białymstoku. Informacja o działalności Fundacji zawarta jest w oddzielnym sprawozdaniu.

Nadal niewielu członków naszego Stowarzyszenia jest równocześnie członkami EAERE. W czerwcu 2014 roku w Stambule odbył się piąty Kongres AERE i EAERE.

Kolejna 21th Annual Conference EAERE zorganizowana będzie w dniach 24-27 czerwca 2015 roku w Helsinkach, a następna 22nd Annual Conference EAERE w Zurichu. Szczegółowe informacje na stronie www.eaere.org.

Decyzją Zarządu z dnia 4 października 2007 roku, powołano – w ramach Stowarzyszenia – Sekcję Ekonomiki Użytkowania i Ochrony Wód. Funkcję przewodniczącego tej Sekcji Zarząd powierzył prof. dr hab. inż. Rafałowi Miłaszewskiemu, który przedstawi sprawozdanie z działalności Sekcji.

W 2011 roku obchodziliśmy skromnie jubileusz 20-lecia Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych. Działalność i osiągnięcia naszego Stowarzyszenia zostały przedstawione przez przewodniczącego Leszka Preisnera w czasopiśmie „Ekonomia i Środowiska", nr 2(43)2012, s. 226-235.

W 2016 roku Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych będzie obchodziło jubileusz 25-lecia działalności, do którego przygotujemy się z należytą starannością.

W imieniu Zarządu

Leszek Preisner
Przewodniczący PSEŚiZN

Łódź, 13 października 2014 roku

SPRAWOZDANIE ZARZĄDU

Polskiego (d. Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych w zakresie polityki finansowej w kadencji: 21 września 2010 roku – 13 października 2014 roku

W kadencji 2010-2014 Zarząd podejmował przedsięwzięcia, których finansowanie uwarunkowane było wysokością dochodów własnych oraz dotychczas zgromadzonych rezerw.

W połowie bieżącej kadencji, w trakcie XII Walnego Zgromadzenia Sprawozdawczego zaakceptowane zostało sprawozdanie finansowe dotyczące okresu: 21 września 2010 roku do 5 grudnia 2012 roku.

Podobnie jak w latach poprzednich, najbardziej aktywni Członkowie Stowarzyszenia starali się powiązać badania naukowe, organizację konferencji i częściowo działalność wydawniczą z uczelniami, w których pracują, przenosząc na te instytucje znaczną część kosztów.

Przychody Stowarzyszenia stanowiły zasadniczo składki członkowskie. Stowarzyszenie nie otrzymuje żadnych dotacji oraz nie prowadzi działalności gospodarczej. Odsetki z lokat bankowych i dywidenda od akcji BOŚ przyniosły symboliczne wpływy.

Jedyne pozycje wydatków Stowarzyszenia stanowiły koszty księgowości oraz sekretariatu. Wszystkie funkcje z wyboru są wykonywane społecznie. Koszty administracyjne działalności Stowarzyszenia pokryła Katedra Ekonomii, Finansów i Zarządzania Środowiskiem Wydziału Zarządzania AGH.

Podstawowym źródłem przychodów Stowarzyszenia są składki członkowskie i odsetki od lokat bankowych. W latach 2010-2013, wysokość rocznej składki członkowskiej pozostawała na poziomie: 40 zł dla osób z tytułem magistra i doktora, a 60 zł dla osób z tytułem co najmniej doktora habilitowanego.

Od 2014 roku wysokość składki członkowskiej wynosi: 50 zł dla osób do stopnia doktora włącznie, a 80 zł dla osób z tytułem co najmniej doktora habilitowanego.

Wydatki Stowarzyszenia, w okresie sprawozdawczym, przedstawiają się następująco:
- wynagrodzenie za prowadzenie sekretariatu w wysokości 1.600,00 zł rocznie,
- wynagrodzenie za prowadzenie księgowości w wysokości 1.600,00 zł rocznie; na wniosek dr Kazimiery Mendys, kwota ta została obniżona od 2012 roku do 500 zł rocznie.

Wykonując uchwałę Zarządu przewodniczący oraz skarbnik dokonali rozeznania warunków prowadzenia rachunku bieżącego w innych bankach i przedstawili Zarządowi propozycję przeniesienia rachunku z BOŚ do Banku Pekao SA. W wyniku zmiany banku nastąpiło obniżenie wysokości opłat i prowizji ponoszonych wcześniej w BOŚ SA; zmniejszyły się odpowiednio: prowizja od wypłaty gotówkowej do 5 zł, prowizja od przelewu (ZUS, US) do 15 zł. Decyzja o przeniesieniu rachunku Stowarzyszenia do Pekao SA spowodowała możliwość uzyskania dostępu elektronicznego do konta, co nie pociąga za sobą żadnych kosztów.

Sytuację finansową Stowarzyszenia w minionej kadencji przedstawiono w tabeli 1.

Jak wynika z danych zamieszczonych w tabeli 1, wielkość zasobów Stowarzyszenia wzrosła, mimo istotnej aprecjacji kursu złotego polskiego do dolara amerykańskiego w analizowanym okresie.

W posiadaniu Stowarzyszenia znajduje się 270 założycielskich akcji BOŚ, będących poza obrotem giełdowym, zdeponowanych w Biurze Maklerskim Banku Pekao SA w Warszawie.

