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REVIEW OF SELECTED ESTHETICAL AND ECONOMICAL LANDSCAPE VALORISATION METHODS AND ASSESSMENTS

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Abstract

Human activities have brought major changes to landscape, as a result of the expansion of settlements, and other activities. The need to valorise the landscape for the requirements of current and future activities results from the more and more limited space, which in itself becomes an important resource, which should be properly valorised and then shaped. The literature presents a wide variety of landscape valorisation and assessment methods used for various aspects of economic or scientific purposes. However, there is no universal method. This review article summarises selected diverse methods used for valorisation, assessment and economic valuation of the landscape.

Key words

landscape • landscape valorisation • methods of landscape research • landscape value • landscape assessment

Introduction

In recent decades, growing human impact has significantly influenced the natural and cultural environment, including the landscape (Goudie, 2018). New ventures often lead to a loss of landscape value, and globalisation, common in investments, contributes to the loss of uniqueness and specificity of given places. Hence there is a growing awareness of the need for better protection and management of the landscape. In the context of the growing role of landscape values in sustainable development, the issue of landscape assessment or valuation is gaining in importance. Defining landscape values is complicated and ambiguous, due to the subjective perception of the landscape and the complexity of connections between its elements.

In order to achieve the above-mentioned objectives, the Council of Europe has taken steps to protect and shape the landscape by drawing up the European Landscape

Convention (ELC) in Florence on October 20th, 2000 (Council of Europe, 2000).

The growing human impact transformations of the landscape and spatial chaos are basic threats on a European scale that the ELC is trying to respond to (Wu & Hobbs, 2007; Chmielewski et al., 2018). However, it does not define the methods that should be followed in order to achieve these goals. So it leaves them as an open question to each country.

Hence the need to use various methods, the choice of which is very large, and which are characterised by a different approach and varying degrees of difficulty.

To achieve the goals set in the legal documents, appropriate and comparable methods are needed to determine the features, amenity and value of the landscape.

The assessment of landscape values in Poland began to be used in the 1930s as a tool for proper space management. Research by European experts on the structure and possibilities of modelling landscape components, both biotic and abiotic, has been going on since the 1930s. These included, inter alia, the ecosystem concept developed by Tansley (1935), the landscape ecology concept developed by Troll (1939) and finally the geo-complex concept developed by Haase (1964). Landscape is often seen as a subjective assessment of the observer, and scientists have been trying to valorise and valuate landscape for years. These methods have changed gradually over the last few decades and developed along with the development of technological possibilities and new theoretical concepts. The developed methods are characterised by a very large variety, ranging from methods based only on natural values to methods that take into account socio-economic conditions.

Unfortunately, landscape valorisation or assessment methods are used only partially and only in specific circumstances in spatial planning, making decisions about the location of strategic and cubature investments. On a smaller scale, they are used by landscape architects when planning public and private spaces. One of the few stakeholder groups who use these methods in grants and scientific research are landscape ecologists. Over the past few decades, rapid civilisational changes have led to significant changes in the natural environment, which are particularly visible in the landscape. These changes were and are an impulse to conduct research related to valorisation and assessment of the landscape, especially in the aspect of its physiognomy and functioning (Antrop, 2005), economical values (Bottero, 2011; van der Heide & Heijman, 2013) or in relation to the concept of ecosystem services (de Groot & Hein, 2007). Chmielewski et al. (2018) raises similar topics, indicating that the main cause of emergence and exacerbation of spatial disorder in Poland is the development of anthropogenic landscape systems in conflicts to landscape ecological systems.

Due to the growing pressure on space, it becomes increasingly necessary to organise the methodology of valorisation and valuation of the landscape and to create a coherent methodology. But is this even possible? Currently, two groups of methods are used that are strictly related to landscape valorisation and landscape valuation. However, the latter group is not well recognised and doubts about its economic valuation are high. However, such solutions are increasingly expected due to the economisation of the environment (e.g. ecosystem services, landscape services). The aim of the paper, which is based on a broad literature review, is to present in a comprehensive way the methods of landscape esthetical and economical valorisation, assessment and landscape valuation used in Europe and in the world, indicating their main applications, areas, as well as their strengths and weaknesses. Therefore, this article focuses on the methods that potentially most correspond to spatial planning issues in relation to the Polish legal reality and spatial planning practice.

The concept of landscape and landscape assessment, valorisation and valuation

We can easily find numerous definitions of landscape in the literature on the subject. The variety of definitions results from the needs of the recipient, the progress of science and the field of science it represents. According to Schmithüsen (1978), Alexander von Humboldt tried to define the first concept of landscape as "a complex of features of a certain area". See more for example in Mazurski (2012), Gobster and Xiang (2012) and Mathewson et al. (2019).

The essence of the harmonious shaping of landscape is the use of resources, values and potentials of its ecological and cultural heritage in a way that does not degrade, but develops their structure and functioning.

Due to the variety of definitions of the concept of landscape itself, it is certainly not surprising that the methods of its analysis are diverse and numerous. It is also worth emphasising that these methods are more or less subject to subjectivism that is difficult to eliminate, so a good solution is to cross-apply several different methodological approaches for the valorisation or valuation of the same landscape.

In the literature on the subject, it is very difficult to find differences between valorisation, assessment and valuation of a landscape. The definition boundaries are therefore fluid and ambiguous. In the case of landscape it is particularly difficult because the multitude of its definitions results in different views and scientific approaches to its classification. Therefore, it is conditioned by the availability of a given information resource, which allows for the evaluation of the analysed area depending on the need.

For the purposes of this article, it was assumed that the assessment is understood as a description / classification of landscape quality; valorisation as a comparison of individual fragments of a given area, while valuation in the sense of the economic value of a given area.

Review of the selected methods of landscape assessment, valorisation and valuation

The methods known from the literature on the subject are presented below, divided into 4 groups based on qualitative and quantitative aspects, such as:

- visual aspect using images (photographs);
- visual aspect using user ratings;
- indicators, specifying values for selected / applied assessment criteria;
- economic value based on available or modified methods used in other fields.

The applied division into 4 groups is author's own proposal and results from the selection of methods in the field of visual, aesthetic and economic value of the landscape, which seem to be desirable in the case of applicability for planning purposes.

