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ASSESSMENT OF NATURAL VALUES AND ENVIRONMENTAL THREATS – A CASE STUDY: EASTERN PART OF THE GÓRA KALWARIA COMMUNE, POLAND

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ABSTRACT

Natural evaluation is carried out in order to assess or update the assessment of the natural values of studied area. This method is necessary when implementing investments as well as when planning conservation measures and shaping the landscape and minimalize negative impact of environmental threats. The purpose of this work was perform natural evaluation and diagnose environmental threats on east-part of Góra Kalwaria commune for regional and local planning policy. It was used natural assessment according to Żarska (2006) and Fornal-Pieniak et al. (2018) with modification. Modification in whole process of assessment was connected with purpose and character of studied area. The purpose of this paper was to present assessment of natural values and environmental threats of the eastern part of the Góra Kalwaria commune in middle part of Poland. East part of Góra Kalwaria commune is characterized by very diversified landscape form natural forests, wet meadows, water and rushes plants along Vistula river up to anthropogenic areas as villages, towns and agriculture areas as fields, orchards. The stages of natural evaluation were included: field researches, divided areas into spatial-landscape units, formulated criteria to assessment, evaluation, distinguished areas with diversified types of natural values. It was distinguished four types of spatial-landscape units as: *L* – spatial-landscape units with forest dominated; *S* – spatial-landscape units with orchards and agricultural areas (fields) dominated; *Z* – spatial-landscape units with built-up areas dominated; *W* – spatial-landscape units with surface waters dominated. From the whole spatial-landscape units (areas) 10 areas are represented high natural values, 17 areas with medium values and 8 areas with low natural values. It was recognized threats, which have got negative impact on values of landscape. It was presented possibility of solutions how to minimalize negative impact of threats. Used natural evaluation is usefulness for shaping landscape by planners, ecologists and landscape architects including mosaic character of landscape elements of commune.

Key words: evaluation, natural values, commune, environmental threats, Poland

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INTRODUCTION

The interest of researchers has recently, in last decades, increased in such issues, including landscape evaluation as a base for rational planning (Żarska et. al 2014, Oliveira Paiva et al. 2015). Natural evaluation is the assignment of previously studied areas of ranks or categories describing their natural value. Documents containing natural evaluation contain information for the entrepreneur who should avoid areas of valuable natural value when planning investments. The document containing evaluation is often the key stage of consultation in the process of environmental decisions (Radlińska 2013). The main task of evaluation is to assign to landscape elements (Hopfer et al. 1982, Radlińska 2013, Antolak and Małkowska 2019). To perform natural evaluation, an inventory of the current state of natural elements must be carried out in advance. Inventory stages were developed, among others by Kassenberg (1986), Richling and Solon (1996). To perform evaluation of the landscape, the study area is divided into spatial-landscape units. By using the term spatial-landscape it's mean a surface unit to which one can unambiguously attribute a certain value obtained in assessing the environment. This value characterizes the entire surface of this field (Bajerowski 2007). Evaluation can be divided into stages. They are: defining the purpose and scope of the study, data collection and field research. During these stages, the area under development is divided into spatial-landscape units. Then performing the evaluation sets the methodology for assessing the value of the units created (Bajerowski et al. 2007). Natural evaluation is limited by access and information. They are often not sufficient to determine landscape units, which dictates the selection of features and values that are the basis for evaluation in the studied area (Litwin et al. 2009).