Na podstawie powyższych informacji ogólną sytuację finansową Stowarzyszenia ocenić można jako dobrą.

Tabela 1: BILANS Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych na dzień 30 listopada 2012, 30 listopada 2013 oraz 31 sierpnia 2014

	2012	2013	2014
AKTYWA			
Aktywa trwałe [PLN]	29 396,44	27 077,07	26 682,87
IV. Inwestycje długoterminowe			
- akcje BOŚ	2 760,00	2 760,00	2 760,00
- lokata w USD	26 636,44	24 313,07	23 922,87
Aktywa obrotowe			
III. Inwestycje krótkoterminowe			
- lokata krótkoterminowa	22 000,00	25 000,00	25 000,00
- rachunek bieżący	4 007,70	5 177,89	9 911,57
- kasa	177,63	477,63	702,38
AKTYWA RAZEM	55 581,77	57 732,59	62 296,82
PASYWA			
Fundusze własne [PLN]	55 581,77	57 732,59	62 296,82
I. Fundusz statutowy	54 729,44	56 928,40	58 167,64
II. Wynik finasowy	852,33	804,19	4 129,18
Zobowiązania	0,0	0,0	0,0
PASYWA RAZEM	55 581,77	57 732,59	62 296,82

Tadeusz Pindór
Skarbnik PSEŚiZN

Łódź, 13 października 2014 roku

Sprawozdanie Komisji Rewizyjnej sporządzone na Walne Zebranie Sprawozdawczo-Wyborcze Polskiego (d. Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych

Łódź, dnia 13 października 2014 roku

Przedmiotem sprawozdania jest ocena działalności Zarządu Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych w okresie: od 21 września 2010 roku – 13 października 2014 roku, w zakresie realizacji zadań statutowych oraz prowadzonej gospodarki finansowej. Należy dodać, w dniu 9 lipca 2014 roku nastąpiła zmiana nazwy Stowarzyszenia na nową: Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych, zatwierdzoną przez Sąd Rejonowy dla Krakowa-Śródmieścia.

Komisja Rewizyjna, powołana na Walnym Zebraniu Sprawozdawczo-Wyborczym ESEŚiZN we Wrocławiu w dniu 20 września 2010 roku, działała w kadencji 2010-2014 w składzie:

1. prof. dr hab. inż. Ryszard Janikowski – przewodniczący
2. dr hab. inż., prof. PB Joanna Ejdys – wiceprzewodnicząca
3. dr hab., prof. USz Barbara Kryk – wiceprzewodnicząca
4. dr inż. Joanna Czerna-Grygiel
5. dr hab., prof. SGH Piotr Jeżowski
6. dr Karol Kociszewski
7. prof. dr Johannes (Joost) Platje

Ocena realizacji zadań statutowych Stowarzyszenia

1. Zgodnie z uchwałą X Walnego Zebrania Sprawozdawczo-Wyborczego we Wrocławiu, dotyczącą zmian statutowych, Zarząd Stowarzyszenia złożył wniosek do Krajowego Rejestru Sądowego. W długo trwającej procedurze Sąd Rejonowy w Krakowie zatwierdził wszystkie zmiany wniesione we wniosku, w tym zmianą nazwy Stowarzyszenia. Komisja Rewizyjna uznała, że Przewodniczący i Zarząd podjęli odpowiednie działania dla realizacji uchwały dotyczącej zmian statutowych, podjętych w trakcie Walnych Zebrań bieżącej kadencji w 2010 i 2012 roku.
2. Komisja Rewizyjna oceniła, iż Zarząd Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych spełnił formalny wymóg statutowy dotyczący zwołania Walnego Zebrania w połowie kadencji, które odbyło się we Wrocławiu 5 grudnia 2012 roku. Zarząd zwołał dodatkowe Walne Zebranie w dniu 4 grudnia 2013 roku w Białowieży. O organizacji Walnego Zebrania w dniu 13 października 2014 roku poinformował członków Stowarzyszenia zgodnie z wymogami, określonymi w obowiązującym od 9 lipca 2014 roku Statucie Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych.
3. Komisja Rewizyjna oceniła, iż Zarząd Polskiego (wcześniej Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych spełnił formalny wymóg statutowy, dotyczący odbywania co najmniej trzech spotkań w ciągu roku. W okresie objętym

sprawozdaniem odbyło się łącznie jedenaście zebrań Zarządu, z tego jedno w 2010 roku, po trzy w latach 2011, 2012 i 2013 oraz jedno zebranie w 2014 roku.

