

Application of New Methods of Environment Analysis and Assessment in Landscape Audits – Case Studies of Urban Areas Like Częstochowa, Poland

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Abstract. Following the 2000 European Landscape Convention, a new act strengthening landscape protection instruments has been in force since 2015. It sets forth legal aspects of landscape shaping (Dziennik Ustaw 2015, poz. 774) and introduces landscape audits at the province level. A landscape audit consists in identification and characterization of selected landscapes, assessment of their value, selection of so-called priority landscapes and identification of threats for preservation of their value. An audit complies with GIS standards. Analyses use source materials, i.e. digital maps of physical-geographical mesoregions, current topographic maps of digital resources of cartographic databases, latest orthophotomaps and DTMs, maps of potential vegetation, geobotanic regionalization, historic-cultural regionalization and natural landscape types, documentation of historical and cultural values and related complementary resources. A special new methodology (Solon *et al.* 2014), developed for auditing, was tested in 2015 in an urban area (Myga-Piątek *et al.* 2015). Landscapes are characterized by determining their analytic (natural and cultural) and synthetic features, with particular focus on the stage of delimitation and identification of landscape units in urban areas. Częstochowa was selected as a case study due to its large natural (karst landscapes of the Częstochowa Upland, numerous forests, nature reserves) and cultural (Saint Mary's Sanctuary, unique urban architecture) potential. Częstochowa is also a city of former iron ore and mineral resources exploitation, still active industry, dynamic urban sprawl within former farming areas, and dynamically growing tourism. Landscape delimitation and identification distinguished 75 landscape units basing on uniform landscape background (uniform cover and use of the land). Landscape assessment used a new assessment method for anthropogenic transformation of landscape – the indicator describing the correlation between the mean shape index (MSI) and the Shannon diversity index (SHDI) (Pukowiec-Kurda, Sobala 2016). Particular threats and planning suggestions, useful in development of urban areas, were presented for selected priority landscapes.

Keywords: urban planning, landscape management, landscape audit, landscape monitoring.

Conference topic: Sustainable urban development.

Introduction

The effectiveness of landscape policy is emphasised in the current studies and European-level planning documents. Landscape values constitute the common good, and their protection is a public task. Management of the landscape is a very important task of each country. The problem is the creation of an effective mechanism of encouraging public authorities to adopt this policy at the local, regional and national level. The basic difficulty in developing uniform principles of action is caused by the fact that landscape management falls within the scope of interest and competence of many stakeholders, including government, regional and municipal institutions, nature and monument conservation services, national forests, and the scientific community of various disciplines (Degórski 2015; Degórski *et al.* 2014; Myga-Piątek 2010, 2012, 2014; Myga-Piątek, Nita 2015). As far as Poland is concerned, additional difficulty in landscape management results from the existing, relatively hermetic treatment of natural and cultural aspects of the landscape in the legislation (separate laws and forms of legal protection – both with regard to areas, and facilities), and also in science and education, and even in social perception. In addition, the landscape is a multilayered meaning concept, analysed in metrial, aesthetic-physiognomical and symbolic-semantic aspect. It is also an interdisciplinary concept (from the area of geography, landscape ecology, landscape architecture, art, sociology, etc.), which further hinders practical decision-making about the processes of its planning, shaping, management and protection. By introducing the definition of the landscape, the European Landscape Convention seems to put an end to the heated academic discussion over its wording and scope that has lasted for many years. According to the Convention (Art. 1a), “*Landscape*” means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. It also defines the landscape policy as follows: “*Landscape policy*” means an expression by the competent public authorities of general principles, strategies and guidelines that permit the taking of specific measures aimed at the protection, management and planning of

landscapes. The need for adopting a coherent landscape policy is clearly emphasised in the current applicable studies and planning documents. One of them is the National Spatial Management Concept (Konceptcja Przestrzennego Zagospodarowania Kraju, KPZK) 2030. At least two out of the six strategic objectives of KPZK 2030 directly relate to landscape policy (Myga-Piątek, Nita 2015).

The definition scope of the landscape was transferred to the Polish legislation by way of the Act reinforcing the tools for landscape protection (Act of 24 April 2015 amending certain laws in connection with the reinforcement of the tools for landscape protection (Dziennik Ustaw 2015 poz. 774) the so-called “Landscape Act”). It defines the landscape as *an area, as perceived by people, containing natural elements or products of civilization, shaped as a result of the action of natural factors or human activity*. The Act provides for at least 3 relevant activities: obligatory introduction of a landscape audit in the area of the province, introduction of landscape planning principles and designation of priority landscapes.