Methods based on visual aspect using images (photographs)

Cymerman's and Hopfer's photographic method

In the Cymerman's and Hopfer's method (1988a, b) landscape assessment is based on the image recorded in the photo. The study area is divided into squares with sides of 1 km. Pictures are taken from the vertices of each square in the basic directions of the world (N, S, W, E). The assessment of the landscape is made by dividing the photo by a vertical line through the centre into two segments, within which the value of the landscape is assessed on a scale of 0 to 3. The range of the assessed landscape in each photo should cover about 25 ha. The assessment of the attractiveness of the landscape is made by the observer (observers) of the photos, who assigns values to individual fragments according to the scale. Points obtained by individual segments should be marked on the map of the assessed area. Fragments of land that received the lowest value at a scale of 0 – 1 should be considered as requiring consideration to improve. The authors also distinguished 4 classes to which all assessed areas can be assigned. Depending on the number of points obtained by all segments (maximum sum – the product of the number of segments and the sum of points) there are: class A with high landscape values (over 70% of points), not requiring shaping, only conservation; class B with good landscape values (from 50 to 70% of points) requiring minor shaping activities; class C with moderate landscape values (from 30 to 50% of points) requiring broader shaping activities and class D with low landscape values (less than 30% of points) requiring transformation.

SBE method (Scenic Beauty Estimation)

The method by Daniel and Boster (1976) initially developed for the assessment of forest areas is based on aesthetic assessment of the landscape. It consists of four stages including: dividing the landscape into units that will be assessed, taking 10-25 photos for each unit to represent its appearance, presenting the photos in front of a group of observers who assess them according to the adopted scale and counting the ratings of observers. The final result is a grade given for each unit.

In order to increase credibility, it is necessary to diversify the group of observers. According to the method, they must represent different environments, be in different age groups, and gender is also important. Observers view photos simultaneously and during the same show, each photo is displayed for the same time. They assess the aesthetic level of the unit captured in the pictures. Their subjective feelings translate into a numerical rating on a scale from 1 to 10. During the last stage, observer ratings are counted and then standardised.

The 'landscape shots' method

The method by Kępkowicz (2008) defines the formal features of the landscape of a given area for use in design work in the field of landscape architecture. The method consists of three stages: (1) taking pictures of characteristic views (panoramas) according to the assumed key (views available from communication routes, viewpoints), (2) formal analysis of selected features, and (3) drawing up a graphic database of characteristic landscape forms.

The formal analysis of selected panoramas is an assessment of the composition of the frame and consideration of visual relations between all registered elements of the panorama. All landscape elements, both natural and anthropogenic, are subject to analysis, which are treated equally and reduced to simple graphic signs. The examination of individual characters consists in describing their characteristics and parameters.

Methods based on visual aspect using user ratings

Wejchert's impression curve method

Wejchert's (1974) impression curve method involves the observer recording subsequent images of specified intervals closely related to the shape of the space under study. While moving, a person experiences various emotional tensions related to the aesthetics of the environment being viewed. Stresses of emotional impressions and sensations occurring at the observer while moving in the examined space are graphically presented. The landscape in this method is classified subconsciously. Despite the subjective experiences and assessments of the spatial systems of various observers, it can be assumed that there is a clear group that reacts similarly to the images seen, and the graph of deviations from the average response will be close to the normal distribution curve. The projected impression curve should therefore be read as an illustration of average impressions. No unit of measure can be determined for the impression curve. It is only a means of comparing individual fragments of space and is only a conventional and relative comparison of the impact of subsequent images.

VMS method (Visual Management System)

Bacon's (1979) method was developed to manage forest landscapes. Its purpose is to assess landscape resources through proper land management and assumes that landscape quality is directly related to landscape diversity. VMS classifies forms (e.g. gorges, mountains, foothills and plateaus) and diversity (form, line, colour and texture), as well as determines the level of sensitivity (referring to the relative importance of landscape as visual or recreational resources).

Landscape Character Assessment (LCA)

The LCA method has been developed by the Countryside Commission in Great Britain and Scotland since the late 1980s. As described by Swanwick (2002), it takes into account the arrangement of landscape elements proving its differentness and character. It is a combination of natural features, perception and aesthetics, and culture. It combines features that identify landscape in geographical terms and in individual reception, taking into account such features of perception as: sound, smell, touch, colour, texture, pattern or form. The essence is making assessments at various scales (country, region, local) with reference to the landscape unit.

Direct comparison method

The method developed by Bajerowski et al. (2007), is where the observer assessing the landscape marks points in the diagram, in which he thinks the landscape was less, more or just as valuable, compared to the current observation point. It compares pairs of objects in all possible combinations ('peer-to-peer'). It eliminates the difficulty in determining the value of the landscape on an arbitrarily adopted scale. Mathematical development of observation results enables assessment (Tab. 1).

Methods based on indicators, specifying values for selected / applied assessment criteria

The method of point bonitation

The method of point bonitation by Leszczycki (1937, 1938, as cited in: Jackowski & Liro, 2015) uses a point assessment of selected factors (features) having a major impact on the landscape values of the area. The method is limited to so-called basic assessment fields, which are spatial units to which certain point values obtained during their assessment are assigned. For this reason, it is sometimes criticised for its subjectivity, but on the other hand it is often used in valorisation of the landscape and the natural environment. For the purposes of assessment, three types of main fields can be distinguished: natural (most often they are geocomplexes), administrative (artificial, constituting the boundaries of municipalities or other entities) and geometric (located evenly and randomly, usually having the same size and shape, e.g. squares, hexagons).

Söhngen method

In the Söhngen's (1975) method, valorisation of the landscape is based on the assessment of several elements of the natural environment at the same time. It was used for the first time in Germany to assess the landscape, for the purposes of spatial development of the local area. It uses point assessment of selected elements of the natural environment, which analyses the following landscape elements: vegetation – size, condition, type of vegetation, intensity of the phenomenon, spatial and

Table 1. Landscape value assessment diagram for the method of direct comparisons in observation points

	$Point_1$	$Point_2$	$Point_3$	Sum
$Point_1$	x	↑	↓	2
$Point_2$	↓	x	=	1
$Point_3$	↑	=	x	3

Legend: ↑ 2 pt; = 1 pt; ↓ 0 pt

Source: Based on Bajerowski et al. (2007)

protective properties (e.g. against wind), additional factors, such as: forest edges as well as trees and bushes; surface shape – size, condition, intensity of phenomena and spatial features, e.g. occurrence of ravines, slopes, areas with grassy vegetation, wetlands and marshes; waters – the state, vegetation, intensification of phenomena and spatial features of two factors – standing waters and flowing waters. Each of the tested elements is evaluated on a point scale from 1 to 5. The sum of points of individual parameters makes up the total value of the evaluated element. In the case of vegetation, the maximum number of points is 30, in the case of topography it is 20, and in the case of surface waters the maximum number of points is 25.