Matysiak (2012) describes the methodology of environmental evaluation. He states that independent but complementary indicators should be used. One of the evaluation criteria it presents are elements of nature called 'special care'. Relate to rare species whose protection is the responsibility of the state. Another method of environmental evaluation is Paprzycka's methodology (2005). The author emphasizes the essence of information which is the degree of landscape saturation. It is a method based on determining the surface share of naturally saturated areas falling into a separate landscape unit. Protected areas such as national parks, Natura 2000 Areas, etc. are particularly valuable (Du et al. 2015). Work on the evaluation methodology has led to a comparison of methods to determine which ones better reflect the value of the areas studied. One of the works is the group development of in situ methods and cartographic methods. The first one is based on detailed field research covering terrain, flora and fauna, sounds, views, etc. The second one involved the use of maps and information available on them, which saved time. The result of the work was the statement that the cartographic method is sufficient for evaluation, however, it can be used only with sufficiently accurate and information-rich maps (Pasto et al. 2006). Most evaluation methods combined data from soil, climate, vegetation or landform analysis. From this information, it is possible to define and evaluate terrain units. They are more objective than methods using sensations or impressions when describing nature. Still, they are not perfect due to the fact that they also need to be selected in which variables will be evaluated (Fairbanks and Benn 2000). The way of valuing landscape elements is point bonitation. It consists in assigning points to environmental attributes (Bajerowski et al. 2007).

Environmental threats may disturb the natural balance or cause degradation of natural elements (Olson and Rejeski 2018). It is a term covering a wide range of natural disasters as well as anthropogenic factors. The most basic examples of natural threats to the environment are tsunamis, earthquakes or cutting down trees. They have a significant impact on large areas of the natural environment. When it comes to anti-pathogenic sources, they are most often pollutants with certain substances or failures in industrial crushers (Prandecki and Sadowski 2010). Environmental threats are most often changes in the form of use or more intensive use of land

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for human needs. The research on the Apennine Peninsula described by Antrop (2006) presents a trend that has been appearing all over Europe over the last several years. The greater demand for food, as well as the low interest shown by tourists for traditional farms, caused changes in the forms of use. Currently, most of the land is characterized by intensive agriculture that meets the economic pressure of the region. This resulted in the loss of the unique landscapes of traditional agriculture (Antrop 2006).

Road transport is one of the main sources of emissions of carbon dioxide, hydrocarbons, nitrogen oxides as well as heavy metals and particulates. The emission of these pollutants increases the risk of human diseases and illnesses. The natural environment is also exposed to the negative effects of these compounds. One of the problems created by transport is acidification of the environment by sulfur oxides or nitrogen oxides. Deposition of pollutants hinders the proper growth and vegetation of plants, especially in forests (Badyta 2010). Agricultural spraying is the second major problem. Commonly used plant protection products such as pesticides can be a major threat to living organisms, including humans. They can migrate to the aquatic and soil which increases their range of toxic effects in environment (Kociołek-Balawejder and Stanisławska 2012). However, they are widely used in the fight against pests in agricultural areas, which can cause death of organisms in the surrounding areas, especially if pesticides get into the water. Natural floods are caused by big river and its periodic high states are also a significant threat. They cause flooding of basements and interruption of embankments, which is associated with social and economic start-ups in the event of crop destruction (Źróbek 2009). Environmental protection is taking measures to restore nature's balance. This balances the negative effects of environmental threats and allows for restoring the proper state for individual natural elements (Environmental Protection Law 2001, Olson and Rejeski 2018). Evaluation is therefore a tool for spatial planning. Interpretation of terrain diversity and functional ecological structure is necessary for further management (Stola 1993, Fornal-Pieniak and Żarska 2014).

The purpose of this work was perform natural evaluation and diagnose environmental threats on east-part of Góra Kalwaria commune. It was also formulated directions shaping and protection landscape of this area for regional and local planning policy.

Hypothesis: Góra Kalwaria commune has got areas with valuable natural values which should be proper protection and shaping.

STUDY AREA AND METHODOLOGY

The Góra Kalwaria commune is located in the central part of the Mazowieckie Voivodeship, 20 km from Warsaw in Poland. The commune has an area of 145 km^2, while the eastern part of the commune has an area of 39 km^2 (Fig. 1).

The analysis were conducted only on east part of Góra Kalwaria commune not on the whole commune as a case study, because this part of commune has got very diversified landscape form natural forests, wet meadows, water and rushes plants along Vistula river up to anthropogenic areas as villages, towns and agricultural areas as fields, orchards as well as connecting and dividing them by roads.

