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THE METHOD OF DETERMINING RESEARCH UNITS FOR THE NEEDS OF VALORISATION OF RURAL LANDSCAPE AT THE LEVEL OF PLANT COVER ON THE EXAMPLE OF THE PUCHACZÓW COMMUNE

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ABSTRACT

One of the methods of landscape valorization is assessment based on the analysis of vegetation. It makes it possible to recognize changes taking place in the natural environment. The first stages of valorization include the designation of relevant research units. The aim of the article is to present a model method of extracting research units for valorization of a rural landscape. The area for which the author presents the research model is the Puchaczów commune, located in the Lublin province. The method of determining units used in the research combines two types of research fields: natural and geometric. In order to designate research units in the commune, the author used the analysis of land cover and topography. The comparison of the results of the above-mentioned studies allowed to recognize 16 homogeneous types of landscapes. The next stage of research was the generalization the shape and surface of units of landscape types by lay on them a grid of squares. An important issue was the selection of the appropriate size of research fields. The article tested the possibility of using squares with sides equal to 500 m and 1 km. The results indicated that too high a degree of generalization of units would lead to a reduction in landscape types on the map, which would distort future valorisation results.

Keywords: landscape valorization, rural landscape, landscape research units, plant cover

INTRODUCTION

The concept of sustainable development of rural areas assumes shaping them in such a way that their economic does not adversely affect the resources of the natural environment, landscape or cultural heritage of the village, while improving the quality of people's lives. This idea seeks to reconcile competitive factors: economics and ecology by adapting business activities and planning to existing natural and social conditions [Urban, 2003].

The implementation of the principles of sustainable rural development is influenced by legal acts, development strategies of international and national rank. Agenda 21 emphasizes the great importance of local authorities of municipalities in achieving the goals set out in this document – stop the degradation of the environment and its protection [Regionalne

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Samorządowe Centrum, 1993]. Shaping a pro-ecological, regional spatial policy is connected with the obligation for municipalities to adopt a study of spatial development conditions and local spatial development plan. Another document that shows how to achieve lasting progress, built on harmonious relations between socjety, economics and the natural environment is the European Landscape Convention, wich is the first international treaty devoted exclusively to landscape issues. In Poland, legal acts referring to the idea of sustainable development include The Constitution (Article 5), the Act of 27 April 2001 – Environmental Protection Act, or the Strategy for the sustainable development of rural areas, agriculture and fisheries for 2012–2020 [Żmija, 2014]. All the above-mentioned documents set directions, the implementation of which will ensure sustainable and balanced development of the village. However, it should be remembered that such development will not occur without a planning act carried out and implemented, and this requires specific landscape research, including its valorisation and recognizing the problems with the functioning of rural areas in relation to natural resources.

In Poland, the methods associated with the valorisation of cultural landscape, which includes rural areas, have been most widely developed by the Krakow universytyof landscape architecture [Antolak, 2017]. Professor Janusz Bogdanowski [1976] proposed a method for assessing JARK-WAK landscape units and interiors, the designation of which is based on the division of land according to three criteria: form of terrain, land cover and historical origin. The JARK-WAK valorization method does not directly refer to plant communities, but it can be a guideline for developing a method for their detailed research. An example would be the research carried out by Targońska and Łukasik [2010] regarding the assessment of the landscape of the village Owińsk in the Greater Poland Voivodeship. In the research the authors used two different methods. The first consisted in a compositional analysis based on general inventory and valorisation of cultural and natural elements. The second stage of the study was based on the JARK-WAK method, which was expanded to include plant cover assessment. The studied area divided into homogeneous areas, designating units with cultural, natural-cultural and natural features. It should be added that at the level of phytocoenoses, anthropogenic processes trigger transformation of communities with a more organized structure into less organized ones. Synanthropization of flora is a directional process whose distinguishing feature is the replacement of native species by foreign plants [Plit, 1996]. Considering the above, valorisation based on plant cover can be used to assess the degree of naturalness of plant landscapes. The exaple may be assessment method developed by Olaczek and Sowa [1972]. They distinguished a number of replacement phytocoenoses for potential phytocoenoses, and assessed the degree of transformation on a six-point scale [Wysocki & Sikorski, 2014]. A similar research method, which assumes that the compatibility of real vegetation with the habitat potential is the most important, was developed by Plit [1996]. The method emphasizes qualitative changes in vegetation, and indirectly also changes in the environment [Plit, 1996].