Bajerowski's value matrix method

Bajerowski's (1991, as cited in: Antolak, 2017) method is based on the analysis and use of information contained in maps, which are widely available, i.e. topographic maps and land registry maps. The aesthetic value of the landscape is the result of a specific configuration of space features. Many of these features can be identified by in-house studies based on the analysis of the content of cartographic materials. The method focuses on studying phenomena using so-called primary assessment grids. Each basic field is assigned a number specifying the aesthetic value of the landscape, resulting from the distribution of space features occurring in the area covered by the basic field. The next stage is the imposition of grids of basic fields on the map of the examined area, as a result, an isarithmic map illustrating the severity of a given phenomenon is obtained. It is usually assumed that this value is inversely proportional to the degree of landscape devastation.

Architectural and landscape units and interiors method (JARK-WAK)

The method developed by Bogdanowski (1994) assesses architectural and landscape units as well as architectural and landscape interiors. This method envisages operating ranges in three spatial scales: (1) architectural and landscape units (planning scale), (2) architectural and landscape interior complexes (urban scale), (3) architectural and landscape interiors (architectural scale). The following criteria are taken into account when designing architectural and landscape units: landform, land cover, history, and historical changes.

The JARK-WAK method requires going through the following stages: (1) identification of resources related to the area, (2) valorisation of these resources (i.e. assigning them values), (3) drawing up guidelines, and (4) preparation of the plan.

WIT Litwin's method

In the Litwin's (1997) method the WIT indicator has been defined for three basic functions of rural areas: agricultural, non-agricultural and recreational. This index evaluates the value of each of the separated areas and types of activity, taking into account the adopted set of features whose appropriate selection is the basis for calculating the landscape value. Each feature is assigned a weight, which determines its impact on the usability of the area for individual economic functions and a coefficient determining the significance of a given feature in relation to other features and the degree of its significance. The positive or negative impact of a feature on the suitability of the area in question for an activity is the advantage of the feature. The importance of a characteristic for a given activity in the studied area of potential is significant. For the purpose of determining the benefit weights, an expert test is used, in which specialists dealing with spatial development, environmental protection, agriculture and non-agricultural activities fill out a survey covering all the studied traits. They are scored on a point scale, assuming: -2 for a 'very unfavourable trait', -1 for 'an adverse trait', 0 for 'a neutral trait', 1 for 'a favourable trait', 2 for 'a very favourable trait'.

Visual attractiveness of the landscape

The method proposed by Śleszyński (1999) assumes that the visual attractiveness of the landscape consists of the following factors:

form diversity, which is the mean of the sum of shape and length and contrast ratio (shape and size of the geocomplex and differences in coverage), diversity of the mean sum of the horizontal extent of the relief and the extent of the horizontal cover (height vegetation layer) and the richness of vegetation, the impact of human activity understood as a manifestation of adverse impact, a factor that may reduce the assessment (occurrence in the landscape unit of such elements as: power and telephone lines, roads with paved surfaces, the occurrence of waste landfills, etc.). Visual attractiveness is calculated according to the formula:

$$AWK = 0.5 \cdot [0.5 \cdot (R_P + R_K) + 1/3 \cdot (R_{Pr} + R_{Pt} + R_B)] - C$$

where:

AWK – Visual attractiveness of the landscape,
R_P – surface differentiation: L/A, where L – unit circumference, A – unit surface,
R_K – differentiation of the contrast between landscape boundaries,
R_{Pr} – vertical diversification of the relief, expressed in the density of contours,
R_{Pt} – vertical variation of land cover; expressed by the height of the vegetation layer,
R_B – typological richness of vegetation,
C – indicator of the adverse impact of human activity.

The result of determining the visual attractiveness of landscapes is the assignment of individual geocomplexes to 8 classes: terribly unattractive areas, very unattractive areas, unattractive areas, low attractive areas, average attractive areas, attractive areas, very attractive areas, extremely attractive areas.

The method of integrated assessment of values, problems and potentials of landscape systems

Chmielewski's (2001) method consisting of six stages was created for the needs of spatial planning, which includes the assessment of problem and conflict situations. The first stage involves the division into spatial units. In the second stage, the values, problems and potentials are analysed. The third stage is the integration of professional assessments. In the fourth stage, general development and protection objectives are formulated. The fifth stage involves developing recommendations to protect assets, resolve or minimise conflicts, use resources and potentials, and restore assets to degraded areas. In the sixth stage, areas for protection are identified, requiring revalorisation and are predisposed to perform specific functions.

State-Model-Execution STAMEX

This method of system approach to landscape assessment through a comparative analysis of the current state with a balanced pattern was developed by Solon (2004). The determination of the landscape value is preceded by choosing the right set of indicators and determining their target values. The basic element of this assessment system is the development of a sustainable landscape status model, the definition of which is preceded by the selection of an appropriate set of indicators and the determination of their target values. Three groups of conditions influence the structure of the pattern: the applied paradigm of biotic landscape use, the size of the reference area and the categories of landscape status description.

Model of population dynamics

This is a method by Assumma et al. (2016) based on a mathematical model, constructed from differential equations that study population dynamics in the structure of territorial poles. Their interactions generate the attractiveness of a given area which is not only an expression of the economy, social and cultural resources of a given landscape, but also mobility, in terms of the distance of the territorial poles. The population dynamics model examines the mobility of residents in the territorial system according to attractiveness, taking into account different time scales that determine the final or temporary movements.

A Landscape Sustainability Evaluation Model Based on Information Entropy

The method by Liang et al. (2018) adopts symbolic representations and calculation formulas for entropy flow, entropy production and total entropy change. Firstly, the information entropy is calculated using index standardisation and then used to calculate the index weight. Secondly, four types of entropy are calculated using annual information entropy. Finally, the result of durability of the landscape is obtained by means of standardisation of the index and the weight of the indicator.

The method indicates positive indicators, for which both the landscape service ability index and the landscape response capability are considered, while the demand rate for landscape services and the landscape sensitivity index are considered as negative indicators (the greater the demand, the greater the anthropogenic pressure; the greater the sensitivity of the landscape, the greater the damage caused by human activity). The range method is used to standardise the rating index, and the result is between 0 and 1.

Spatially Explicit Landscape Sustainability Method

The constructing of a landscape sustainability indicator system is a current challenge in landscape sustainability research. In this method Liang et al. (2018) combined landscape composition indicators and landscape configuration indicators. This allows us to directly express the spatial and temporal differentiation of landscape sustainability.

For evaluation of the contribution of landscape metrics to the explanation of variability in landscape sustainability, the following steps were undertaken by the authors. At the beginning, two landscape metrics were selected: the landscape patch density, which represents the landscape composition, and the landscape shape index, which represents the landscape configuration. Combining landscape composition indicators and landscape configuration indicators to directly express the spatial and temporal differentiation of landscape sustainability. After that the equations presented below were used to quantify the contribution of each of the two landscape metrics.

$$G_i = \mathrm{LSS}_i \cdot \mathrm{R}^2_{ij}$$

$$\mathrm{R}^2_{ij} = \sum_{j=1}^{6} \alpha \mathrm{ij} \cdot \mathrm{r}_{LSSij}, \mathrm{j}$$

where:

G_i – the sustainability score of the i-th village,
LSS_i – the sustainability score of the community,
α_{ij} – the standardised regression coefficient of the j-th landscape variable,
r_{ij} – the correlation coefficient between the landscape sustainability score,
j-th – landscape variable.