The most important action for identification of the state of Poland’s landscape is the landscape audit. The landscape audit consists of the following stages:

- typological identification of landscapes;
- description of the identified landscapes;
- assessment of the value of landscapes (valorisation);
- naming of priority landscapes (i.e. those that are particularly valuable and that require protection);
- identification of risks to the ability to preserve the value of priority landscapes;
- making recommendations and proposals concerning the development and conservation of priority landscapes and landscapes within the existing areas or protected facilities;
- determining local architectural forms of development for priority landscapes.

In Poland, a heated scientific debate is currently held over the ways of conducting the individual stages, and in particular over the methods of objective valorisation of the landscape that will allow the designation of priority landscapes. Valorisation of the landscape should be understood as the process of assessing the value of a given area and comparing the values of individual parts of the area. Valorisation can be performed according to the following criteria a) universal values; b) ability of the land to perform certain functions; c) suitability of the land (Chmielewski 2013). The aim of this paper is to test the new typology of Poland’s current landscapes (Chmielewski *et al.* 2015) in an urban area. The second aim of the research was to examine the methods of analysis and assessment of the environment that were proposed in the Audit Instructions (Solon *et al.* 2014) and to apply the author’s additional methodological modifications to the valorisation of the urban landscape (Pukowiec-Kurda, Sobala 2016). The issue has been presented against the background of the experience of other countries. The study also shows the effect of the proposed microregionalization of Częstochowa. Further research on this allows us to compare the results with the experience of other countries, also with regard to microregionalization (e.g. Veteikis, Jankauskaite 2009).

Prolandscape experience in selected European countries

Landscape studies in European countries are becoming increasingly popular (e.g. Berte *et al.* 2013; Plieninger *et al.* 2016). Their importance is also recognized in the context of the dynamic transformation in landscape use (e.g. Bičík, Jeleček 2009; Plit, Myga-Piątek 2014, 2016). The results of these studies translate into practical effects in landscape policy. However, no EU country has a perfect planning system which, if it became widespread, would guarantee success and was a solution capable of being applied in all regions and countries of the European Union. However, there are at least several valuable solutions with regard to landscape policy and prolandscape activities that can be an inspiration in other countries.

The issues of protecting, managing and planning the landscape has existed in Europe since the turn of the 20th century. The initiatives are led by France and Germany, where landscape research has a long tradition (Hettner 1927; Vidal de la Blache 1922). A high prolandscape awareness in those countries gave rise to the first legal acts that enabled rational management of space. Also today, Germany and France are considered to be countries with high culture of space as they use exemplary prolandscape instruments (cited in publications by Raszeja 2013; Wojciechowski 2008; Böhm 2008; Wiśniewska 1997).

The German prolandscape legislation is based on two levels of management. The most important law is the federal *Act of 1976 on the protection of nature and development of the landscape* (Raszeja 2013). Decentralized landscape policy in Germany enables verification of initiatives against the provisions of *the act on the conservation of wildlife, care of the landscape and ensuring recreation in the bosom of nature at the level of Lands* (Böhm 2008). This allowed the development of an effective model of spatial planning, based on the hierarchy of management levels in Germany (principles of large-space development, Land planning, local planning) (Kwartnik-Pruc, Przewiężlikowska 2007). A not binding plan of spatial policy principles was drawn up for the whole country (federal level). At the level of Lands, Plans of Land development and Regional Plans are drawn up, and at the level of municipalities – Plans of land use (scales of topographic maps) and Development plans (scales of Master Map) (Izdebski *et al.* 2007).

France has the Act of 1993 on the protection and development of the landscape, but the most important prolandscape document is the Urban Development Code, which is a set of rules governing the actions for the protection, management and planning of the landscape (Wojciechowski 2008). The urban development law governs matters related to the planning issues at the regional level through preparing Territorial cohesion plans (SCOT) and at the local level through Local urban plans (PLU) (Tokarczyk-Dorociak, Jankowska 2014). An effective instrument is the use of graphical attachments (*volet paysager*) of the investment placed in the landscape, containing he photomontage confirming its fitting in the environment (Wiśniewska 1997).