4. Komisja Rewizyjna oceniła, iż Zarząd prowadził aktywną politykę pozyskiwania nowych członków, skreślania tych, którzy nie spełniają obowiązków (głównie brak wnoszenia składek członkowskich). Ponadto Zarząd podejmował działania na rzecz zainteresowania nowych ośrodków naukowych działalnością Stowarzyszenia. Według stanu na dzień 30 września 2014 roku Stowarzyszenie liczyło 165 członków. W okresie sprawozdawczym do Stowarzyszenia przystąpiło 37 nowych członków, a skreślono 13 członków, w tym: 7 osób na ich prośbę, a dodatkowo ze względu na niechęć tych osób do uiszczenia zaległych, wieloletnich składek członkowskich. Komisja Rewizyjna pozytywnie ocenia działania Zarządu zmierzające do dyscyplinowania członków Stowarzyszenia w zakresie wywiązywania się z obowiązków statutowych i rekomenduje prowadzenie takiej polityki w przyszłych latach.
5. Stowarzyszenie aktywnie uczestniczyło w procesie kształtowania i wdrażania polityki środowiskowej między innymi poprzez uczestnictwo członków Stowarzyszenia w pracach różnych instytucji i organów władzy oraz poprzez udział w projektach badawczych.
6. W okresie sprawozdawczym Stowarzyszenie było współorganizatorem 15 konferencji. Konferencje organizowane były wspólnie z uczelniami, w których zatrudnieni są członkowie Stowarzyszenia.
   Komisja Rewizyjna podkreśla duże znaczenie tych konferencji dla rozwoju ekonomii środowiskowej i polityki ekologicznej w Polsce oraz integracji ekonomistów środowiska i zasobów naturalnych pracujących w różnych uczelniach i instytucjach w Polsce.
7. Komisja Rewizyjna pozytywnie oceniła działalność publicystyczną i wydawniczą Stowarzyszenia w okresie sprawozdawczym, opartą na wydaniu szeregu publikacji.
8. Komisja Rewizyjna uznała, że powołana w ramach Stowarzyszenia, Sekcja Ekonomiki Użytkowania i Ochrony Wód funkcjonuje właściwie.

Ocena gospodarki finansowej Stowarzyszenia

1. Kierunki działalności finansowej dochodów i wydatków Stowarzyszenia w okresie sprawozdawczym Komisja Rewizyjna uznała za prawidłowe, to jest zgodne z uchwałami Zarządu i statutowymi celami Stowarzyszenia. Lata 2010, 2011 i 2012 zamknęły się dodatnim wynikiem finansowym. Zdyscyplinowanie w 2010 roku członków do uiszczenia zaległych i bieżących składek skutkowało istotnym wzrostem przychodów, szczególnie w 2011 roku. Miało to istotny wpływ na wynik finansowy 2011 roku, który był znacznie wyższy niż w roku poprzednim i następnym. W 2011 roku wynik finansowy był wysoki również ze względu na wyższe odsetki od dokonanych lokat terminowych i niższe prowizje bankowe, co wiązało się ze zmianą banku prowadzącego rachunek Stowarzyszenia z BOŚ na Bank Pekao SA.
2. Głównym źródłem dochodów Stowarzyszenia są składki członkowskie. Komisja uznaje za właściwą decyzję Zarządu o zwiększeniu składki członkowskiej z poziomu 40 i 60 zł do poziomu 50 i 80 zł.
3. Zarząd słusznie rozważa możliwości sprzedaży akcji Banku Ochrony Środowiska S.A., zdeponowanych w Biurze Maklerskim w Warszawie a pozostających poza obrotem giełd-

dowym. Komisja Rewizyjna zasugerowała Zarządowi rozważenie możliwości poprawy gospodarki finansowej Stowarzyszenia poprzez usprawnienie strategii lokowania środków finansowych, a także rozważenia decyzji o sprzedaży akcji BOŚ S.A.

4. Komisja Rewizyjna wysoko oceniła sposób prowadzenia sekretariatu, dokumentacji finansowej oraz niezbędnej sprawozdawczości. Komisja wysoko oceniła także działania Zarządu, których efektem są niskie koszty obsługi administracyjnej Stowarzyszenia.

Z przedstawionych wyżej względów Komisja Rewizyjna uznała, że praca Zarządu Polskiego (wcześniej Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych jest zgodna z normami prawnymi oraz zasadami rzetelnej gospodarki finansowej Stowarzyszenia. Zarząd Stowarzyszenia dostosowuje ponoszenie wydatków do wielkości przychodów.

Stowarzyszenie nie ma żadnych zobowiązań finansowych.

Księgi są prowadzone rzetelnie i prawidłowo dokumentują gospodarkę finansową, w tym wynik finansowy Stowarzyszenia.

Z przedstawionej oceny działalności merytorycznej i finansowej wynika, że Zarząd prawidłowo realizował zadania statutowe Stowarzyszenia, a także wnioski i zalecenia Komisji Rewizyjnej, przekazywane przez przewodniczącego Komisji na posiedzeniach Zarządu.

Komisja Rewizyjna sugeruje podjęcie przez Zarząd działań na rzecz usprawnienia mechanizmów egzekwowania składek.

Komisja Rewizyjna wnioskuje do Walnego Zebrania Sprawozdawczo-Wyborczego Polskiego (wcześniej Europejskiego) Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych o udzielenie Zarządowi Stowarzyszenia absolutorium za działalność w kadencji 2010-2014.

prof. dr hab. inż. Ryszard Janikowski

Przewodniczący Komisji Rewizyjnej PSEŚiZN

Protokół z Walnego Zebrania Sprawozdawczo-Wyborczego Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych Łódź, 13 października 2014 roku

W pierwszym terminie (godz. 18:00) zwołania Walnego Zebrania przewodniczący Stowarzyszenia prof. Leszek Preisner stwierdził brak quorum, więc Zebranie rozpoczęto o godz. 18:15 gdyż, zgodnie ze Statutem Stowarzyszenia, w drugim terminie nie obowiązuje wymóg quorum. Stwierdzono obecność 42 członków Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych (PSEŚiZN). Lista obecności stanowi załącznik do protokołu.