Landscape audit

Landscape audit as an analytical and planning tool introduced into Polish legislation (Regulation..., 2019) should play an important role in landscape protection and development. It is prepared on a voivodeship scale to select priority landscapes. The ordinances of the Council of Ministers regarding the preparation of landscape audits, defined the detailed scope and methodology of landscape auditing, including the classification of landscapes used in the preparation of landscape audits, the method of assessing identified landscapes and the methodology for determining priority landscapes. The purpose of the audit is to identify landscapes occurring throughout the region, determine their characteristics and assess their value. Its scope includes the indication of: threats to the possibility of preserving the value of priority landscapes and the value of landscapes within the indicated areas and objects, recommendations and conclusions regarding the shaping and protection of priority landscapes and landscapes within the indicated areas or objects, and local architectural forms of buildings within the priority landscapes.

Methods based on economic value based on available or modified methods used in other fields

Total Economy Value (TEV)

Generally the Total Economic Value (TEV) approach is suitable for dealing with the economic valuation of environmental and landscape goods (Pearce & Turner, 1990, as cited in: Assumma et al., 2016). TEV is a sum of the use and non-use values of goods. The use value is the result of the direct use (revealed preferences), indirect use (stated preferences, hypothetical markets), while the non-use value is an effect of resources unrelated to a current, future or potential use (existence value and bequest value). Both these components produce the option value, that is the potential for goods to be available in the future (Pearce & Turner, 1990, as cited in: Assumma et al., 2016). In economic definition, landscape is a public good available to the whole of society in a limited quantity, because of unsuitable resources allocation (Santos, 1998, as cited in: Assumma et al., 2016). TEV method tools determine and evaluate the economic value starting from the predictable benefits of use and transformation actions of landscape, as well as the efficiency and efficacy of the public expense for landscape interventions. It is worth emphasising here that for public goods, market prices either do not exist or only capture a small part of the total value.

Ecosystem services

The concept of ecosystem services was born at the end of the 20th century (Costanza et al., 1997; Daily, 1997). Nonetheless, it refers to earlier definitions, terminology and works in which the relationship between ecosystem functioning and the benefits to society were considered as early as the 1970s, describing these relationships as environmental services (Study of Critical..., 1970), public service functions of the global environment or natural services (Mooney & Ehrlich, 1997; National Research Council, 2005). Existing economic valuation methods that are used in total economic value calculations, such as production function approaches and contingent valuation methods, refer to the value of nature to humans, allegedly acting as rational actors (Bockstael et al., 2000; Farber et al., 2002). Costanza et al. (1997) presents a list of 17 types of ecosystem services and assessed their economic value on a scale of the whole globe. Initially, the division of ecosystem services into four main groups (Millennium Ecosystem Assessment, 2005) is applied, namely: provisioning services, regulating services, supporting services and cultural services. Currently, they have been aggregated into three groups: provisioning services, regulating and maintenance services and cultural services (Haines-Young & Potschin, 2018). The use of economic values is effective in that it enables landscape value to be taken into account in social development and local policy by promoting sustainable use of natural resources, landscape restoration and efforts of nature conservation (Admiraal et al., 2013).

Estimation method

The estimation method developed by Schläpfer et al. (2015) uses semi-logarithmic models regarding the functional form for hedonic regressions. The first stage is to estimate a sequence of models using the full dataset to provide an overview of the data and to estimate variance components based on equations. In the second stage OLS (ordinary least squares) regression is used with spatial fixed effects to estimate separate hedonic price functions, for example for different types of communities: e.g. urban centres, suburban, high-income and peri-urban. In these models, the fixed consequences for communities control the effects of community-level environmental variables and socioeconomic variables.

Accounting for unobserved effects of centrality

In this method Schläpfer et al. (2015) used centrality which was controlled by the variables: distance to services (by car) and inner city location which is a dummy for the central neighbourhoods of the largest cities which may not be easily accessible by car. Each of the amenity variables: open space, forest, national landscape and urban parks and disamenity road noise are correlated with the distance to central services. Since distance to services has a strong effect on prices the bias due to omitted effects of centrality is likely to be important as well. The procedure allows us to distinguish between relatively reliable estimates and effects that are likely to be biased upwards or downwards. The method defines explicit criteria for the interpretation of coefficient estimates to account for biases. There is no objectively correct critical level of correlation. The standard interpretation is followed if the absolute value of the correlation coefficient with distance to services and inner city location is smaller than 0.1. This information allows additional insights into how environmental features are independently and jointly distributed in the landscape, and it enables us to understand which coefficient estimates would likely change – and in which direction – if a particular independent variable was dropped from the models.

Landscape Economic Valuation (LEV)

Landscape Economic Valuation (LEV) is a synthetic index of a system of economic indicators. LEV measures the attractiveness of landscapes. The system of indicators, arising from the relevant literature, identifies mainly four macro-indicators, and for each the main economic elements of landscape have been selected, namely 'Agriculture', 'Tourism', 'Real estate' and 'Forestry' (OECD, 2001). In order to carry out standardisation of indicators related to different clusters in a common scale in order to aggregate incomparable items the following formula is used (Assumma et al., 2016):

$$i_i = x_i / x_{max}$$

where:

i_i – the standardised value of the indicator,
x_i – the original value,
x_{max} – the maximum value of the indicator in the data set.

The next step is weighting of the indicators as follows (Assumma et al., 2016):

$$I_j = \sum_{i=1}^{n} i_i \cdot w_i$$

where:

I_j – the partial index of macro-indicators,
i_i – the standardised value of the i-th indicator,
w_i – the weight of the i-th indicator.

The final index of the Landscape Economic Valuation is acquired by aggregation of the partial indicates. The weights for the aggregation have been determined by Saaty (1980, as cited in: Assumma et al., 2016) in the Analytic Hierarchy Process (AHP), where a panel of experts was questioned about the importance of different economic elements of landscape. The formula is as follows (Assumma et al., 2016):

$$LEV = y1 \cdot A + y2 \cdot T + y3 \cdot RE + y4 \cdot F$$

where:

A – the partial index of Agriculture macro-indicators,
T – the partial index of Tourism macro-indicators,
RE – the partial index of Real Estate macro-indicators,
F – the partial index of Forestry macro-indicators,
y1, y2, y3, y4 – the relative weights.