Currently, valorization methods developed with the use of GIS are becoming more popular. Picuno et al. [2019] focused on identifying changes in the rural landscape and their impact on environmental aspects by comparing historical maps from different eras with aerial photographs. The scope of the research covered the region of Basilicata (southern Italy). This method allowed to study the direction of landscape changes along with the time analysis. The transformation of landscape under the influence of human activity over the centuries with the use of Geographic Information System, was also studied by De Jong and Stremke [2020]. The article presents a case study that aimed to map the evolution of energy landscapes in the region of the western part of the Netherlands. The research shows that all energy transformations are related to the transformation of landscapes.

It should be pointed out that landscape identification and valorisation requires the adoption of appropriate measures and units. The main purpose of the article is to present a model method

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of extracting research units for the valorization of rural landscape based on research on plant cover. The research territory is the area of the Puchaczów commune located in the Łęczna County in Lublin Voivodeship. It is a rural commune with a complex functional, spatial and environmental structure. A distinctive feature of the area is the presence of hard coal deposits. Natural conditions largely define the contemporary development of the commune, where, apart from the agricultural function of the area, the mining industry developed. In this situation, the selection of the appropriate methodology for assessing rural landscapes should be dictated by the possibility of conducting surveys on the scale of the entire commune, based on documents unified at the national level. The research model that the author tries to present should also be as simple as possible so that they can be used in the future for planning purposes.

MATERIALS AND METHODS

Landscape-building components, both abiotic and biotic, are connected through close correlations. This landscape design allows the use of selected elements as indicators for the assessment of entire natural systems [Szyszko, 2013]. Plant cover, as one of the most labile landscape components, reflects natural and anthropogenic changes [Plit, 1996]. Based on the presence of plant species, communities can indirectly conclude about other features of the natural environment. The big advantage of plants as indicators is also the lack of mobility, which allows greater accuracy of research than in the case of fauna. Depending on the scale of the studied area, the vegetation cover can be an information indicator at the species and biocenotic level and landscape [Wysocki & Sikorski, 2014]. It is worth noting that the study of plant cover in times of huge climate changes, which have already become a fact, have additional value. The transformation of weather conditions is largely influenced by increased greenhouse gas emissions caused by anthropogenic processes. Plant cover is an element of the environment that is particularly sensitive to climate change, and the response of ecosystems to extreme weather is easily noticeable [Czerepko et al., 2010]. Atmospheric conditions determine the spatial distribution of flora. The transformation of environmental conditions caused by global warming can lead to significant changes in the species chorology model, and also affects the range of plant occurrence [Chauchard et al., 2010].

For the Puchaczów commune, the author planned a valorisation based on analyzes of the plant cover, consisting of comparing potential and real vegetation. The scope of research related to the assessment of plant cover transformation covers the area of the Puchaczów commune within its current administrative boundaries. This area has been selected due to its location in the Lubelskie Voivodeship and the complex functional and spatial structure and environmental conditions. Puchaczów is a rural commune located in the Łęczna County. The area of the commune is estimated at 91 km^2, and the number of inhabitants is about 4884 people. Geographically, the Puchaczów commune belongs to two physiographic units of the Łęczyńsko-Włodawskie Lake District and the Dorohuska Plain [Mącik et al., 2012]. A special feature of this commune is its situation within hard coal deposits and it is crucial for the development of region. The largest company in this territory is Lubelski Węgiel "Bogdanka" S.A. [Szot-Gabryś, 2008].