Walne Zebranie otworzył przewodniczący Stowarzyszenia prof. Leszek Preisner, przedstawiając proponowany porządek obrad:

- wybór przewodniczącego Walnego Zgromadzenia i sekretarza obrad, zatwierdzenie porządku obrad,
- wybór Komisji Skrutacyjnej oraz Komisji Matki,
- wybór Komisji Uchwał i Wniosków oraz Komisji do spraw Odwołań,
- sprawozdanie Zarządu Stowarzyszenia (prof. L. Preisner, dr hab. T. Pindór),
- sprawozdanie Komisji Rewizyjnej (prof. R. Janikowski),
- sprawozdanie z działalności Sekcji Ekonomiki Użytkowania i Ochrony Wód (prof. R. Miłaszewski),
- sprawozdanie z działalności Fundacji Stowarzyszenia i Wydawnictwa (mgr inż. A. Demianowicz, dr M. Cygler),
- dyskusja programowa,
- udzielenie absolutorium ustępującemu Zarządowi,
- zgłaszanie kandydatów do Zarządu,
- głosowanie, wybór i ukonstytuowanie się Zarządu,
- zgłaszanie kandydatów do Komisji Rewizyjnej,
- głosowanie, wybór i ukonstytuowanie się Komisji Rewizyjnej,
- sprawozdanie Komisji Uchwał i Wniosków,
- zamknięcie obrad.

Prof. L. Preisner zaproponował kandydatów na przewodniczącego oraz sekretarza obrad, odpowiednio: dr. inż. Mariusza Trelę, dr Paulinę Szyja. Zebrani wyrazili zgodę na głosowanie w trybie jawnym przez podniesienie ręki. Wymienione osoby zostały jednomyślnie wybrane.

1.

Przewodniczący dr inż. M. Trela poddał pod głosowanie zaproponowany przez prof. Leszka Preisnera program obrad Walnego Zebrania Stowarzyszenia, pytając uprzednio o propozycje zmian przebiegu zebrania. W wyniku braku zgłoszeń, jednomyślnie przyjęto przebieg zaproponowany przez przewodniczącego PSEŚiZN.

2.
Przewodniczący Walnego Zebrania dr inż. M. Trela ogłosił przystąpienie do wyboru składu Komisji Skrutacyjnej.

Kandydatów zgłosili:
Prof. Małgorzata Burchard-Dziubińska – dr Annę Dubel,
Prof. Marta Gollinger-Tarajko – dr Krzysztofa Posłusznego.

Prof. L. Preisner zgłosił wniosek formalny, aby poszczególne kandydatury poddano odrębnej procedurze głosowania. Dr M. Trela, przewodniczący Walnego Zebrania, zapytał zgromadzonych o wyrażenie zgody na jawna formę głosowania. Obecni wyrazili zgodę. Przewodniczący zapytał kandydatów o zgodę na udział w wyborach. Kandydaci wyrazili zgodę.

Jednomyślnie wybrano dr inż. Annę Dubel oraz dr inż. Krzysztofa Posłusznego na członków Komisji Skrutacyjnej. Poszczególne sprawozdania zamieszczono na: www.sprawozdaniaopp.mpips.gov.pl. W tym samym punkcie obrad przewodniczący dr inż. M. Trela ogłosił wybory na członków Komisji Matki. Propozycje kandydatów zgłosili:
– Prof. Małgorzata Burchard-Dziubińska – prof. Mariusza Plicha,
– Prof. Tadeusz Pindór – prof. Martę Gollinger-Tarajko.

Przewodniczący zapytał kandydatów o zgodę na udział w wyborach. Kandydaci wyrazili wolę kandydowania.

Przewodniczący Zebrania zapytał zgromadzonych o wyrażenie zgody na jawną formę głosowania. Obecni wyrazili zgodę. Następnie jednomyślnie wybrano wskazanych kandydatów na członków Komisji Matki.

3.
Przewodniczący dr inż. M. Trela przystąpił do wyboru Komisji do spraw Uchwał i Wniosków.

Propozycje kandydatów zgłosili:
Prof. Tadeusz Pindór – prof. Kazimierza Górkę i prof. Adama Budnikowskiego,
Prof. Piotr Małecki – dr Ksymenę Rosiek.

Przewodniczący zapytał kandydatów o zgodę na udział w wyborach. Kandydaci wyrazili wolę kandydowania. Przewodniczący zapytał zgromadzonych o wyrażenie zgody na jawną formę głosowania. Obecni wyrazili zgodę. Następnie jednomyślnie wybrano wskazanych kandydatów na członków Komisji do spraw Uchwał i Wniosków.

Kolejnym punktem obrad miał być wybór składu członków Komisji do spraw Odwołań. Jednak na wniosek przewodniczącego Komisji Rewizyjnej prof. Ryszarda Janikowskiego, który zgłosił bezzasadność jej wyboru z uwagi na brak jakichkolwiek odwołań. Uczestnicy Walnego Zebrania wyrazili poparcie wniosku.

4.
Następnie przewodniczący Zebrania poprosił prof. Leszka Preisnera – przewodniczącego PSEŚiZN o przedstawienie raportu z działalności Zarządu oraz prof. Tadeusza Pindóra o zaprezentowanie sprawozdania z działalności finansowej.