The methodology are included field and indoor studies in year 2018–2019. First stage of landscape evaluation was collection of information about studied areas. Next stage was divided area into spatial-landscape units, where the main criteria of division was dominated types of land form-use. It was distinguished areas in different categories: *L* – spatial-landscape unit with forest dominated; *S* – spatial-landscape unit with orchards and agricultural areas (fields) dominated; *Z* – spatial-landscape unit with built-up areas dominated; *W* – spatial-landscape unit with surface waters dominated. Natural evaluation according to Żarska (2006) and Fornal-Pieniak et al. (2018) was used and modified by Koźma (2015) taking criteria of percentage cover of forests. It was also analyzed environmental threats according to Spellman (2016). The next stage including nature evaluation with seven assessment criteria, i.e. the degree of naturalness of vegetation, percentage coverage of forests, surface waters,

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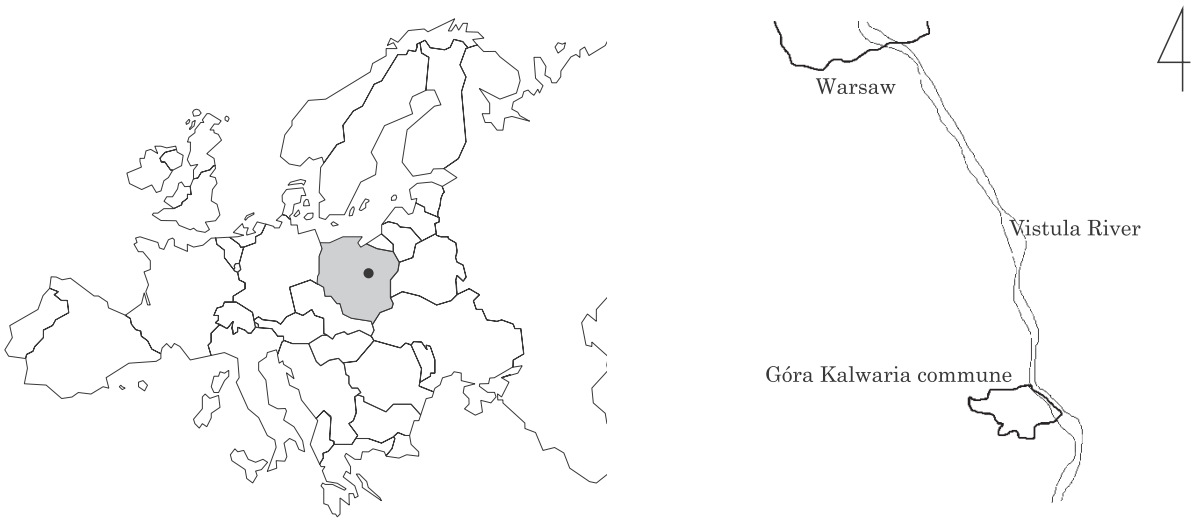

Fig. 1. Location of Góra Kalwaria commune (central part of Poland, nearby Warsaw) in Poland (schemate)
Source: authors' own work

meadows, trees or groups of shrubs, Natura 2000 Areas, types of environmental threats. It has been applied bonitation points from 1 point up to 3 points for assessment (Table 1). It was used criteria as:
– the degree of naturalness of vegetation (according to Matuszkiewicz, 2019) as natural vegetation (3 points), semi-natural vegetation (2 points) and synanthropical vegetation (1 point);
– percentage cover of forests (according to Koźma, 2015) with a breakdown into: from 61% to 100% (3 points), from 25% to 60% (2 points), from 1% to 24% (1 point) and no forest (0 points);
– surface waters where a large reservoir or river occurring (3 points), a local small reservoir (2 points) small artificial reservoirs (1 point), and the lack of surface water (0 points);
– meadows occurring (fresh, floodplains etc.) – 1 point;
– trees or groups of shrubs occurring – 1 point;
– Natura 2000 Areas occurring – 1 point;
– environmental threats occurring – from 0 points to 3 points (Table 1).

