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## THE VALUATION OF ECOSYSTEM SERVICES FOR THE SAKE OF REVITALIZATION PROCESSES

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### WYCENA ŚWIADCZEŃ EKOSYSTEMOWYCH NA RZECZ PROCESÓW REWITALIZACJI PRZESTRZENI

STRESZCZENIE: Wycena świadczeń ekosystemów miejskich może stać się elementem ewaluacji działań strategicznych i planistycznych w miastach. Szczególnie wartościowa wydaje się w odniesieniu do procesów rewitalizacji przestrzeni. Specyfika procesu odnowy przestrzeni miejskiej, połączonej z szerokim spektrum interwencji społeczno-ekonomicznej, umożliwia wykorzystanie co najmniej kilku metod wyceny świadczeń. Zdecydowanie mniej kosztowne wydaje się jednak posługiwanie się wynikami badań prowadzonych dla innych potrzeb lub adaptowanie wyników z innych jednostek przestrzennych. Jako przykład praktycznego zastosowania zaprezentowano ewaluację świadczeń dla terenów zieleni poddawanych rewitalizacji w Gnieźnie.

SŁOWA KLUCZOWE: świadczenia ekosystemów, rewitalizacja, park, tereny odłogowane, ogrody działkowe

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## Introduction

The valuation of urban ecosystem services may be a valuable diagnostic tool for programming revitalization processes. At the same time, the specific nature of these processes and a multitude of their aspects, thus, a high cost of implementing them (as it involves extended social research, field studies, etc.), make it unjustifiable to undertake yet another environmental diagnosis due to financial and time reasons. It would thus seem reasonable to include such issues in the situations when it is possible to use data from other studies and analyses carried out in a given area or comparable data from other spatial units.

Such an approach is illustrated by the case of programming the revitalization of a part of Osiedle Grunwaldzkie (Grunwaldzkie housing estate) in Gniezno. The valuation of different forms of ecosystem existing there was based on comparable results of survey made in different parts of Gniezno. The main aim was to present the possibility of use the results of other studies for the purpose of planning revitalization processes of green areas in cities. It helped to assess the value of environmental factor, which is often overlooked in analyses and may be costly as well.

## An overview of literature

The existing body of literature, both Polish and international, lacks extensive studies devoted to the environmental implications of revitalization, especially in the context of ecosystem services.

There are a variety of works, however, which discuss ecosystem services, including their valuation in urbanised areas, and the opportunities and barriers to the application of this approach in the planning procedure. They range from comprehensive studies in the form of book publications e.g. Elmqvist et al.<sup>1</sup>, through review papers e.g., Żylicz, Dobbs et al., Gómez-

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<sup>1</sup> T. Elmqvist et al. (eds), *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*, Springer 2013.

Baggethun and Barton, Mizgajski et al.<sup>2</sup>, to detailed environmental or economic issues – Escobedo et al., Pataki et al., Nowak et al. or Szczepanowska<sup>3</sup>.

The issue of the valuation of services in urbanised areas, in various contexts, has been also the subject of a large number of analytical and practical studies. An interesting approach in this field was proposed by Baró et al.<sup>4</sup>, who performed a qualitative analysis of the supply and demand for ecosystem services in five European cities.

As regards green areas in cities and changes in their productivity resulting from functional transformations, it is worth mentioning an interesting work by Middle et al.<sup>5</sup>. Considering the issue of the organisation of housing estate gardens in the space of public parks, they raised the related problem of the potential for increasing ecosystem services. Littke<sup>6</sup> discussed the practical aspects of this issue in the context of the green area development strategy in Stockholm. Niemelä et al.<sup>7</sup>, in turn, dealt with the application of ecosystem services as an element which improves the planning and protection of green zones in built-up areas, using the example of Finnish cities.