Prof. L. Preisner zaprezentował działania Zarządu od 21 września 2010 roku do 13 października 2014 roku, podkreślając iż z uwagi na przedstawienie 5 grudnia 2012 roku w trakcie Walnego Zebrania Sprawozdawczego (połowa kadencji) oraz 4 grudnia 2013 roku w trakcie Walnego Zebrania w Białowieży sprawozdania z kolejnego 2013 roku, prezentowane sprawozdanie nawiązuje do poprzednich, zaakceptowanych już wcześniej przez wspomniane Walne Zebrania. Natomiast szczegółowo zostały przedstawione przedsięwzięcia podjęte przez Zarząd i Stowarzyszenie od 5 grudnia 2013 do 13 października 2014 roku.

Przewodniczący przedstawił 10-osobowy skład Zarządu w kadencji 2010-2014:
przewodniczący – prof. L. Preisner,
wiceprzewodniczący – prof. A. Budnikowski, prof. B. Fiedor,
skarbnik – prof. T. Pindór,
członkowie – dr E. Broniewicz, prof. M. Burchard-Dziubińska, prof. K. Górka, prof. A. Graczyk, prof. Elżbieta Lorek, prof. R. Miłaszewski.

Przewodniczący przedstawił także skład Komisji Rewizyjnej w kadencji 2010-2014:
przewodniczący – prof. Ryszard Janikowski,
wiceprzewodniczące – prof. Joanna Ejdys, dr hab. prof. Barbara Kryk
członkowie – dr inż. Joanna Czerna-Grygiel, prof. Piotr Jeżowski, dr Karol Kociszewski, prof. Johannes (Joost) Platje.

Następnie przewodniczący poinformował o najważniejszej zmianie, jaka nastąpiła w związku z formalnym funkcjonowaniem Stowarzyszenia. Sąd Rejonowy w Krakowie 9 lipca 2014 roku wpisał do KRS nową nazwę Stowarzyszenia: Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych, zastępując tym samym dotychczasową, Europejskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych. Przewodniczący Zarządu podziękował członkom Stowarzyszenia za cierpliwość w oczekiwaniu na zmianę nazwy, a szczególnie prof. Tadeuszowi Pindórowi za pomoc w przeprowadzeniu procedury. Ponadto, prof. L. Preisner poinformował o dokonaniu wymaganej zmiany nazwy Stowarzyszenia we wszystkich instytucjach, w których jest to niezbędne, z wyjątkiem Banku Pekao S.A. prowadzącego rachunek Stowarzyszenia. Przewodniczący PSEŚiZN zaproponował, aby zmiany w tym ostatnim zakresie dokonał nowy skład Zarządu, którego wybór miał nastąpić 13 października 2014 roku, legitymizując się wyborem na nową kadencję.

Prof. L. Preisnera poinformował, że liczba członków Stowarzyszenia na 30 września 2014 roku wynosiła 165 osób. Od 21 września 2010 do 13 października 2014 roku przyjęto 34 osoby, a skreślono z listy 13 osób, w tym 7 na ich osobistą prośbę. Prof. L. Preisner podkreślił, że wśród członków dominują pracownicy naukowi ośrodków akademickich z Warszawy (41), Krakowa (35 osób), Białegostoku (23 osoby) i Wrocławia (22 osoby).

Następnie przedstawił informację o zebraniach Zarządu odbytych w kadencji 2010-2014. Jednocześnie przewodniczący zaproponował, aby po zakończeniu obrad Walnego Zebrania, nowo wybrany Zarząd odbył swoje pierwsze zebranie.

Ponadto, Prof. L. Preisner przypomniał o rozwijaniu komunikacji wewnętrznej i zewnętrznej przez Stowarzyszenie za pośrednictwem strony internetowej, a także korespondencji mailowej i tradycyjnej. Następnie Przewodniczący przybliżył zebranym zakres inicjatyw i działań realizowanych przez Stowarzyszenie w okresie sprawozdawczym, takie jak współudział

w organizacji konferencji. Przewodniczący podziękował prezesowi mgr. inż. Andrzejowi Demianowiczowi za współpracę PSEŚiZN oraz kierowanej przez niego Fundacji Ekonomistów Środowiska i Zasobów Naturalnych oraz dr inż. Elżbiecie Broniewicz, redaktorowi naczelnemu czasopisma „Ekonomia i Środowisko".

Prof. L. Preisner podkreślił znaczenie udziału członków PSEŚiZN w European Association of Environemental and Resource Economics i wyraził żal, że obecnie jest niewiele osób decydujących się na członkostwo w EAERE. Przewodniczący poinformował o zbliżającym się jubileuszu 25-lecia działalności Stowarzyszenia, który przypadnie w 2016 roku i o konieczności podjęcia odpowiednich przygotowań w tym zakresie.

Następnie prof. Tadeusz Pindór, skarbnik Stowarzyszenia, przedstawił sprawozdanie dotyczące sytuacji finansowej Stowarzyszenia (dokument stanowi załącznik do raportu), precyzując źródła przychodów oraz kierunki wydatkowania środków pozostających w dyspozycji. Zwrócił uwagę na uzyskanie przez przewodniczącego Stowarzyszenia zerowej stawki za wynajem pomieszczeń biurowych Wydziału Zarządzania Akademii Górniczo-Hutniczej w Krakowie, a także deklaracji dr Kazimiery Mendys – prowadzącej księgi rozrachunkowe Stowarzyszenia o obniżeniu wynagrodzenia za wykonywaną pracę. Ponadto zaprezentował bilans PSEŚiZN, informując o nadwyżce środków finansowych, pozostających w dyspozycji, której część może być wykorzystana na wydawnictwo i inne wydatki jubileuszowe.