Landscape Performance Assessment

Landscape Performance Assessment was defined by the Landscape Architecture Foundation as "the measure of efficiency and effectiveness with which landscape solutions fulfil their intended purpose and contribute towards sustainability". The Landscape Architecture Foundation in the guidebook by Canfield et al. (2018) defined seven economic benefit categories:

Property Values. The increase in property value is an advantage derived from landscape design. This increase is probably the most reliable indicator of the economic effectiveness of the landscape. It happens that the design of the landscape may be the only change that has occurred in a given area, showing a direct impact on the value of the property. However, changes in the landscape are often associated with other important factors. In such cases, landscape intervention can be described as a factor contributing to the increase in the value of property, and not only as the cause.

Operations and Maintenance Savings. To achieve significant long-term savings throughout the life of the investment, it is necessary to create a resilient and self-sufficient landscape that requires less time, money and resources than is traditionally required. The savings that arise belong to the category of operational and maintenance savings.

Construction Cost Savings. Landscape Performance Assessment classifies one-off savings resulting from the reduction of expenses related to the implementation of a landscape project as a saving of construction costs. The landscape design phase can be planned in such a way as to achieve significant savings. Many such savings treatments also provide environmental benefits.

Job Creation. Landscape development can lead to the creation of permanent jobs. It contributes to the development of the local economy through the indirect creation of jobs in nearby areas that serve visitors, residents or other people who are attracted to the area thanks to the enhancement of the landscape. The implementation of activities in the area where there is a sustainable landscape creates temporary jobs during the construction and implementation of investments. These aspects of economic growth belong to the class of creating permanent and temporary jobs. Job creation is a key indicator of economic growth and is an important tool for researchers quantifying landscape performance.

Visitor Spending. Visitor spending refers to the amount of money spent by visitors to the area due to the landscape. Expenses incurred to shape the landscape may have the ability to attract local, regional, national and international guests. Depending on the nature of the area, admission fees, membership fees or other expenses incurred by visitors may apply. Particularly large and well-known areas, which attract hundreds of thousands or even millions of visitors a year, have a significant impact on visitor spending.

Increased Tax Base/Revenue. Measuring the tax revenue generated for municipalities through landscape improvements usually falls into the category of increased-tax-base or revenue. An increase in tax base reveals as the public-sector equivalent benefit that derives from increased property values. Investment in landscape projects can lead to a broader tax base, which may lead to increased revenue as an area becomes more popular and active.

Economic Development. Landscape design can have a profound influence on the overall economic development of a site. Economic development is a category concerning benefits that assess the impact on spending and occupancy derived from landscape projects. Economic development is usually indicated by measurements of spending, growth, and increased revenue in areas directly affected by landscape development projects.

Case study

A case study was carried out in order to check the applicability of individual methods of landscape valorisation, valuation or assessment. For this purpose, a Local Land Use Plan (LLUP) was selected, approved by resolution no. XXXIV/711/16 The Wrocław City Council of December 22, 2016 on the adoption of the local spatial development plan for the site located in the area of Grabiszyńska and Mosiężna streets in Wrocław (Fig. 1). According to the LLUP, this zone will undergo significant changes. At the time of enactment of the LLUP, this area were occupied by old industrial buildings, warehouses, parking lots and paved areas. In LLUP, the main purposes are multi-family housing (MW), service development (U), as well as service and multi-family housing (U-MW). Currently, part of them it is developed with new multi-family housing, and the construction process continues on subsequent sections of the area (Fig. 2, 3). The LLUP area is relatively large in terms of urban

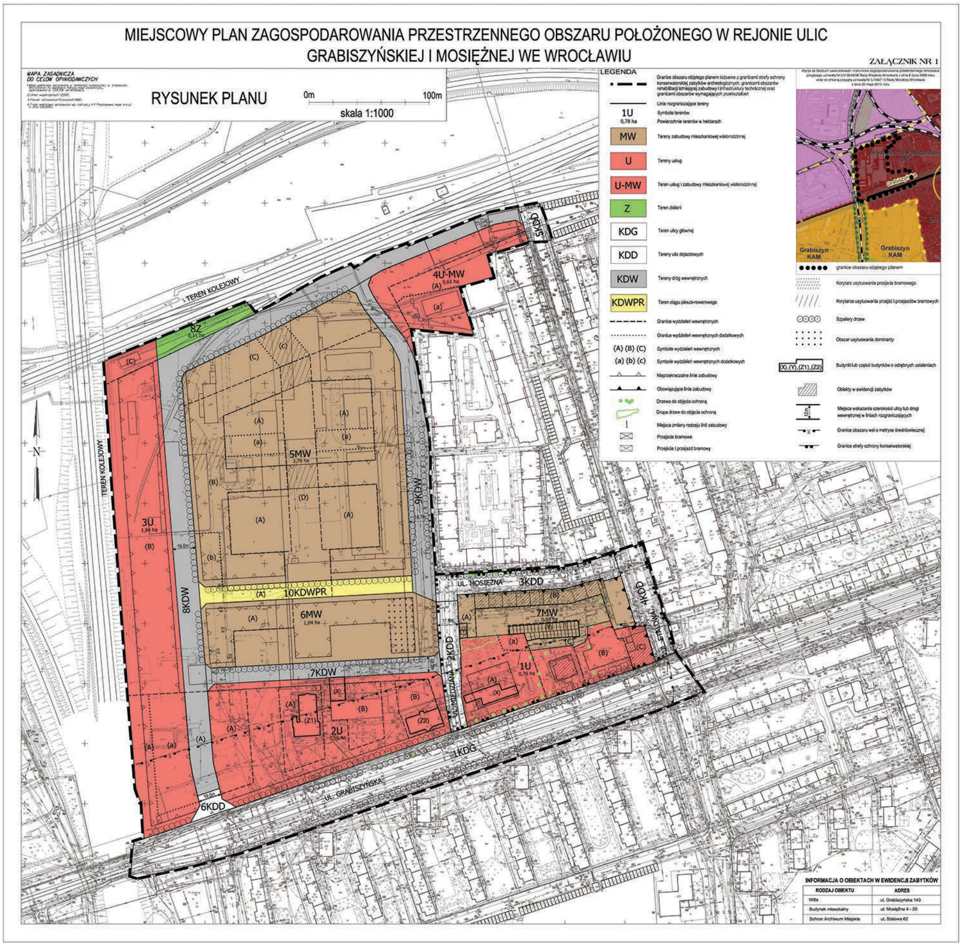


Figure 1. A drawing of the local land use plan approved by The Wrocław City Council Resolution no. XXXIV/711/16 of December 22, 2016 on the adoption of the local land use plan for the area located in the area of Grabiszyńska and Mosiężna streets in Wrocław

the boundaries of the area covered by the plan, the same as the boundaries of the conservation protection zone of archaeological monuments, the boundaries of the rehabilitation areas of the existing buildings and technical infrastructure, and the boundaries of areas requiring transformation