Due to the nature of the valorisation, the purpose of which is to assess the degree of naturalness of the vegetation cover, and indirectly also to assess landscape transformations, the current land cover and its topography have been chosen as the basis for determining research units for the Puchaczów commune. This information provided data on the structure of the landscape, which enabled the selection of homogeneous areas in terms of development and topography (landscape types). The source materials used during the research were orthophotomap, topographic map, digital terrain model – ISOK project – hypsometry [https://puchaczow.e-mapa.net/, date: 06.01.2018] and the Study of Conditions and Directions of Spatial Development of the Puchaczów Commune [Mącik et al., 2012].

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Fig. 1. Location of the Puchaczów commune in Poland and Europe
Source: Author's own work based on the map from: https://d-maps.com, date: 05.09.2020.

RESULTS

The land cover analysis has identified five main forms of municipal development:
– forest areas (L);
– meadows and pastures (Ł);
– concentrated settlement rural areas (Z);
– agricultural areas with dispersed rural buildings (R);
– industrial areas (P).

The dominant form of land cover are agricultural areas (R), occurring throughout the commune as multifaceted patches. Meadows and pastures (Ł) with a flap-band system are next in terms of size. These areas accompany mainly the valleys of the Mogielnica and Świnka rivers. Compact settlement systems (Z) occupy about 14% of the total area of the studied commune. These areas have a band character and are located along the main communication routes. The largest part of the compact settlement system is located in the western part of the commune. Forest communities constitute about 12% of the commune's area. They include complexes found in Ciechanki, Ostrówek, Zawadów, Wesołówka, Puchaczów and Nadrybie. Forests located in the southern part of the commune, they form part of the Nadwieprzański Landscape Park and its buffer zone. There are 4 main industrial areas in the Puchaczów commune. The largest area is occupied by the Bogdanka Coal Mine, located in the central part of the commune. Percentage share of individual development forms in relation to the area of the entire commune is shown in the diagram (Fig. 3).

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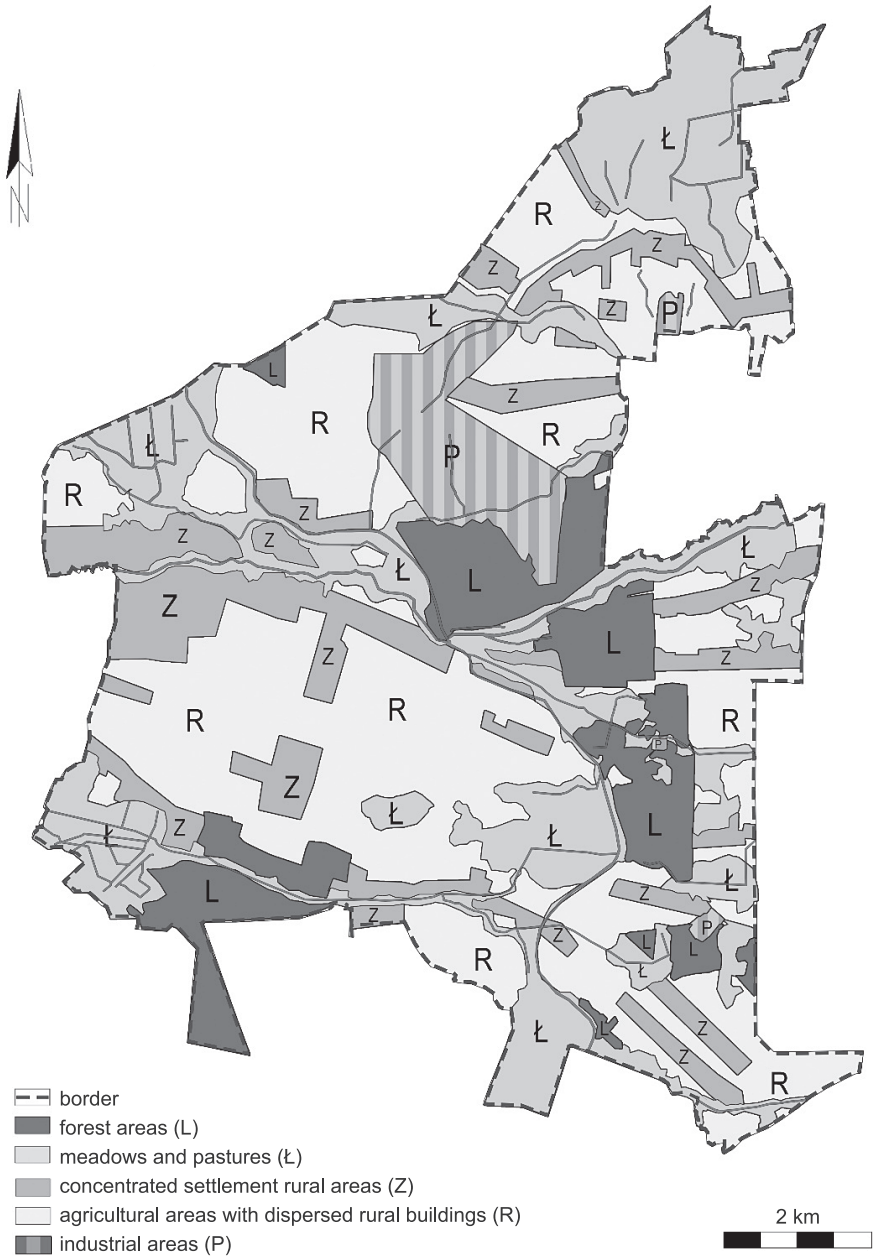