5.
Kolejny punkt programu Walnego Zebrania stanowiło sprawozdanie przewodniczącego Komisji Rewizyjnej, zaprezentowane przez prof. R. Janikowskiego.

Komisja pozytywnie oceniła realizację przez Zarząd postanowień Statutu Stowarzyszenia, a także skuteczność działań na rzecz zmiany nazwy oraz kondycję finansową. Jednocześnie zaprezentowano zalecenia:

- wzrost skuteczności mechanizmu pozyskiwania składek członkowskich,
- udzielenie absolutorium Zarządowi Stowarzyszenia.

6.
Następnie prof. Rafał Miłaszewski, przewodniczący Sekcji Ekonomiki Użytkowania i Ochrony Wód, funkcjonującej w ramach PSEŚiZN, przedstawił sprawozdanie z działalności Sekcji. Szczegółowo przybliżył historię jej powstania, realizowane projekty, inicjatywy oraz zakres działalności dydaktycznej oraz współpracy z różnymi instytucjami.

7.
Kolejny punkt obrad stanowiło wystąpienie mgr. inż. Andrzeja Demianowicza dotyczące sprawozdania z działalności Fundacji Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych w Białymstoku oraz Wydawnictwa (dokument stanowi załącznik do protokołu). Prezes A. Demianowicz potwierdził ogromne zainteresowanie publikowaniem w czasopiśmie „Ekonomia i Środowisko", jednocześnie wskazując na konieczność ograniczenia nakładu z uwagi na wysokie koszty.

8.
Następnie Przewodniczący Walnego Zebrania dr M. Trela zaprosił do dyskusji programowej. W jej trakcie pojawiły się następujące uwagi:

- Dr Elżbieta Broniewicz przedstawiła pomysł wprowadzenia elektronicznej formuły publikacji „Ekonomii i Środowiska".
- Prof. Tomasz Żylicz podkreślił konieczność rozważenia kwestii przeznaczenia nadwyżki finansowej.
- Prof. Kazimierz Górka zwrócił uwagę na konieczność określenia dalszych losów tak zwanej zielonej serii wydawniczej Biblioteki „Ekonomia i Środowisko".
- Prof. Kazmierz Górka zaproponował rozważenie kwestii organizacji konferencji Stowarzyszenia niezwiązanej z żadnym ośrodkiem akademickim.
- Prof. Kazimierz Górka zaproponował, aby zastanowić się nad możliwością powołania kolejnej sekcji w ramach Stowarzyszenia.
- Prof. Kazimierz Górka zaproponował zorganizowanie grupy członków Stowarzyszenia, która udałaby się na konferencję European Association of Environemental and Resource Economics, organizowaną w Helsinkach, w czerwcu 2015 roku.
- Prof. Małgorzata Burchard-Dziubińska zaproponowała wymianę adresów mailowych celem przesłania członkom Stowarzyszenia sprawozdań poszczególnych Komisji.
- Dr Ksymena Rosiek zaproponowała stworzenie portalu społecznościowego wewnątrz Stowarzyszenia, umożliwiającego komunikację bezpośrednią.
- Prof. Tadeusz Pindór przedstawił wysokość wpłat zaległych składek członkowskich, jakie wpłynęły do Stowarzyszenia 13 października 2014 roku.
- Prof. Adam Budnikowski podkreślił zadowolenie z dużej liczby członków Stowarzyszenia z Warszawy.
- Dr Mariusz Trela potwierdził kontynuowanie prac związanych z administrowaniem strony internetowej Stowarzyszenia.

9.

Kolejny punkt obrad stanowiło głosowanie nad absolutorium dla Zarządu. Przewodniczący Walnego Zebrania dr inż. Mariusz Trela zaproponował głosowanie w trybie jawnym. Zgromadzeni wyrazili zgodę, a następnie jednomyślnie udzielili absolutorium ustępującemu Zarządowi za kadencję 2010-2014. Przewodniczący PSEŚiZN, prof. Leszek Preisner, podziękował uczestnikom obrad za akceptacje dokonań.

10.

Następnie przewodniczący Walnego Zebrania ogłosił przystąpienie do wyborów, w trybie tajnym, nowego Zarządu Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych. Prof. L. Preisner wyraził chęć pomocy dla nowego składu Zarządu. Następnie prezes A. Demianowicz zaproponował, aby kandydatami były wszystkie osoby z ustępującego Zarządu. Pani prof. M. Burchard-Dziubińska zaproponowała jeszcze jedną kandydaturę prof. Barbary Kryk.

Przewodniczący dr inż. M. Trela odczytał skład dotychczasowego Zarządu i zapytał o wyrażenie zgody na kandydowanie. Wymienione osoby będące w składzie dotychczasowego Zarządu oraz prof. Barbara Kryk wyraziły zgodę. Prof. L. Preisner zwrócił uwagę na nieobecność prof. Bogusława Fiedora informując, że posiada oświadczenie zgody prof. Bogusława Fiedora na kandydowanie w kadencji 2014-2018. Następnie Komisja Skrutacyjna przygotowała procedurę głosowania. Odbyła się ona w trybie niejawnym (karty głosowania i protokół stanowią załącznik do protokołu).

