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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.