Environmental threats are defined as undesirable effects affecting changes in the natural environment (Spellman 2016). They are also burdensome for the development of human civilization that exist and grow together with technological and cultural progress (Żółtowski and Kwiatkowski 2012, Olson and Rejeski 2018).The criterion for assessing how the absence of threats means that there is no infrastructure (road and residential) in the studied area (spatial-landscape units). Small threats are the presence of unpaved roads that are rarely used or abandoned buildings. Medium threats are built-up areas and paved roads, as well as agricultural areas where spraying or plant protection products are used. Cities, compact rural buildings and major transport routes present major threats (according to Kocur-Bera 2012, Żółtowski and Kwiatkowski 2012 with authors modification). The research area was divided into spatial-landscape units based on the criterion of land cover. Each spatial-landscape units was subject to environmental assessment and the occurrence of threats to the natural environment was recognized. The threats are distinguished during the filed analysis.

The result of the evaluation was to distinction of areas (spatial-landscape units) with different natural values:
– spatial-landscape units with low natural values (from 1 point up to 5 points);
– spatial-landscape units with medium natural values (from 6 points up to 10 points);
– spatial-landscape units with high natural values (from 11 points up to 16 points).

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Table 1. Assessment criteria and bonitation points – according to Żarska (2006) and Fornal-Pieniak et al. (2018) with modification

Criteria		Bonitation points
The degree of naturalness vegetation (according to Matuszkiewicz 2019)	natural (forest, water and aquatic, peat bogs vegetation)	3
	semi-natural (grasslands, pastures, meadows)	2
	synanthropical (ruderal and segetal vegetation)	1
Percentage cover of forests (according to Koźma 2015)	from 61 to 100%	3
	from 25 to 60%	2
	from 1 % to 24%	1
	no occurring	0
Surface waters occurring	large local water reservoirs/ contact with the Vistula river	3
	local watercourses	2
	small artificial reservoirs	1
	no occurring	0
Meadow	occurring	1
	no occurring	0
Trees or groups of shrubs, including orchards	occurring	1
	no occurrence	0
Natura 2000 Areas	occurring	3
	no occurring	0
Environmental threats	no occurring	3
	low threats occurring	2
	medium threats occurring	1
	big threats occurring	0

Source: authors' own work

It was formulated direction to landscape shaping and minimizing environmental threats on studied areas. for strategic regional and municipality programs. The spatial-landscape units and result of natural evolution were presented also on graphic version. It was used maps in scale – 1: 50 000.

RESULTS AND DISCUSION

It was distinguished 34 spatial-landscape units (eleven units dominated by forests, nine units dominated by orchards and agricultural areas, twelve units dominated by built-up areas and three units dominated by surface waters). The following designations for types of spatial-landscape units were used (Fig. 2):

L – spatial-landscape unit with forest dominated;
S – spatial-landscape unit with orchards and agricultural areas (fields) dominated;
Z – spatial-landscape unit with built-up areas dominated;
W – spatial-landscape unit with surface waters dominated.