W trakcie liczenia głosów zaprezentowano wnioski Komisji Uchwał i Wniosków. Sprawozdanie przedstawił prof. Adam Budnikowski, wskazując na:

- postulat zebrania adresów mailowych,
- postulat wydatkowania części nadwyżki finansowej w związku z jubileuszem PSEŚiZN,
- postulat rozważenia kwestii wydawnictwa Biblioteki „Ekonomii i Środowiska" redagowanej dotychczas przez prof. Kazimierza Górkę,
- postulat wstępowania członków PSEŚiZN do European Association of Environemental and Resource Economics,
- postulat utworzenia kolejnej sekcji,
- postulat korzystania z nowych form komunikacji,
- postulat dyscyplinowania członków w zakresie regulowania składek.

Następnie dr inż. Anna Dubel – przewodnicząca Komisji Skrutacyjnej – ogłosiła wyniki wyborów. Komisja stwierdziła obecność 40 członków Stowarzyszenia, uprawnionych do głosowania. Oddano 40 głosów, wszystkie ważne. W skład nowego Zarządu weszły następujące osoby (z liczbą uzyskaną głosów):

1. dr inż. Elżbieta Broniewicz – 40 głosów ZA,
2. prof. dr hab. Adam Budnikowski – 38 głosów ZA, 2 NIE,
3. dr hab. Małgorzata Burchard-Dziubińska, prof. UŁ – 40 głosów ZA,
4. prof. dr hab. Bogusław Fiedor – 40 głosów ZA,
5. prof. dr hab. Kazimierz Górka – 38 głosów, 2 NIE,
6. dr hab. inż. Andrzej Graczyk – prof. UEWr – 39 głosów ZA, 1 NIE,
7. dr hab. Barbara Kryk, prof. USz – 40 głosów ZA,
8. prof. dr hab. Elżbieta Lorek – 40 głosów ZA,
9. prof. dr hab. inż. Rafał Miłaszewski – 39 głosów ZA, 1 NIE,
10. dr hab. inż. Tadeusz Pindór – 40 głosów ZA,
11. dr hab. Leszek Preisner, prof. AGH – 40 głosów ZA.

Komisja nie stwierdziła głosów WSTRZYMUJACYCH ani NIEWAŻNYCH

11.

Kolejny punkt obrad stanowił wybór Komisji Rewizyjnej.

Zaproponowano następujące osoby do składu Komisji:
Prof. Piotr Małecki – dr Ksymenę Rosiek,
Prof. Kazimierz Górka – dr Paulinę Szyja,
Prof. Leszek Preisner – prof. Ryszarda Janikowskiego,
Dr Damian Panasiuk – dr Pawła Bartoszczuka,
Prof. Małgorzata Burchard-Dziubińska – prof. Mariusza Plicha.

Komisja Skrutacyjna przeprowadziła głosowanie w trybie tajnym. Karty do glosowania oraz protokół stanowią załącznik do protokołu). Następnie ogłoszono wyniki. Obecność na sali wynosiła 40 członków PSEŚiZN uprawnionych do głosowania. Oddano 40 głosów, wszystkie ważne. W skład nowej Komisji Rewizyjnej weszły następujące osoby (z liczbą uzyskaną głosów „ZA"):

1. dr Paweł Bartoszczuk – 39 głosów ZA, 1 NIE,
2. prof. dr hab. inż. Ryszard Janikowski – 40 głosów ZA,

3. dr hab. Mariusz Plich, prof. UŁ – 38 głosów ZA, 2 NIE,
4. dr Ksymena Rosiek – 39 głosów ZA, 1 NIE,
5. dr Paulina Szyja – 38 TAK, 2 NIE.

Komisja nie stwierdziła głosów WSTRZYMUJACYCH ani NIEWAŻNYCH.

12.

Kolejny punkt obrad stanowiło ukonstytuowanie się składu Zarządu Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych w kadencji 2014-2018. W trakcie pierwszego posiedzenia w nowej kadencji Zarząd ukonstytuował następująco:

1. dr hab. Leszek Preisner, prof. AGH – przewodniczący,
2. prof. dr hab. Adam Budnikowski – wiceprzewodniczący,
3. prof. dr hab. Bogusław Fiedor – wiceprzewodniczący,
4. dr hab. Małgorzata Burchard-Dziubińska, prof. UŁ – sekretarz,
5. dr hab. inż. Tadeusz Pindór – skarbnik,
6. dr inż. Elżbieta Broniewicz,
7. prof. dr hab. Kazimierz Górka,
8. dr hab. inż. Andrzej Graczyk – prof. UEWr,
9. dr hab. Barbara Kryk, prof. USz,
10. prof. dr hab. Elżbieta Lorek,
11. prof. dr hab. inż. Rafał Miłaszewski.

13.

Ukonstytuowała się także Komisja Rewizyjna w składzie:

1. prof. dr hab. inż. Ryszard Janikowski – przewodniczący,
2. dr hab. Mariusz Plich, prof. UŁ – wiceprzewodniczący,
3. dr Paulina Szyja – wiceprzewodnicząca,
4. dr Paweł Bartoszczuk,
5. dr Ksymena Rosiek.