It should also be indicated that Kronenberg and Bergier<sup>8</sup>, in their study concerning challenges of sustainable development in Poland, raised the issue

- <sup>2</sup> T. Żylicz, *Valuation of ecosystem services. An overview of world research* "Ekonomia i Środowisko" 2010 no 1(37), p. 31–45; C. Dobbs, F.J. Escobedo, W.C. Zipperer, *A framework for developing urban forest ecosystem services and goods indicators*, "Landscape and Urban Planning" 2011 no. 99, p. 196–206; E. Gómez-Baggethun, D.N. Barton, *Classifying and valuating ecosystem services for urban planning*, "Ecological Economics" 2013 no. 86, p. 235–245; A. Mizgajski et al., *Development of the ecosystem services approach in Poland*, "Ekonomia i Środowisko" 2014 no 4(51), p. 10–19.
- <sup>3</sup> F.J. Escobedo, T. Kroeger, J.E. Wagner, *Urban forests and pollution mitigation: analyzing ecosystem services and disservices*, "Environmental Pollution" 2011 no. 159, p. 2078–2087; D.E. Pataki et al., *Coupling biogeochemical cycles in urban environments: ecosystem services, green solutions, and misconceptions*, "Frontiers in Ecology and the Environment" 2011 no. 9, p. 27–36; D.J. Nowak, D.E. Crane, J.F. Dwyer, *Compensatory value of urban trees in the United States*, "Journal of Arboriculture" 2002 no. 28, p. 194–199; H.B. Szczepanowska (ed.), *Metoda wyceny wartości drzew na terenach zurbanizowanych dla warunków polskich*, Warszawa 2009.
- <sup>4</sup> F. Baró et al., *Mismatches between ecosystem services supply and demand in urban areas: A quantitative assessment in five European cities*, "Ecological Indicators" 2015 no. 55, p. 146–158.
- <sup>5</sup> I. Middle et al., *Integrating community gardens into public parks: An innovative approach for providing ecosystem services in urban areas*, "Urban Forestry and Urban Greening" 2014 no. 13(4), p. 638–645.
- <sup>6</sup> H. Littke, *Planning the green walkable city: Conceptualizing values and conflicts for urban green space strategies in Stockholm*, "Sustainability" 2015 no. 7, p. 11306–11320.
- <sup>7</sup> J. Niemelä et al., *Using the ecosystem services approach for better planning and conservation of urban green spaces: a Finland case study*, "Biodiversity and Conservation" 2010 no. 19(11), p. 3225–3243.
- <sup>8</sup> J. Kronenberg, T. Bergier (ed.), *Wyzwania zrównoważonego rozwoju w Polsce*, Kraków 2010.

of revitalization as one of the significant aspects contributing to the improvement of environmental conditions in cities.

### The functional diversity of the selected types of urban ecosystems. The case of Osiedle Grunwaldzkie in Gniezno

A part of Osiedle Grunwaldzkie that has been selected for revitalization covers the area of around 68 ha located in the southern part of Gniezno. The residential area includes multi-family buildings, mainly barracks, but also a few blocks and tenement houses. The unused green area in its northern part covers the territory of 9 ha, including a 6.5-hectare area that was divided into allotment gardens in the past. At present, all this territory may be considered as abandoned land, used neither for cultivation nor for recreation. Its services are reduced to a group of regulating and maintaining services, as well as to provisioning ones to a limited extent. It is also a source of ecosystem disservices in the social, spatial and environmental dimension. In the social aspect, this is the area which generates danger for people staying there, as well as for local residents. It creates conditions conducive to the development of harmful social phenomena, such as homelessness, addictions, and crime. As regards space, it constitutes a functional gap in the structure of the estate, at the same time being the area of high potential that is not being used at the moment. When it comes to the environmental aspect, it has lost its original farming and recreational function, having been covered with ruderal species in an unorganised way.