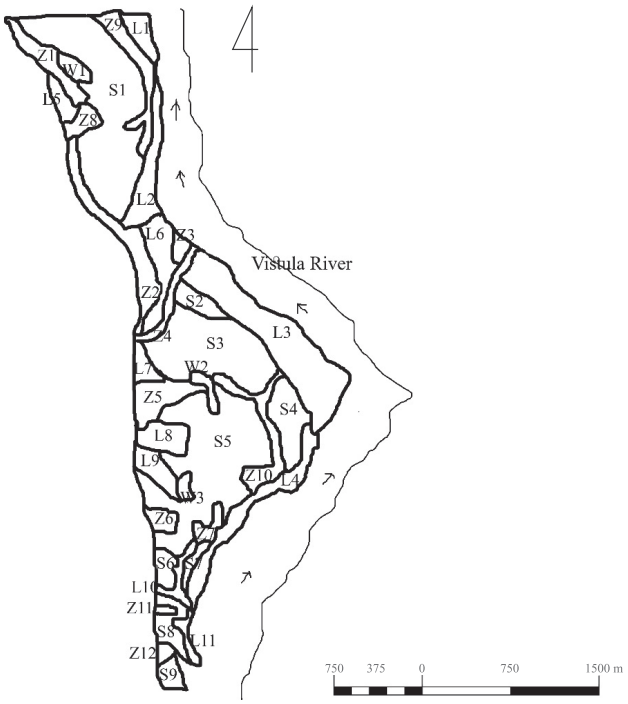

Fig. 2. Types of spatial-landscape units – a case study: eastern part of Góra Kalwaria commune – schemate
Source: own work

Based on the evaluation, spatial-landscape units with high (10 areas), medium (17 areas) and low (8 areas) natural values have been distinguished (Tab. 2). The spatial-landscape units with high (L1, L2, L3, L4, L6, L10, L11, W1, W2, W3) natural values are mostly located on the Natura 2000 Areas, in the eastern part of the studied area. Surface water was also found which, despite the proximity of agricultural areas with low natural values, retains the functions of natural habitats for flora and fauna (Tab. 2).

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Table. 2. Results of natural evaluation (own research)

No of spatial--landsape units	Type of spatial--landscape unit	The degree of naturalness of the vegetation	Percentage cover of forests	Surface waters	Meadow	Trees or groups of shrubs	Natura 2000 areas	Occurrence of environmental threats		Results of natural evaluation
Bonitation points:		1–3	0–3	0–3	0–1	0–1	0–3	0–3		
1	L1	3	2	3	1	1	3	3	**16**	High natural values
2	L2	3	3	3	0	1	3	3	**16**	
3	L3	3	3	3	1	1	3	2	**16**	
4	L4	3	3	3	0	1	3	2	**15**	
6	L6	2	3	3	1	1	0	1	**11**	
10	L10	2	3	2	1	1	0	2	**11**	
11	L11	3	3	2	0	1	0	2	**11**	
33	W1	3	1	3	1	1	0	2	**11**	
34	W2	3	1	3	1	1	0	2	**11**	
35	W3	3	1	3	1	1	0	2	**11**	
9	L9	2	3	0	1	1	0	2	**9**	Meadow natural values
5	L5	2	3	0	0	1	0	2	**8**	
7	L7	2	3	0	0	1	0	2	**8**	
23	Z3	3	1	3	0	1	0	0	**8**	
8	L8	2	2	0	1	1	0	1	**7**	
14	S3	1	1	2	1	1	0	1	**7**	
16	S5	1	1	2	1	1	0	1	**7**	
20	S9	2	2	0	0	1	0	1	**7**	
25	Z5	2	1	1	1	1	0	1	**7**	
28	Z8	2	1	1	0	1	0	2	**7**	
12	S1	1	1	1	1	1	0	1	**6**	
18	S7	1	1	2	0	1	0	1	**6**	
26	Z6	2	1	0	1	1	0	1	**6**	
27	Z7	2	0	1	1	1	0	1	**6**	
30	Z10	2	1	0	1	1	0	1	**6**	
31	Z11	2	1	0	0	1	0	2	**6**	
32	Z12	2	1	1	1	1	0	0	**6**	
13	S2	1	0	0	1	1	0	2	**5**	Low natural values
15	S4	1	0	2	0	1	0	1	**5**	
19	S8	1	1	2	0	1	0	0	**5**	
29	Z9	1	1	0	0	1	0	2	**5**	
17	S6	1	0	2	0	1	0	0	**4**	
21	Z1	1	0	1	0	1	0	0	**3**	
22	Z2	1	0	1	0	1	0	0	**3**	
24	Z4	1	0	0	0	1	0	0	**2**	