14.

Dr inż. Mariusz Trela, przewodniczący Walnego Zebrania Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych, podziękował zgromadzonym członkom za udział w obradach i zakończył posiedzenie.

Protokół sporządził sekretarz
Walnego Zebrania PSEŚiZN
Dr Paulina Szyja

Przewodniczący
Walnego Zebrania PSEŚiZN
Dr inż. Mariusz Trela

Sprawozdanie Komisji Uchwał i Wniosków
Walne Zebranie Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych

Łódź, 13 października 2014 roku

Komisja w składzie: prof. dr hab. Adam Budnikowski –członek, prof. dr hab. Kazimierz Górka – Przewodniczący, dr Ksymena Rosiek – sekretarz.

W trakcie walnego zgromadzenia Walnego Zebrania Sprawozdawczo-Wyborczego Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych, które odbyło się 13 października 2014 roku w Łodzi, zgłoszono wnioski w następujących sprawach

1. Zaniechanie powoływania członków Komisji do spraw odwołań, ze względu na brak odwołań – złożony przez prof. Ryszarda Janikowskiego przewodniczącego Komisji Rewizyjnej – wniosek został poparty przez Walne Zgromadzenie.
2. Wprowadzenie – oprócz dotychczasowej formy drukowanej, chociaż w zmniejszonym nakładzie – elektronicznej formuły publikacji „Ekonomii i Środowiska" – złożony przez dr Elżbietę Broniewicz. W niosek poparto i zalecono kontynuację działań rozpoznawania wymagań prawnych i technicznych.
3. Rozważenie kwestii przeznaczenia nadwyżki finansowej – złożony przez prof. Tomasza Żylicza, przyjęty do rozpatrzenia; wskazano na możliwość zaangażowania tych środków w organizowanie konferencji jubileuszowej.
4. Rozważenie możliwości sprzedaży akcji BOŚ SA – złożony przez prof. Tomasza Żylicza, przyjęty do rozpatrzenia.
5. Określenie dalszych losów tak zwanej zielonej serii wydawniczej Biblioteki „Ekonomia i Środowisko" – złożony przez prof. Kazimierza Górkę, przyjęty do rozpatrzenia.
6. Rozważenie kwestii organizacji konferencji Stowarzyszenia z okazji 25-lecia Stowarzyszenia – złożony przez prof. Kazimierza Górkę, przyjęty do rozpatrzenia.
7. Rozważenie możliwości powołania kolejnej sekcji w ramach Stowarzyszenia – złożony przez prof. Kazimierza Górkę, przyjęty do rozpatrzenia.
8. Zorganizowanie grupy członków Stowarzyszenia, która udałaby się na konferencję European Association of Environemental and Resource Economics, organizowaną w Helsinkach w czerwcu 2015 roku i kolejną w Zurichu w 2016 roku – złożony przez prof. Kazimierza Górkę, przyjęty do rozpatrzenia.
9. Zebranie adresów mailowych celem przesłania członkom Stowarzyszenia sprawozdań poszczególnych Komisji przed walnym zebraniem, co usprawniłoby obrady – złożony przez prof. Małgorzatę Burchard-Dziubińską, przyjęty do rozpatrzenia;
10. Stworzenie internetowego portalu społecznościowego wewnątrz Stowarzyszenia, umożliwiającego szybszą komunikację – złożony przez dr Ksymenę Rosiek, przyjęty do rozpatrzenia.

Wszystkie wnioski zostały złożone prawidłowo, wniosek numer jeden został od razu przegłosowany, pozostałe zostały przyjęte do rozpatrzenia przez Zarząd Stowarzyszenia.

Protokół sporządził sekretarz Komisji Uchwał i Wniosków: Ksymena Rosiek

Sekretarz Komisji Uchwał i Wniosków
dr Ksymena Rosiek

Przewodniczący Komisji Uchwał i Wniosków
prof. dr hab. Kazimierz Górka

Information for the authors

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  - *Ekonomia środowiska*, ed. Jan Kowalski, Warsaw 2002, p. 22.
  - J. Nowak, *Teoretyczne podstawy ekonomii środowiska*, in: *Ekonomia środowiska*, ed. Jan Kowalski, Warsaw 2002, p. 35.
  - J. Nowak, *Zarządzanie środowiskiem w przedsiębiorstwie*, "Ekonomia i Środowisko" 2004 No 2(26), p. 15.
  - J. Nowak, *Teoretyczne podstawy ekonomii środowiska,* www.ukie.gov.pl [15-06-2006].
  - Act from 11 May 2001 r. on packages and packaging wastes (Act of Journals No 63 item 638).

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  - J. Nowak, *Teoretyczne podstawy ekonomii środowiska*, w: *Ekonomia środowiska*, red. Jan Kowalski, Warszawa 2002, s. 35.
  - J. Nowak, *Zarządzanie środowiskiem w przedsiębiorstwie*, „Ekonomia i Środowisko" 2004 no. 2(26), s. 15.
  - J. Nowak, *Teoretyczne podstawy ekonomii środowiska,* www.ukie.gov.pl [15-06-2006].
  - Ustawa z dnia 11 maja 2001 r. o opakowaniach i odpadach opakowaniowych (Dz.U. no. 63 poz. 638).

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