Fig. 2. Land cover in the Puchaczów commune
Source: Author's own work, 2018.

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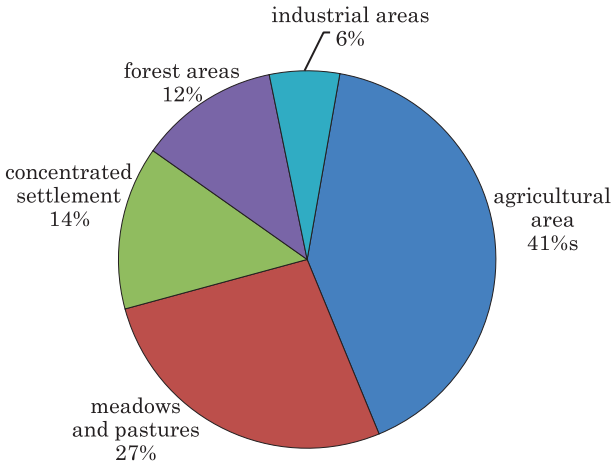

Fig. 3. The structure of land cover in the Puchaczów commune
Source: Author's own work, 2019.

During the analysis of the terrain, height and type of relief were taken into account. Four main landforms have been identified:
– Areas of the main watercourse valleys (D);
– Flat areas with few, small hills or depressions (P);
– Slightly wavy areas with small differences in height (L);
– Strongly wavy areas (W).

The landscape of Puchaczów commune is characterized by low altitude variation. In the hypsometric context, there are mainly types of slightly wavy or flat, flat forms with few elevations or depressions. Areas with a strongly wavy terrain are located mostly at the eastern border of the commune.

The imposition of information from maps presenting forms of land cover (Fig. 2) and landforms (Fig. 4) allowed to distinguish 16 homogeneous in the area of the Puchaczów commune in terms of use and shape of units, types of landscapes:
– Compact buildings on flat areas (ZP);
– Compact buildings on slightly wavy areas (ZL);
– Compact buildings in clearly undulated areas (ZW);
– Agricultural areas in flat areas (RP);
– Agricultural areas in slightly wavy areas (RL);
– Agricultural areas in strongly wavy areas (RW);
– Industrial areas in slightly wavy areas (PL);
– Industrial areas in strongly wavy (PW);
– Industrial areas in river valleys (PD);
– Forest areas in slightly wavy areas (LL);
– Forest areas in strongly wavy areas (LW);
– Forest areas in river valleys (LD);
– Meadows and pastures in flat areas (ŁP);
– Meadows and pastures in slightly wavy areas (ŁL);
– Meadows and pastures in strongly wavy areas (ŁW);
– Meadows and pastures in river valleys (ŁD).