Source: authors' own work

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The natural evaluation has shown that the majority of the designated spatial-landscape units fall within point intervals corresponding to average natural values (Tab. 2). It is caused by a significant predominance of agricultural areas in the developed area, and hence, a small part of the area covered with forests or other green areas. The occurrence of monoculture forests and limited diversity of plant communities has often been found, which reduces the value of these studies of landscape and spatial units, ruderal vegetation predominates in combination with vegetable and orchard cultivation. The most common threat is road transport, and thus pollution and the slogan that cars generate. Environmental threats in the described area are represented mainly by traffic in particular transport, as well as agricultural management dominating in this area. The problem of road transport affects the studied area because of the location. Being on the communication route between eastern and western Poland, as well as being in the fruit-growing region, the natural environment in the commune of Góra Kalwaria is affected by constant emission of pollutants.

Potential harmful effects of plant protection products are another threat. It can not only adversely affect the soil and water in a given outskirts, but also through surface and groundwater to get to other areas. An equally big problem is the cultivation of organic plants, which cannot function properly in neighboring crops undergoing spraying. Development of new built-up areas was found in most agricultural areas. Fragmentation of forests were also classificated as the environmental threats (Tab. 3).

The evaluation was generaly conducted using diffent matching methods which help to achived the best results. (Żarska et al. 2014, Oliveira Paiva et al. 2015). The similar approach it was presented by Authors of this paper. It was presented evaluation mathod which could be used on areas with mixed types of lans uses, with different antropogenic pressure – from natural to semi-natural vegetation on areas (as Natura 2000 areas) up to areas transfomed by man (agricultural areas with fields, orchards and settelemets). The quality of landscape is influenced by both natural and anthropogenic (man-made) elements (Jokimäki 2017). The presented natural evaluation by Authors of this paper is focused on landscape protection and planning.

In Poland it was distinguished diffrent level of protection. Among of these forms, one of the

Table 3. Types of spatial-landscape units with location, characteristics and environmental threats (existing and potential in future)

No	Location of spatial-landscape units	Characteristic of units	Threats – existing and potential
1	2	3	4
L1	north-eastern part of the analyzed area	riperian forest with low density, large surface of floodplain meadows	the proximity of agricultural areas and built-up areas
L2	central part of the analyzed area	riparian forests, individual buildings from the city side	the nearby of agricultural areas
L3	central-eastern part of the analyzed area	mosaic of riparian forests, city beach and dirt roads	the nearby of agricultural areas
L4	a narrow strip from the center from the south on the eastern border of the area	mosaic of riparian foretss	the nearby of agricultural areas, small part with vegetation
L5	north-west border of studied area	disturbanced pine forets	adjacent to main road
L6	central part of the studied area	mosaic of riparian forests, urban greenery and buildings	–
L7	central part of the studied area	pine forests, single buildings	new build up areas
L8	central-northern part of the studied area	pine forests cutted by agriculture areas	fragmentation of forests
L9	central-northern part of the studied area	pine forests separated by single buildings	fragmentation of forests