Effective prolandscape tools are also used in Spain. The legal regulations concerning the landscape relate to the specificity and spatial characteristics of regions. Applicable landscape laws were established in the region of Valencia and Catalonia (among others) where Landscape Observatory was founded, and the main prolandscape tools are directories of landscapes and landscape guidelines (Nogue, Sala 2006). The landscape protection law also functions in the regions of Galicia, Castile and La Mancha, placing more and more emphasis on the aesthetic values of the landscape (Casado-Arzuaga *et al.* 2014).

The experience of European countries, in which legislation on the landscape quality is well developed, is increasingly more frequently concerned with the problem of the visual and aesthetic quality of the landscape. Research on the visual (aesthetic) value of the landscape was conducted as early as in 1976 by Daniel and Boster who proposed a model of aesthetic assessment of the landscape. At present, theoretical deliberations about the aesthetic value of the landscape are held by Ode, Hagerhall and Sang (2010) among others. The relationship between the visual value of the landscape and its structure was investigated in Norway by Dramstad and others (2006), and a similar study was conducted in Saxony, Germany, by Frank with her team (2013). In addition, for the whole of Germany research into the quality of the space is done, including the aesthetics of the landscape (Nohl 2001).

In Poland, since 2015, there has been a law which deals with determining the priority landscapes. Selecting these landscapes requires the use of cartographic analysis methods, including GIS techniques and tools.

Area of study

For the purposes of the landscape audit, a detailed landscape assessment methodology was developed (Solon *et al.* 2014). This methodology has been tested and refined in the city area of Częstochowa (Częstochowa Upland, Poland), for example. As a result of the test analyses, it was possible to verify the proposed procedure, and to refine and modify certain methods, especially in relation to the environmental assessment parameters (Pukowiec-Kurda, Sobala 2016). The city selected for the analysis covers an area of 160 km² and is the largest urban centre in terms of population (over 235,000 inhabitants) in the northern part of the Silesian Voivodeship. Physicogeographically, Częstochowa is situated within three mesoregions: Częstochowa Upland in the eastern part of the city, Upper Warta Depression, in the southern part of the city and Wieluń Upland in the northern part of the city (regional divisions according to the Poland-applicable regionalization by Kondracki 2011). During the testing of the audit methodology, initial division was made of the studied land into microregions. Considering the lower level of the physicogeographical division, Częstochowa is situated within the four entities: Pagóry Częstochowskie, Wyniesienie Bleszna, Dolina Górnej Warty and Dolina Przełomu Mirowskiego (Nita *et al.* 2016) (Fig. 1).

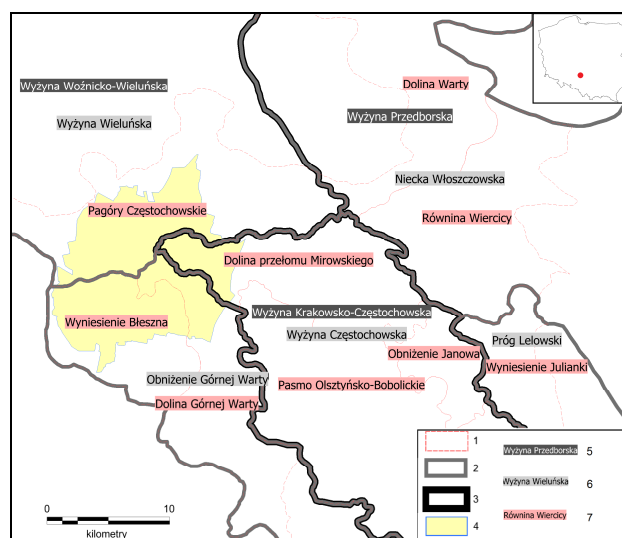


Fig. 1. The location of the research area against the administrative division of Poland. Legend: 1 – boundaries of microregions, 2 – boundaries of mesoregions, 3 – boundaries of macroregions, 4 – municipality Częstochowa, 5 – name of makroregion (in Polish), name of mesoregion (in Polish), name of microregion (in Polish) (Source: own elaboration)

Methodology of landscape identification and data sources

The primary research stage, on which depends the result of the landscape assessment procedure called the audit, is the distinguishing of local landscapes as individual spatial units. During the testing, landscape units were selected according to the criterion of the landscape background uniformity, as determined on the basis of land cover forms (Fig. 2).