Table 1. Comparison of different degrees of generalization of units

The length of the side of the square	500x500 [m]	1x1 [km]
Surface units [km^2]:		
Compact buildings on flat areas (ZP)	8,5	5
Compact buildings on slightly wavy areas (ZL)	8	6
Compact buildings in clearly undulated areas (ZW)	1,75	-
Agricultural areas in flat areas (RP)	13	15
Agricultural areas in slightly wavy areas (RL)	18,75	23
Agricultural areas in strongly wavy areas (RW)	4,75	5
Industrial areas in slightly wavy areas (PL)	3,25	3
Industrial areas in strongly wavy (PW)	0,75	-
Industrial areas in river valleys (PD)	0,5	-
Forest areas in slightly wavy areas (LL)	6,25	9
Forest areas in strongly wavy areas (LW)	6,5	6
Forest areas in river valleys (LD)	0,25	-
Meadows and pastures in flat areas (ŁP)	4,75	7
Meadows and pastures in slightly wavy areas (ŁL)	4	6
Meadows and pastures in strongly wavy areas (ŁW)	1,5	2
Meadows and pastures in river valleys (ŁD)	21	22
Sum of identified units	16	12

Source: Author's own work, 2020.

The above analysis showed that the isolated units are strongly diversified in terms of size, and also have an irregular shape of the borders, which is often not sharply marked in the landscape, it has the character of a gradient. The next stage of research was the generalization the shape and surface of units of landscape types, which is very important from a methodical point of view.

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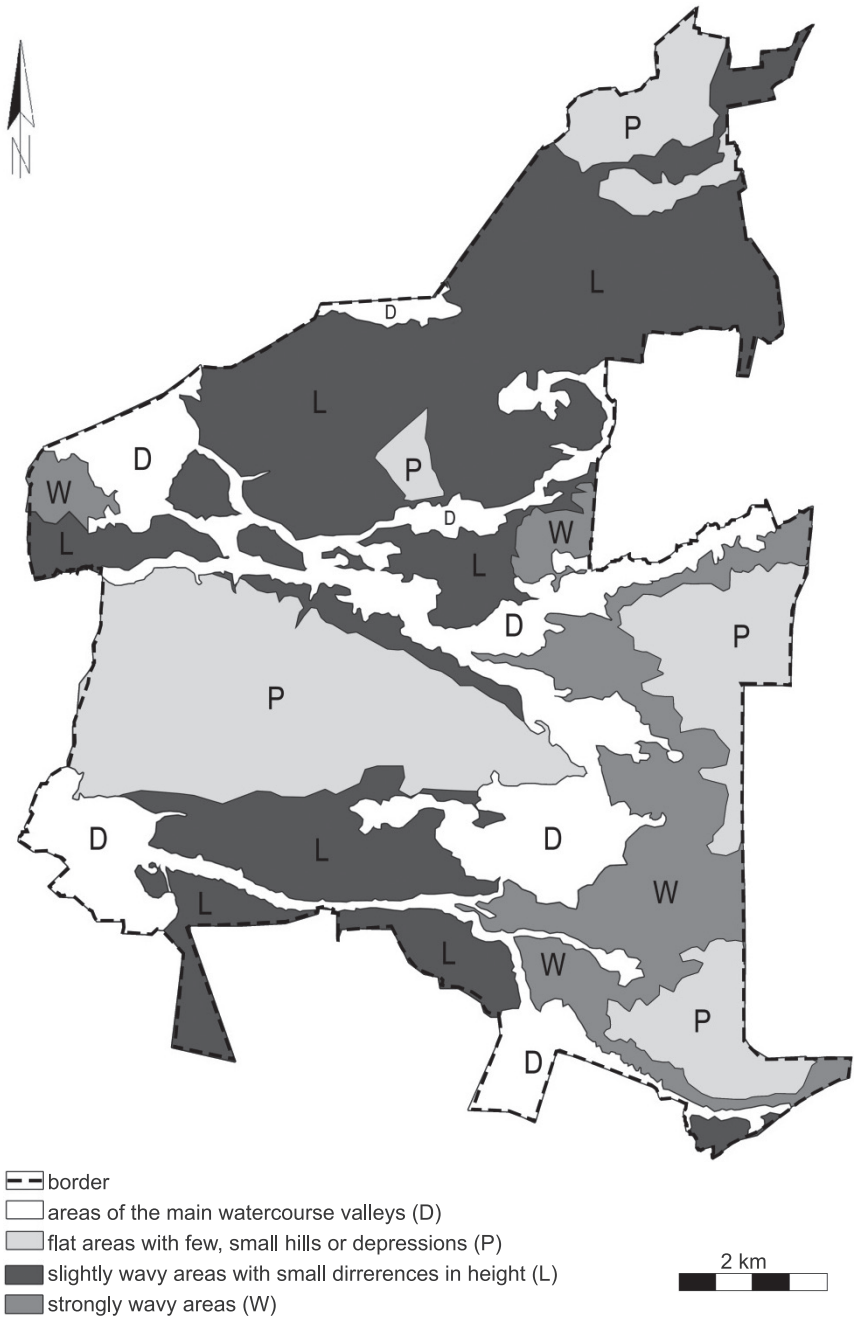