The value of services provided by the green area under discussion has never been assessed. No field studies, combined with wildlife inventory, have been conducted. At the same time, other parts of the city were the subject of an extensive study consisting in the valuation of services provided by selected types of ecosystems<sup>9</sup>. As a result, it has become possible to adopt the research results for the sake of the revitalization process, to assess the comprehensive cost-effectiveness of the process taking into account the environmental factor. Their informational value was of auxiliary importance. For example, the cultural services of the ecosystems under study were not evaluated, which, from the point of view of revitalization, would add to the significance of the research. However, limiting oneself to the results of the study of the valuation

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<sup>9</sup> The study was conducted in the years 2013–14 by the team headed by A. Bernaciak, consisting of the representatives of Poznan University of Economics and Business, Adam Mickiewicz University, WSB University: A. Bernaciak, B. Trafna, P. Mudrak, J. Celiński, K. Harendziak, K. Silska, M. Hejna, N. Maciejuniec, M. Wojcieszak.

of regulating and resource services, it is possible to define the environmental diversity of the area under consideration.

Originally, the area was used for allotment gardens. The way they were developed was not much different from the way other gardens of this type were developed in the city. As the authorities decided to discard them, their owners took some of the plants with them. With time, the area was becoming covered with flora in an unorganised way. As the result of social consultation procedures and field analyses during planning the revitalization process, it was decided that the estate park would be the most desirable target function of this land.

The distinction between three development types – allotment gardens, abandoned land and a park – entails changes in the dominant function of the area, its availability, maintenance costs and species diversity (or in a broader sense – biodiversity), (table 1).

**Table 1.** The functional and spatial diversity of the area of allotment gardens, abandoned land and the park

Development type	Allotment gardens	Abandoned land	Estate park
Function	Regulating, recreational, resource, leisure	Regulating	Regulating, recreational, leisure, cultural
Accessibility	Limited	Limited/Unlimited	Unlimited
Maintenance costs	Medium	Marginal	High
Species diversity	Low	High	Medium

From the point of view of the local community, it is the estate park and allotment gardens that perform the biggest number of functions. Apart from the regulating services they provide, they also fulfil recreational and leisure functions. Moreover, allotment gardens provide resource services, while the park offers cultural services. As far as the functionality of abandoned land is concerned, it is the provision of regulating functions that is of the highest importance. What is also significant is the differentiation of these areas in terms of their availability. There is unlimited access to the estate park, which is not the case when it comes to the allotment gardens, used only by their owners, their friends and family members. People from outside are not allowed to enter this space. The issue of the availability of abandoned land is controversial. There are no physical barriers which disturb the access to this area, nor there are effective formal barriers to entry. However, the fact that it is undeveloped land, perceived as a dangerous place, does not encourage residents to visit it. The other elements that differentiate the selected development types include maintenance costs – the lowest in the case of abandoned

land (they are practically non-existent), the highest for the park (it does not matter whether the costs are incurred by natural persons, legal persons or local government units). The species diversity in this area was also the lowest in the case of its original function (allotment gardens). It was moderate in the case of the park, while abandoned land exhibits the highest diversity in this respect.

The change in the function of this area in time and the proposed new function also entail changes in the value of services provided. The study of the valuation of resource and regulating services provided by allotment gardens, abandoned land and parks in Gniezno has been conducted (it did not include this area, though). Its results, however, may be used to make general conclusions referring to the area under consideration.

## The methodology and results of the research

The research methodology was based on the valuation of basic regulating services, such as water retention, the absorption of carbon dioxide, and oxygen supply. What is more, with reference to parks and allotment gardens, the value of trees and – only for gardens – the value of crops was evaluated as a significant element of their functioning (table 2). What was the principal research tool used for the valuation of the provision of allotment gardens' services were survey questionnaires and direct interviews with people growing plants in the gardens (the total number of the respondents was 112). Additionally, individual in-depth interviews with the representatives of the College of Heads of Family Allotment Gardens were conducted. The principal research methods included the replacement cost method and the replacement value method<sup>10</sup>. As far as abandoned land is concerned, it was evaluated on the basis of natural inventory, supplemented by the methods of spatial analysis and mapping. The basic elements that were evaluated included: the degree of succession and the density and diversity of vegetation, as well as its size. The main method was the replacement cost method. The valuation of parks, performed for four separate areas, was principally based on detailed species natural inventory combined with the evaluation of the size and condition of trees. Its results were mainly obtained with the application of the replacement value method. The provided values always refer to the time span of one year.