Landscape background is considered to be a structural element (or set of elements), which is the most often distinguished in terms of land cover and which dominates the surface within the landscape. Landscapes with uniform background are distinguished by connecting all the outermost border points of the landscape (the unit being distinguished). The landscape background may include forests, combined arable land, meadows and pastures, built-up areas and/or technical infrastructure, natural and semi-natural vegetation of humid and wet habitats or other type (types) of land cover (Solon *et al.* 2014). Units distinguished in this way should meet the conditions of landscape background homogeneity while preserving spatial heterogeneity that is maintaining functional relationships between the landscape elements and the repeatability of the spatial structure and physiognomy in different parts of the landscape.

In accordance with the recommendations in the above-mentioned proposal of methodology for preparing landscape audits, the basic materials for delimitation and identification of the landscapes include:

- digital map of physico-geographic mesoregions (and microregions in the future);
- up-to-date topographic map or equivalent digital materials of cartographic databases (eg BDOT, TBD, etc.);
- the latest available Orthophotomap and NMT;
- map of potential vegetation and geobotanical regionalization;
- map of historical and cultural regionalization;
- map of natural landscape types;
- documentation and boundaries of the protected areas;
- documentation of historical and cultural values;
- thematic supplemental materials.

The second stage of landscape identification is their typology, which is performed on the basis of the table of Poland's current landscapes (Chmielewski *et al.* 2015). Landscape units are coded with eight-digit numbers, of which the first six digits mean the physico-geographical position (including microregions), and the last two – the order of the landscape within it. The classification of landscapes is based on two main groups of criteria: the scale of the anthropogenic transformation of the landscape, subdivided into three groups, and the dominance of cover forms. Group A – Natural landscapes, for cultural use, functioning mainly as a result of natural processes, modified only in varying degrees by human activity; Group B – Natural-cultural landscapes, formed as a result of joint action of natural processes and conscious human modifications of the land cover and the spatial structure; Group C – Cultural landscapes, in which the structure and function are fully shaped by human activity. The second typological level is based on the criterion of structure and intensity of land development, which provides the possibility of distinguishing 15 types of landscape. The proposed typology also allows distinguishing the third, lowest level of classification which enables identification of 49 subtypes of landscapes differing from one another by spatial structure (Chmielewski *et al.* 2015).

Next, landscapes are subject to description with regard to the occurrence of natural and cultural characteristics as well as landscape synthetic characteristics which include sustainability, tradition, identity, familiarity, representativeness, uniqueness, physiognomical type, genetic type, basic and supplemental functions of the landscape. The natural and cultural characteristics determined at this research stage are provided in Table 1.

Table 1. List of categories of areas and facilities evaluated in the landscape audit process (Source: Solon *et al.* 2014)

Groups of characteristics	Categories of areas and facilities
Formal description	Areas and facilities under legal protection
	The structure of land cover
Natural facilities	Outstanding geological, lithological and geomorphological facilities
	Outstanding hydrological facilities
	Valuable forest clusters and areas of woodland
	Areas with the function of ecological corridors
	Other valuable facilities and areas of vegetation
Spatial structure	Surface diversity
	Surface fragmentation
	Integrity of the landscape background

Groups of characteristics	Categories of areas and facilities
Anthropogenic facilities and systems	Archaeological facilities
	Rural complex systems and facilities of rural and suburban development
	Facilities of the former borders and relict forms of ownership
	Facilities of fortified, defence and military architecture
	Mining and metallurgy facilities
	Craft and industry facilities
	Religious complexes and objects of worship
	Places of martyrdom and memory
	Facilities of bourgeois and residential architecture
	Facilities of transport infrastructure
	Facilities of spa, tourist, sporting, observation and navigation architecture

The last stage of landscape identification is the assessment of the degree of hazard according to a 12-degree scale, as proposed by Chmielewski (2012). The final result of the landscape audit is the selection of priority landscapes representing the highest natural, cultural and synthetic values, which may be at risk as a result of anthropogenic changes. The areas of priority landscapes should be protected, ensuring the preservation of high natural, cultural and aesthetic values. In addition, an analysis of look-out panoramas was performed for selected viewpoints, including dominants, subdominants and landscape accents, which is expressed in placing emphasis on the importance of the assessment of the landscape visual values.