Fig. 4. Landforms in the Puchaczów commune
Source: Author's own work, 2019.

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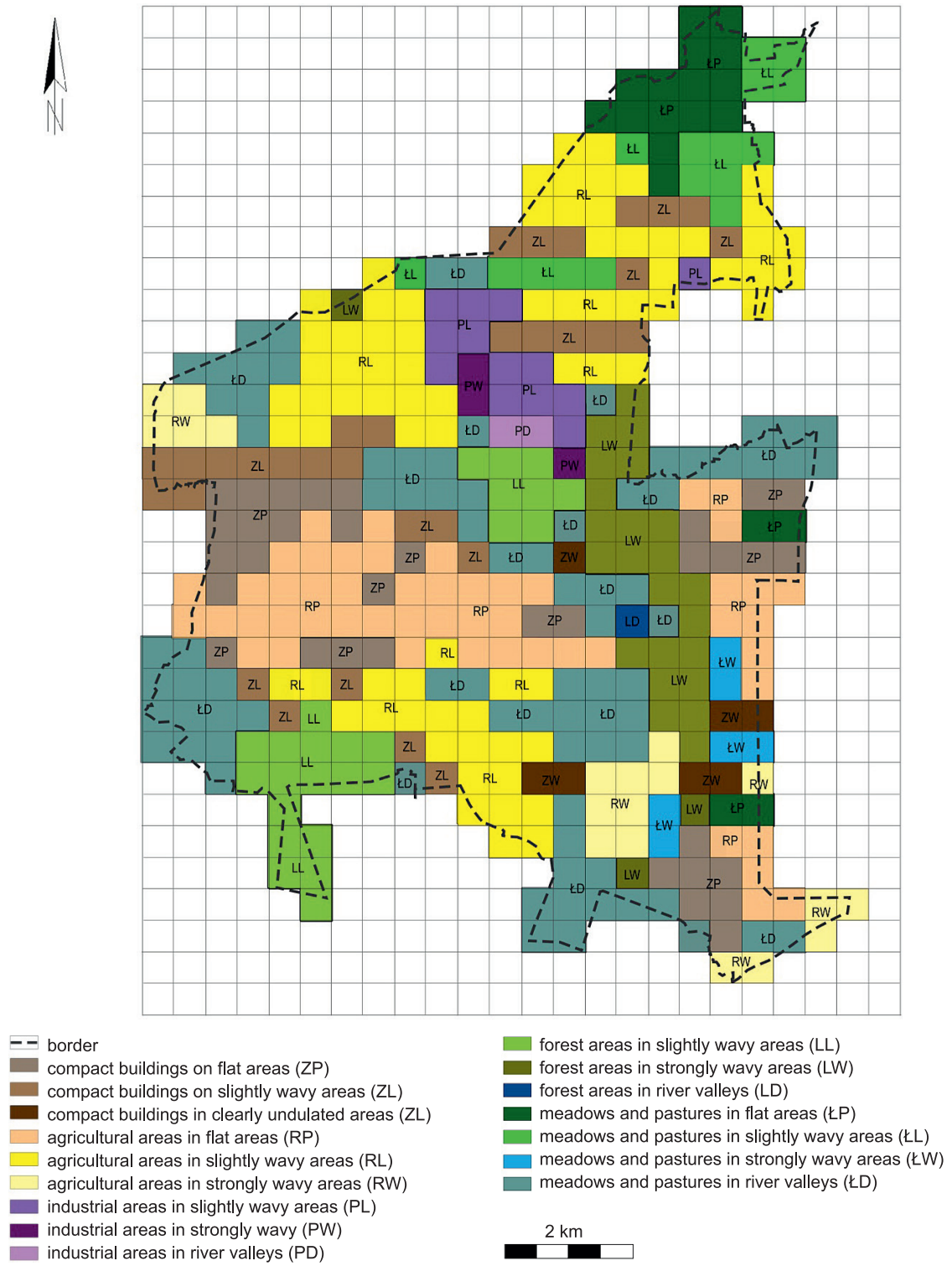