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<sup>10</sup> The detailed elements of the research procedure, due to the limited size of the study, were not presented.

**Table 2.** The methodology of the study of the valuation of services provided by areas of different development type in Gniezno

Development type	Allotment garden	Abandoned land	Park
	Regulating • Water retention • Absorption of carbon dioxide • Oxygen supply		
Evaluated elements	Provisioning (Crops) Value of trees (replacement value + ecosystem services value)	–	Value of trees (replacement value + ecosystem services value)
Research tools	Questionnaires and direct interviews among randomised allotment owners	Natural inventory (the degree of succession and density of vegetation)	Natural inventory in 5 city parks
Research methods	Replacement cost method, replacement value method	Replacement cost method	Replacement value method

Due to the differences in the availability of data and in the research methods applied in the evaluation of each ecosystem type, the obtained results are not fully comparable. However, they are of high cognitive value, defining first of all relations between the economic value of the particular types of urban ecosystems. Moreover, they indicate estimated figures that can be broadly applied.

**Table 3.** The value of parks in Gniezno

	Park Miejski (City Park)	Park Trzech Kultur (Three Cultures Park)	Park im. T. Kościuszki (T. Kościuszko Park)	Park im. R. Kaczorowskiego (R. Kaczorowski Park)
Total value of services [PLN]	50,529,308.45	7,526,291.14	6,395,954.59	2,665,842.87
Size [ha]	12	3.7	1.6	0.53
Average value of 1 ha of the park 1 [PLN/1 ha]	4,210,775.70	2,034,132.74	3,997,471.62	5,029,892.21
Total value of services 1 ha of a park in Gniezno				3,818,068.07

Source: author's own work based on Trafna<sup>11</sup>.

As far as the valuation of parks is concerned, it should be pointed out that the value of services they provide is varied (table 3). It is first of all determined by the age and condition of tree stand and by the existing auxiliary

<sup>11</sup> B. Trafna, *Wycena wartości ekonomicznej parków miejskich Gniezna*, MA thesis, typescript.

facilities. The average value of services provided by 1ha of a park in Gniezno is thus almost 4 million PLN.

The value of abandoned land is difficult to assess since areas of such land are scattered all around the city and have a diverse structure. Therefore, the study covered only a part of the vector numerical map of the city, identifying 33 synanthropic plant communities. In the course of the applied research procedure, the average value of the services they provided was estimated at over 1 million PLN (680 thousand PLN per one hectare).

**Table 4.** The value of abandoned land in Gniezno

	The average value of the area under study [ha]	The average value of services [PLN]	The average value of services per 1 ha [PLN/1ha]
Abandoned land	1.75	1,117,329.10	682,853.43

Source: author's own work based on Hejna<sup>12</sup>.

The value of allotment gardens was established for each of the gardens for which data from a survey questionnaire and a direct interview was available. Both the value of regulating and maintaining services and the value of provisioning services were analysed. That is why the value of services is relatively high in the case of garden allotments, which partly reflects their specific nature – quite intensive plant development, relatively low species diversity, and the presence of crop plants. The average annual value of services provided by one garden allotment was estimated at slightly below 200 thousand PLN (almost 5 million PLN per 1 ha).