Results

In the city of Częstochowa, 27 landscape units were distinguished, varying in shape and surface. The largest urban unit covers 34.41 km², and the smallest – 0.26 km². Shapes and sizes of local landscapes are related to their function; for example, the elongated shape of the traffic landscape in the city centre or of the wetland and grassland landscape in the valley of Warta, or the small area of the mining landscape with quarries, clay pits and slag heaps in Gnaszyn. In the area of Częstochowa, within individual microregions, from 4 to 10 landscape units were distinguished, depending on the size of the microregion and land cover.

Within Częstochowa, 9 out of possible 15 types of landscape were distinguished in all three groups of landscapes: natural (group A), natural and cultural (group B) and cultural (group C). The following types of landscape were distinguished: wetland and grassland, forest, rural (agricultural), mosaic, suburban and residential, metropolitan, industrial, mining and traffic landscape. The largest area is occupied by mosaic units (53.26 km²), which are also the most common units (7 units). The smallest area (0.58 km²) is occupied by 2 communication units. The distinguished landscapes and their types are presented on the map (Fig. 2).

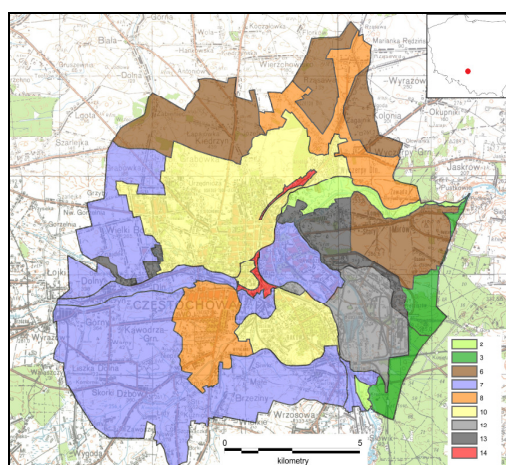


Fig. 2. The results of the identification of landscape units in Częstochowa. Legend: numbers of landscape types according to typology (Chmielewski et al. 2015): 2 – marshy-meadow landscape, 3 – forest landscape, 6 – rural landscape, 7 – mosaic landscape, 8 – suburban and residence landscape, 10 – urban landscape, 12 – industrial landscape, 13 – mining landscape, 14 – communication landscape (Source: own elaboration based on the Topographic Map M-34-39 A and C, scale 1:50 000)

Discussion – proposal to assess the degree of anthropogenic transformation of the landscape

In relation to Poland's current landscape typology that distinguishes 3 groups of landscapes, a new method for assessing the degree of anthropogenic transformation of the landscape was developed. It provides the ability to monitor the state of the landscape based on the assessment of the relationship between the basic landscape metrics (Pukowiec-Kurda, Sobala 2016). The proposed index of anthropogenic transformation of the landscape (ALTI – anthropogenic landscape transformation index), based on the relationship between the mean shape index (MSI) and Shannon's diversity index (SHDI), indicates anthropogenic changes to the landscape. The index assumes high values in the areas of natural landscapes, and within anthropogenically altered landscapes (for example in cities), it assumes the lowest values. The possibility of using landscape metrics to determine how the landscape functions was analysed by McAlpine and Eyre (2002), Bender *et al.* (2005) as well as Lausch and Herzog (2002) among others. The relationship between the landscape metrics is expressed by the formula: $ALTI = MSI / (SHDI+1)$.

By using a new method of assessing the degree of anthropogenic transformation of the landscape, on the basis of the ALTI index, its values were calculated for the distinguished landscape units in Częstochowa. The results are shown on the map (Fig. 3).