1U 0,78 ha — lines delineating areas
MW — areas of multi-family housing development
U — service development areas
U-MW — areas for service development and multi-family housing development
Z — green area
KDG — main street area
KDD — areas of access streets
KDW — internal roads
KDWPR — pedestrian and bicycle area
boundaries of internal divisions
boundaries of additional internal divisions
(A) (B) (C) — internal divisions symbols
(a) (b) (c) — additional internal divisions symbols
impassable building lines
applicable building lines
trees to be protected
group of trees to be protected
place of changing the type of building line
gate passage (only pedestrian)
gate passage

corridor for the location of the gate passage (only pedestrian)
corridors for the location of the gate passage
rows of trees
area where the dominant is located
(X),(Y),(Z1),(Z2) — buildings or parts of buildings with separate arrangements
object in the register of monuments
places where the width of a street or an internal road is indicated on the demarcation lines
boundaries of the medieval village area
the boundaries of the conservation protection zone

Figure 2. Southern development part of LLUP (own photography)

Figure 3. The southern developed part of the LLUP and the centre part under construction (own photography)

conditions as it covers 15 ha (approx. 330×400 m at its widest point).

The conducted analysis (Tab. 2) shows that most of the methods described can be used for the valorisation and assessment of the landscape. However, this process can be performed for the existing state or partially on the basis of historical data (maps, photos, orthophotomaps etc.) for the baseline state (at the time of the LLUP approved). Unfortunately, this does not mean that these procedures are simple and short-term. On the contrary, very often there are difficulties in obtaining data, the assessments are subjective (e.g. they require the participation of observers), which results in the extension of their execution time. Interestingly the analysis showed that it is impossible to apply economic valuation methods due to the complicated procedures, the required expert knowledge and, above all, the lack of access to reliable data.

Table 2 presents the usefulness of particular methods in the context of spatial planning processes in Poland. The analysis shows that despite the development of technology and the availability of tools, the methods developed in the past (even several dozen years ago) also seem to be useful and, most importantly, much easier to take into account in the spatial planning process. Due to the lack of systemic solutions and the ambiguity of legal regulations, assessments, valorisation and valuations of landscape in the vast majority of cases are not carried out during

Table 2. Case study – possibility of using the method for the analysed LLUP

Method	Possibilities of use in the case study	Advantages of using the method	Obstacles / difficulties in using the method	Evaluated landscape elements		Possibility of using in other planning documents
				natural	cultural (anthropogenic)	
Methods based on visual aspect using images (photographs)						
Cymerman's and Hopfer's photographic method	No	Availability of data for analysis.	It is not possible to designate the assumed polygons (1×1 km). Assessment by several experts is recommended to increase the level of objectivity. The method is time-consuming, requires very high precision and should only be carried out during the growing season.	Yes	Yes	Yes, larger LLUP or Studies of the conditions and directions of spatial development covering entire communes.
SBE method (Scenic Beauty Estimation)	Yes	Accuracy and detail of the assessment, the possibility of distinguishing many different landscape units.	Assessment by diversity group of observers is recommended to increase the level of objectivity. The method is time-consuming and photo-show must be very precision. Photos should only be carried out during the growing season. Primary use only for forest areas.	Yes	Yes	Yes, also smaller and larger LLUP or Studies of the conditions and directions of spatial development covering part or entire communes.
The 'landscape shots' method	Yes	Availability of data for analysis.	Designation of characteristic places (viewpoints, panoramas).	No	Yes	As above
Methods based on visual aspect using user ratings						
Wejchert's impression curve method	Yes	Availability of data for analysis. Indication of places of particular importance to observers as necessary to be preserved.	Assessment by diversity group of observers based on the impressions of a group of observers moving through the space-time sequence. Focusing attention on the emotional aspect of landscape which results is in a high subjectivity of impressions, however, there is a clear group of observers reacting similarly to the images seen.	Yes	Yes	As above

Method	Possibilities of use in the case study	Advantages of using the method	Obstacles / difficulties in using the method	Evaluated landscape elements		Possibility of using in other planning documents
				natural	cultural (anthropogenic)	
VMS method (Visual Management System)	Yes	Availability of data for analysis. Transparent procedure.	Primary use only for forest areas. VMS classifies forms diversity and determines the level of sensitivity of landscape that why has limited possibilities of use in urbanized areas. Should only be carried out during the growing season.	Yes	Yes	As above
Landscape Character Assessment (LCA)	Yes	Transparent procedure. Wide possibilities of use including different types of landscape and scales (LLUP, individual investments).	The necessity to perform many analyses. Limited availability of reliable data (e.g. smell, touch).	Yes	Yes	As above
Direct comparison method	Yes	Availability of data for analysis. Transparent procedure.	Assessment by diversity group of observers is recommended to increase the level of objectivity.	Yes	Yes	As above
Methods based on indicators, specifying values for selected / applied assessment criteria						
The method of point bonitation	Yes	Possibility to choose criteria influencing the visual attractiveness of the landscape.	The method is limited to basic assessment fields to which subjectively certain point values obtained during their assessment are assigned.	Yes	Yes	As above
Söhngen's method	No	Transparent procedure.	Focus only on natural landscape elements.	Yes	No	As above
Bajerowski's value matrix method	Yes	Possibility to perform a series of analyses on the basis of available cartographic materials.	A complicated procedure for determining the aesthetic value of a landscape. The area covered by the case study is relatively little varied, therefore, a mosaic of the configuration of spatial features occurring in the area covered by the base field will not be obtained.	Yes	Yes	As above

Method	Possibilities of use in the case study	Advantages of using the method	Obstacles / difficulties in using the method	Evaluated landscape elements		Possibility of using in other planning documents
				natural	cultural (anthropogenic)	
Architectural and landscape units and interiors method (JARK-WAK)	Yes	Accuracy and detail of the assessment, the possibility of distinguishing many different landscape units.	Complicated procedure. A three-stage research scheme for the identification of landscape resources, their assessment and the formulation of design guidelines – expert knowledge required. Limited to anthropogenic landscapes.	No	Yes	Yes, also smaller and larger LLUP.
WIT Litwin's method	No	Determining the suitability of a given area for a given activity. Wide possibilities of use including different scales.	Limited to three basic functions of rural areas: agricultural, non-agricultural and recreational.	Yes	Yes	Yes, also smaller and larger LLUP or Studies of the conditions and directions of spatial development covering part of communes beside cities.
Visual attractiveness of the landscape	No	Wide possibilities of use including different types of landscape and scales (LLUP, individual investments).	Complicated procedure. Human activity understood as a manifestation of adverse impact. The need to use expert knowledge.	Yes	Yes	Yes, also smaller and larger LLUP or Studies of the conditions and directions of spatial development covering part or entire communes.
The method of integrated assessment of values, problems and potentials of landscape systems	Yes	Assessment of the values of natural and anthropogenic landscape elements on a scale: degraded, insignificant, moderate, high, very high, unique.	Complicated procedure, the need to perform many analyses, including the evaluation and revision of existing documents.	Yes	Yes	As above
State-Model-Execution STAMEX	Yes	Accuracy and detail of the assessment, the possibility of distinguishing many different landscape units.	Complicated procedure. The target state might not be compatible with the LLUP – expert knowledge required.	Yes	Yes	As above