Fig. 5. Map presenting types of landscapes of Puchaczów commune based on a grid of squares with a side equal to 500 m
Source: Author's own work, 2020.

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The generalization by using geometric fields (squares) will facilitate the determination of the total size of units and in subsequent valorisation phases will allow for comparative assessment of vegetation transformations on the same surface of landscape types, as well as statistical analysis of research results. For this purpose, a grid of squares with a side equal to 500 m was used, and individual squares were assigned the dominant type of landscape in a given area. Due to the area of the commune in study examined the possibility of using squares whose dimensions were 1x1 km. The comparison of the degree of generalization of both research fields is presented in Table 1. For a square with a side of 500x500 m, the sizes of the units of landscape types are more accurate than for a square with dimensions of 1x1 km. The level of generalization of units in case with biger square turned out to be too high, as a result, which would reduce the number of landscape types. The disappearance of significant, although small, areas with a landscape that stands out in a particular environment would deform the results of the valorisation. This confirmed that the area should divided into a square with a side equal to 500 m. It should be emphasized that when performing this type of unit delimitation, the size of the geometric fields must be adapted to the study area each time.

DISCUSSION

In general, valorisation of the landscape consists in assigning specific values to individual research units, which will enable the assessment of their use. Units should separate areas uniform in terms of landscape and structural. It should be noted that when determining units, it is not possible to take into account all biotic and abiotic elements of the environment, which is due to its complex structure [Richling & Solon, 1996]. The selection of criteria for the delimitation of research units depends primarily on the purpose and scale of landscape valorisation.

In the process of spatial planning at the regional level, including communal level, units of plant landscapes are most applicable. According to Matuszkiewicz [1978, 1979a, 1979b, 1981a, 1981b, 1993] the plant landscape is a typological group that was created to holistically describe the spatial and typological divergence of plant communities in regional units characterized by basic habitat diversity [Matuszkiewicz & Solon, 2015]. Their determination is based on various foundations, e.g. terrain geomorphology, while the source of information about vegetation is a map of real and potential vegetation or a map of community complexes. One of the most common methods in Poland includes the concept of landscape phytocomplexes proposed by Matuszkiewicz [1993], [Wysocki & Sikorski, 2014]. Landscape phytocomplexes are a spatial system of phytocoenoses characterized by a specific set of plant communities that actually occur in nature. They may refer to real or potential vegetation [Matuszkiewicz, 1981b]. Phytocomplexes are shaped primarily by abiotic factors of the environment and human activity [Richling & Solon, 1996]. The definition of phytocomplexes determines the general nature of units, but does not contain information on how to strictly demarcate them in space from other plant systems. The basic components of phytocomplexes are phytocoenoses, which in typological terms belong to different syntaxones. In addition, plant systems located on the border of two phytocoenoses are also components of phytocomplexes [Matuszkiewicz, 1981b].