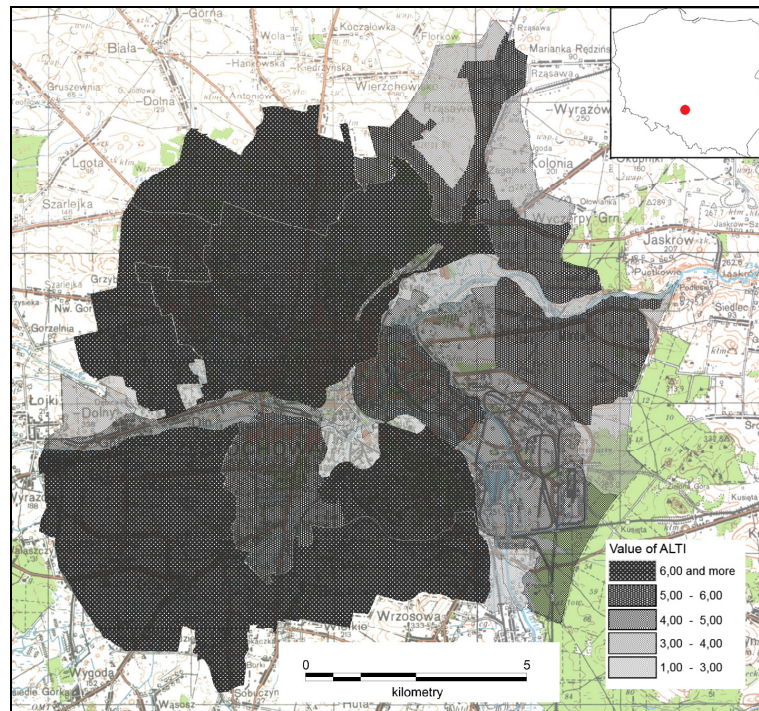


Fig. 3. Values of the ALTI index for the city of Częstochowa (Source: own elaboration based on the Topographic Map M-34-39 A and C, scale 1:50 000)

Due to the fact that the procedure for delimitation of landscape units is burdened with subjectivity, at this stage there are usually difficulties with unambiguous delimitation of the borders of these units. The difficulties are further exacerbated by distinguishing units in the areas that are heavily anthropogenized (for example in cities), due to the structural similarity of the land cover elements. In Częstochowa, the presented problem concerns suburban areas, where the landscape background is a mosaic, chaotic layout of the forms of land use: wasteland, groves, post-exploitation slag heaps; and of the distributed development: residential, commercial, storage and industrial, none of which is the dominant element. In addition, in the areas subjected to heavy anthropogenic transformations, the structure of land use (reflected by land cover elements) does not refer to the outline of the physico-geographical units which are superior in the procedure of distinguishing landscape units. This results in the occurrence of the same type of landscape in two adjacent units, but situated within other micro- or mesoregions. This increases the number of distinguished landscape units (Myga-Piątek *et al.* 2016).

Another difficulty in the identification of landscapes within cities (transformed areas) can be the existence of landscape enclaves, ie island-like location of some units within other, larger ones. In addition, according to the guidelines, for the delimitation of units, a complicated shape of the units being delimited should be avoided. However, in the transformed areas, island-like units are not uncommon, just like complicated shapes of, for example, traffic units (elongated, with a digitate shape). In Częstochowa, an enclave unit was distinguished – the traffic landscape within the metropolitan landscape. The reason for such delimitation was the surface domination of the communication layout (Myga-Piątek *et al.* 2016). In addition, on the basis of the landscape background uniformity

principle, units with complicated shapes were distinguished, referring to the urban space layouts (eg industrial, communication or metropolitan). The solution to this problem may be the use of the ALTI index which can indicate potential landscapes, structure of which has been subjected to the biggest anthropogenic changes. The values of the index will indicate the areas in which there will be a possibility of exceptional situations (distinguishing enclave units and units with complicated shapes). This will also confirm the correctness of the procedure for landscape unit delimitation.

Summary and conclusions

Testing the typology (identification of landscapes) and methods of assessment (valorisation) in the area of Częstochowa allows the following conclusions:

1. Identification of landscapes used in the landscape audit is the first prolandscape tool in Poland which enables the assessment of the landscape state throughout the country.
2. The conducted test of applying methods of identification and assessment in the area of Częstochowa allowed positive verification of the proposed new typology of Poland's current landscapes (by Chmielewski *et al.* 2015), which enables full classification of all types of landscapes occurring throughout the nation. The test studies have shown that its advantage is the independence from the administrative units (it means that, for example, rural landscapes can occur within municipalities).
3. The proposed new method of assessing the degree of anthropogenic transformation of the landscape using the ALTI index can be helpful in determining types of landscape as well as monitoring the current state of the landscape.
4. Correctly performed landscape audit can ensure proper protection of valuable and unique landscapes, specific to regions and the whole country, on an equal basis with other functioning forms of protection concerning nature or culture, for example.
5. Due to the increasing need to use landscapes with high aesthetic and harmonious values (for the leisure, tourist, educational and recreational purposes), their visual assessment should be introduced in parallel and mandatorily at the stage of landscape identification, as is the case in Western countries, for example, in Germany

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