Method	Possibilities of use in the case study	Advantages of using the method	Obstacles / difficulties in using the method	Evaluated landscape elements		Possibility of using in other planning documents
				natural	cultural (anthropogenic)	
Model of population dynamics	No	Wide possibilities of use including different types of landscape and scales (LLUP, individual investments).	Complicated procedure, no access to reliable data needed to apply the method. The need to use expert knowledge.	Yes	Yes	As above
A Landscape Sustainability Evaluation Model Based on Information Entropy	No	As above	As above	Yes	Yes	As above
Spatially Explicit Landscape Sustainability Method	No	As above	As above	Yes	Yes	As above
Landscape audit	No	Systematized and standardized methodology for determining landscape units and priority landscapes.	The methodology developed for the regional (voivodeship) scale is very precise, requiring many analyses and the participation of experts.	Yes	Yes	After the development of the landscape audit on a regional scale, its provisions should be included in municipal documents, ie LLUP or Studies on the conditions and directions of spatial development.
Methods based on economic value based on available or modified methods used in other fields						
Total Economy Value (TEV)	No	Wide possibilities of use including different types of landscape and scales (LLUP, individual investments).	Complicated procedure, no access to reliable data needed to apply the method. The need to use expert knowledge.	Yes	Yes	Yes, also smaller and larger LLUP or Studies of the conditions and directions of spatial development covering part or entire communes.
Ecosystem services	No	As above	As above	Yes	Yes	As above
Estimation method	No	As above	As above	No	Yes	As above
Accounting for unobserved effects of centrality	Yes	As above	As above	Yes	Yes	As above

Method	Possibilities of use in the case study	Advantages of using the method	Obstacles / difficulties in using the method	Evaluated landscape elements		Possibility of using in other planning documents
				natural	cultural (anthropogenic)	
Landscape Economic Valuation (LEV)	No	Thanks to the use of indicators, indexes and weights, the method is precise.	As above	Yes	Yes	As above
Landscape Performance Assessment	No	Wide possibilities of use including different types of landscape and scales (LLUP, individual investments).	As above	Yes	Yes	Yes, also smaller LLUP.

the preparation of documents related to spatial development. Therefore, it is necessary to strive for further development of methods that could be easily applied to the existing formal and legal conditions.

Discussion and Conclusions

Valorisation, valuation and landscape assessment methods have been used around the world for almost 100 years. The variety of assessment methods results from the available techniques and the goal that the researcher wanted to achieve. The need for landscape assessment and valorisation results directly from the development of individual areas. Since this development is a dynamic process, the assessment methods have had to change over time. Changes in the landscape occur constantly, they are caused by numerous variable factors and they constantly affect the development or regression of the area, which are sometimes perceived by users in a different way. Therefore, the idea of sustainable development promoted for years, taking into account the development of space, both environmental and economic and social factors in the landscape, seems to be fully justified. To this end, land is often sought to be utilised to the maximum extent using natural predispositions for specific forms of use. However, in order to know these predispositions, it is required to conduct analyses that will indicate those elements of the landscape that should be preserved, those that need to be upgraded or those that require revitalisation or re-naturalisation. All this is additionally superimposed by local conditions, which may require assessment or valorisation due to the different origins of the landscape or pressure affecting it. The methods presented above show a range of possible solutions and applications. Therefore, we can assess the landscape through the prism of the qualitative and quantitative aspects mentioned earlier, on the basis of which the methods were grouped.

Table 3 and Figure 4 summarises the presented methods and subjectively addresses the possibility of their use in practice, indicating their basic advantages and disadvantages. Points were awarded in two categories: Acquisition of input data and ease of practical application on a scale from 1 to 3, where 1 is easy and 3 is difficult. The assessment took into account the availability and scope of the input data. In the case of practical application, time-consuming required knowledge, and the degree of the complicated

Table 3. Summary of the analysed methods in terms of practical utility, including their basic advantages and disadvantages

Method	Acquisition of input data	Ease of practical application	Scoring the method	Disadvantages	Advantages
Methods based on visual aspect using images (photographs)					
Cymerman's and Hopfer's photographic method	1	2	3	time-consuming recommended implementation during the growing season	large area under assessment
SBE method (Scenic Beauty Estimation)	3	3	6	time-consuming recommended implementation during the growing season involving a large group of observers primary use only for forest areas	as above
The 'landscape shots' method	2	2	4	focusing attention on the aspect of picturesqueness small area under assessment	wide possibilities of use (different types of landscape)
Methods based on visual aspect using user ratings					
Wejchert's impression curve method	1	3	4	focusing attention on the emotional aspect of landscape small area under assessment	ease of use in highly urbanised areas
VMS method (Visual Management System)	2	3	5	recommended implementation during the growing season primary use only for forest areas limited possibilities of use in urbanized areas	large area under assessment
Landscape Character Assessment (LCA)	3	2	5	time-consuming	wide possibilities of use (different types of landscape and scales)
Direct comparison method	1	2	3	subjectivism of assessment	large area under assessment wide possibilities of use (different types of landscape and scales)
Methods based on indicators, specifying values for selected / applied assessment criteria					
The method of point bonitation	1	2	3	subjectivism of assessment	large area under assessment wide possibilities of use (different types of landscape and scales)
Söhngen's method	1	3	4	focus only on natural landscape elements	large area under assessment

Method	Acquisition of input data	Ease of practical application	Scoring the method	Disadvantages	Advantages
Bajerowski's value matrix method	2	3	5	complicated procedure	as above
Architectural and landscape units and interiors method (JARK-WAK)	3	3	6	small area under assessment complicated procedure expert knowledge required	wide possibilities of use (different types of landscape)
WIT Litwin's method	2	3	5	limited possibilities of use (only rural areas: agricultural, non-agricultural and recreational)	large area under assessment determining the suitability of a given area for a given activity
Visual attractiveness of the landscape	3	2	5	expert knowledge required human activity understood only negatively	large area under assessment wide possibilities of use (different types of landscape and scales)
The method of integrated assessment of values, problems and potentials of landscape systems	3	2	5	time-consuming	wide possibilities of use (different types of landscape and scales)
State-Model-Execution STAMEX	3	2	5	time consuming expert knowledge required	large area under assessment wide possibilities of use (different types of landscape and scales) determining the suitability of a given area for a given activity
Model of population dynamics	3	3	6	expert knowledge required difficulty in obtaining data complicated procedure	large area under assessment wide possibilities of use (different types of landscape and scales)
A Landscape Sustainability Evaluation Model Based on Information Entropy	3	3	6	as above	as above
Spatially Explicit Landscape Sustainability Method	3	3	6	as above	as above