**Table 5.** The value of allotment gardens in Gniezno

	Average size [ha]	Average value of services of 1 garden [PLN]*	Average value of services per 1 ha [PLN/1ha]
Allotment garden	0.04	191,538.23	4,788,455.68

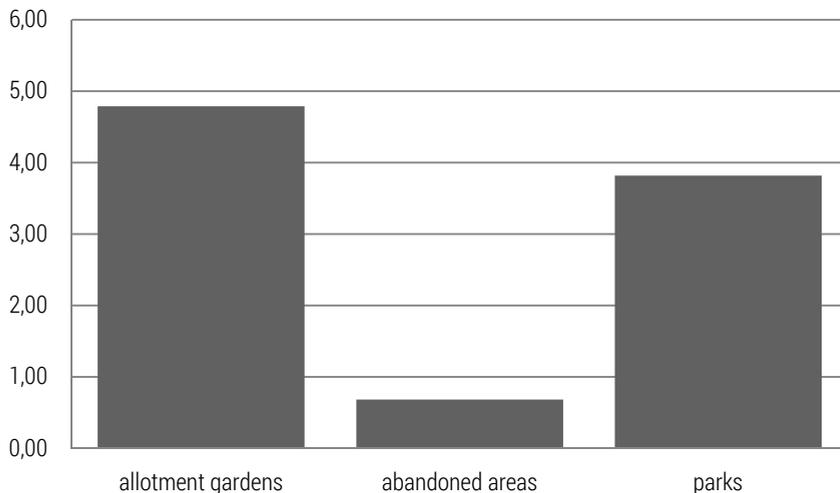
\* it consists of the average annual value of services of crops, the average annual value of services of a lawn, and the average annual value of services of trees and bushes.

Source: author's own work.

The presented research results indicate the high differentiation of the particular types of spatial development (figure 1). The services of allotment gardens and parks are clearly dominant, while abandoned land shows the

<sup>12</sup> M. Hejna, *Wycena wartości świadczeń ekosystemów terenów naturalnych i półnaturalnych w obszarach zurbanizowanych na przykładzie miasta Gniezna*, MA thesis, type-script.

lowest values. The diversity would be even higher if a group of cultural services was included in the valuation of services<sup>13</sup>.



**Figure 1.** The average value of selected ecosystem services provided by 1 ha of areas of different development types. The case of Gniezno [PLN]

## Conclusion

The presented research and its results are an important source of information for local decision-makers. The formulation of strategies, plans and programmes should be based on the broadest possible scope of diagnostic data. As it was pointed out in the introduction, this data may be particularly useful for programming the process of revitalization. It is a costly activity, thus the possibility of applying the results of research conducted for other purposes seems especially valuable. It delivers new dimensions of cost-benefit analysis and gives the possibility to consider different alternatives. In presented case, the revitalization process of Grunwaldzkie housing estate, it strictly provides to the conclusion, that planned park would be almost as “environmentally effective” space as allotment gardens were. Other park’s

<sup>13</sup> Presented results were obtained during research made on different part of the city, but as it was mentioned in the introduction, they could be useful for the sake of planning the revitalization process of Grunwaldzkie housing estate. The results cover the same types of ecosystem located within the same city, so the results seem to be comparable.

characteristic as its availability and cost of maintenance allow to assess the planned land use as the most favourable.

Moreover, the economic and social spheres are often subject to an in-depth diagnosis of strategic process. The economic efficiency of the proposed solutions is evaluated on the basis of data from the labour market, economy or social welfare indicators. At the same time, the economic analysis of environmental resources is not actually used at all. However, its effects may, as it was showed in this paper, constitute an important argument in the decision-making process (as e.g. revitalization). The presented relations between the values of services provided by the selected types of green infrastructure development refer to a specific example. The mutual relations of these values may be also examined from a dynamic perspective, as a change occurring in time with the changing development type. It seems justifiable to conduct analyses for other scenarios as well and to attempt to identify directions of changes in the values of services provided accompanying changes in the functions of green areas in cities.

## Literature

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