A slightly different approach presents the division of the landscape into geocomplexes. Geocomplexes are defined as closed sections of nature that are connected through processes that take place between the components that build them [Barsch, 1979]. The components that build landscape geocomplexes are partial geocomplexes [Szponar, 2005]. As Haase [1964] reports, they reflect the variability of individual geocomponents referring holistically to the natural environment [Richling & Solon, 1996]. Due to the lack of uniform theoretical principles, the concept of geocomplexes in the 1980s and 1990s was questioned [Pietrzak, 2001]. Ambiguity in determining the boundaries of geocomplexes is a significant problem in landscape research [Pietrzak, 1998, Balon, 2007a]. According to Kot [2009], it results primarily from the lack of commonly accepted, ordered in size systems of units

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of all components of the natural environment. It is also believed that the method presented is labor-intensive and time consuming [Balon, 2007a]. Chmielewski and Solon [1996] dealt with the methodology for multi-criteria determination of spatial research units for the needs of spatial planning. Delimitation of basic natural spatial units (BNSU) involves the analysis of a number of superimposed layers of maps reflecting the terrain, soil characteristics, water relations, land use and the range of real vegetation. The isolated units are then grouped into higher order syndromes, i.e. physiocenosis and landscape complexes [Sowińska & Chmielewski, 2008].

The use of geometric fields is also a popular way of determining units for environmental research. Bajerowski et al. [2007] defined the conditions that should be met by basic fields. The publication emphasizes that the shape of the units should be similar to a circle, which is why hexagons are more and more often used in landscape assessments. However, it should be taken into account that the more common method is to use a grid made of square fields. An example may be studies on the assessment of tourist attractiveness [Chojnacka-Ozga & Gabryszewska, 2011, Dubel, 2004, Goosen & Langers, 2000], but also research on the natural environment [Balon, 2007b, Kot, 2014]. The disadvantage of geometric units is their unnatural.

As the analysis of the current state of knowledge shows, there is no single, universal spatial research unit. All research methods presented are based on a specific set of landscape features and highlight selected aspects of it. Therefore, when valorizing rural areas, one should choose a method of their delimitation adequate for the purpose and territory of research [Richling & Ostaszewska, 1993].

The unit determination method used in research combines two types of research fields: natural and geometric. The superimposition of a square grid on predefined landscape types resulted in the generalization of units. This has limited the unnatural resulting from the use of geometric fields, and at the same time, in a further stage of valorization, it will make it possible to compare squares of the same area. The reason for using this method of delimiting units is universality, which consists in the possibility of applying it to various types of areas and the possibility of obtaining statistical data.

CONCLUSIONS

Currently, there are many methods of designating research units for landscape valorization. They can be divided into natural – based on the biotic or abiotic features of the terrain, and geometric ones, in which the basic research fields are e.g. squares. The model method of determining units presented in the article combines two types of research areas.

The author will plan to do the valorization of the degree of naturalness of the vegetation, and indirectly the assessment of landscape transformations. The basis for designating research units for the Puchaczów commune was land cover and its topography. The next stage of research was the generalization of the shape and surface of units of landscape types, which is of great importance from a methodical point of view. The article tested the possibility of using squares with sides equal to 500 m and 1 km. The results indicated that too high a degree of generalization of units would lead to a reduction in landscape types on the map.

Applying generalization with geometrical figures (squares) will make it easier to determine the total size of units. In further valorisation phases, it will allow comparative assessment of vegetation transformations on the same surface of landscape types and statistical development of research results.

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