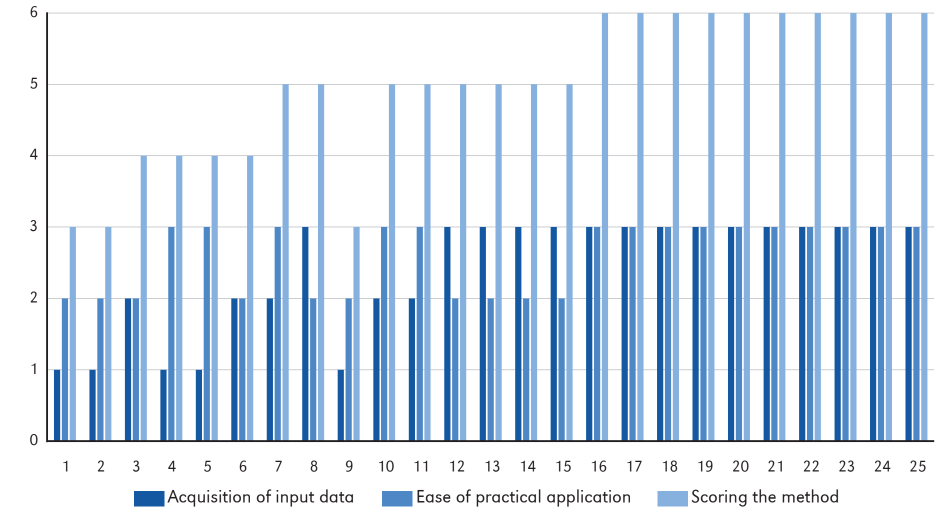
Method	Acquisition of input data	Ease of practical application	Scoring the method	Disadvantages	Advantages
Landscape audit	3	2	5	time consuming expert knowledge required limiting the scale of the study to the province suggested frequency of performance (every 20 years)	large area under assessment the possibility of transferring the results to a local scale
Methods based on economic value based on available or modified methods used in other fields					
Total Economy Value (TEV)	3	3	6	expert knowledge required difficulty in obtaining data complicated procedure	large area under assessment wide possibilities of use (different types of landscape and scales)
Ecosystem services	3	3	6	time consuming expert knowledge required difficulty in obtaining data	as above
Estimation method	3	3	6	expert knowledge required difficulty in obtaining data complicated procedure	as above
Accounting for unobserved effects of centrality	3	3	6	as above	as above
Landscape Economic Valuation (LEV)	3	3	6	as above	as above
Landscape Performance Assessment	2	2	4	difficulty in obtaining data small area under assessment	wide possibilities of use (different types of landscape and scales)

Legend

Acquisition of input data
1 Easy
2 Moderate
3 Hard

Ease of practical application
1 Easy
2 Moderate
3 Hard

Scoring the method
2 Very easy to use in practice
3 Easy to use in practice
4 Average use in practice
5 Hard to use in practice
6 Very hard to use in practice



1	Cymerman's and Hopfer's photographic method	6	Landscape Performance Assessment	11	WIT Litwin's method	16	SBE method (Scenic Beauty Estimation)	21	Total Economy Value (TEV)
2	The method of point bonitation	7	VMS method (Visual Management System)	12	Visual attractiveness of the landscape	17	Architectural and landscape units and interiors method (JARK - WAK)	22	Ecosystem services
3	The "landscape shots" method	8	Landscape Character Assessment (LCA)	13	The method of integrated assessment of values, problems and potentials of landscape systems	18	Model of population dynamics	23	Estimation method
4	Wejchert's impression curve method	9	Direct comparison method	14	State-Model-Execution STAMEX	19	A Landscape Sustainability Evaluation Model Based on Information Entropy	24	Accounting for unobserved effects of centrality
5	Söhngen's method	10	Bajerowski's value matrix method	15	Landscape audit	20	Spatially Explicit Landscape Sustainability Method	25	Landscape Economic Valuation (LEV)

Figure 4. Summary of the analysed methods in terms of practical utility – ranking

procedure were taken into account. The sum of the points from these two categories indicated the possibility of using the methods in practice. The higher the rating, the more difficult the method is to use. This summary convinced the author that there was no defect-free method. Most of the methods described are very difficult or difficult to use in practice. It is also worth noting that the vast majority of the described economic methods are very difficult, but in each of the described groups very difficult procedures for practice use have been identified. Additionally, some of the methods are so complex (e.g. the procedure itself, preliminary analysis, access to data) that they cannot be easily implemented into decision-making processes, such as spatial planning or the investment decisions process (incl. environmental decisions which usually require quick action in a short time, so there is no space to conduct in-depth valorisation analyses).

Unfortunately, in Poland, in decision-making processes, the valorisation of the landscape is largely neglected in practice. However, following the development of Landscape Audits, awareness and application possibilities should also become more common on the local ground.

It seems, however, that there is still space or even the need to refine methods or develop new ones that can be commonly used, in particular regarding economic valuation in the face of the growing pressure on landscape by investors.

The question may be asked whether landscape valorisation or the economic aspects of valuation is significant. This question has no clear answer. The methods cited in the article were usually used for valorisation or economic valuation of sensitive landscapes, i.e. those that are part of ecosystems of natural or cultural significance of the analysed space. Therefore, conducting such assessments seems necessary, in particular in the case of undertaking investments in a given area that may lead to a significant transformation of the landscape, and the analysis carried out may indicate the need to preserve it or adapt the investment process to existing landscape elements.

A very important problem in economic valuation of landscape is the often interchangeable use of the terms 'nature', 'biodiversity' and 'landscape', especially in economic textbooks. In that context for instance, an increase in the loss of biodiversity automatically means a degradation of landscapes. Given the quoted definitions of landscape in this paper, this does not necessary need to be in every case. A landscape should reflect mutual preferences, and landscape policy measures (like spatial planning, investment decisions process) should ensure a trade-off between individual elements of the ecosystems that make up the landscape. The methods of economic valuation of landscape used so far are mainly based on individual valuation of components, such as cultural-historic heritage, certain species, or ecosystem services. This seems to be insufficient, and therefore the need to develop these types of methods is necessary, in particular those whose practical use will be available.

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