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cont. Table 3

1	2	3	4
L10	northern part of the studied area	mixed forest landscape	new build up areas, nearby agriculture areas
L11	north-eastern part of the studied area	reperian forests	nearby agriculture areas
S1	north part of the studied area	orchards and agricultural areas dominated	nearby the main road
S2	central part of the studied area	orchards and agricultural areas dominated	nearby the main road
S3	central part of the studied area	orchards and agricultural areas dominated	increasing built-up areas, improper application of fertilizers
S4	eastern part of the studied area	orchards and agricultural areas dominated	increasing built-up areas, improper application of fertilizers
S5	central-northern part of the studied area	orchards and agricultural areas dominated	increasing built-up areas, improper application of fertilizers
S6	north-west part of the studied area	orchards and agricultural areas dominated	nearby the main road
S7	north-eastern part of studied area	orchards and agricultural areas dominated	improper application of fertilizers
S8	northern part of studied area	orchards and agricultural areas dominated	nearby the main road
S9	northern part of studied area	orchards and agricultural areas dominated	nearby the main road
Z1	north-west part of the studied area	mosaic of dense up build up areas with gardens and meadows	more build up areas
Z2	central part of the studied area	compact urban buildings with accompanying vegetation	–
Z3	central part of the studied area	build up areas dominated	pen removal from the bottom of the Vistula, nearby main roads
Z4	central part of the studied area	build up areas dominated, main road	noise and pollution
Z5	central part of the studied area	compact village buildings,	more build up areas
Z6	north-west part of the studied area	buildings, orchards and field	increasing built-up areas, cutting down roadside trees
Z7	north-eastern part of the studied area	compact buildings, meadow, lake	more build up areas
Z8	north-west part of the studied area	build up areas dominated	improper spraying and fertilizer management
Z9	north-eastern part of the studied area	mosaic of buildings, forests and agricultural areas	building density, deforestation
Z10	central-eastern part of the studied area	rural buildings with gardens, fragments of orchards and greenhouses	building density, deforestation
Z11	southern part of the studied area	rural buildings with gardens, fragments of orchards	increasing built-up areas
Z12	southern part of the studied area	gas station area, individual farms, meadows and orchards	increasing built-up areas
W1	northern part of the studied area	water reservoir surrounded by single trees and dense rushes	the nearby of arable fields and orchards
W2	central part of the studied area	water reservoir – Czerskie Lake, along with surrounding trees and riparian vegetation	the nearby of arable fields and orchards
W3	Czarna River	part of river	increasing built-up areas, adjacent agricultural areas

Source: authors' own work

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most important protected forms are represented by national parks, nature reserves and Natura 2000 areas (Badorau 2014). Natura 2000 Arease are located on east part of Kalwaria commune. Natura 2000 Areas (spatial-landscape units no L1, L2, L3 and L4) should be protected including: separation of places for rest and water sports, reduction of organized events during the breeding season of protected birds, as well as monitoring of newly emerging investments in terms of their impact on the protected area, stopped forest fragmentation (spatial landscape-units as L8 and L9) by controlling expanding villages and agricultural areas, develop organic farming to reduce the consumption of plant protection products (e.g. pesticides). In many regions of the world, the only remaining natural habitats are fragments embedded in landscapes dominated by agriculture.

National, EU and international legal requirements as well as necessity of the implementation of green economy in the framework of adaptation to climate change implementation, sustainable development is very beneficial (Dogaru 2013, Żarska et al. 2014).

Ecological balance in the landscape is one of the stage of environmental protection in management of sustainable development, strictly connected with land use planning (Żarska 2005, Benedict and McMahon 2006, Żarska et al. 2014). It is important to shaping ecological corridors, which help to keep biodiversty of landscape. Authors of paper gave directions of new afforestations, which would lead to enlargement of forest complexes and creation of more compact forest areas (spatial-landscape units no L8 and L9) and keep existing forests as potential ecological corridors (spatial-landscape units no L5, L7).

The protection of the natural environment is strictly connected with proper activities on agricultural areas as fields and orchards (Pretty et al. 2018, Zilberman et al. 2018). It is nesesery to realization sustainable development of agricultural ecosystems and increase the the relationship between a farmer and the environment (Piwowar 2020). Smart Farming is a type of farm management based on data which can increase the productivity of these farms and reduce environmental pollution (Saiz-Rubio and Rovira-Más 2020).

Agricultural pollution depends on many factors, so solutions such as vegetated buffer zone around farms and water bodies, as well as other interventions along the landscape, cancomplement on-farm practices for water pollution control. A high level of consumption of mineral fertilizers, especially nitrogen and phosphorus fertilizers, can cause adverse changes in soils and waters (Wang et al. 2017). Buffer zones are as filters that stop the movement of sediments, nitrogen, phosphorus, pescides into water basin adjacent to fields, orchards and pollution from roads (Bentrup 2008, Mateo-Sagasta and Albers 2018). The other sollution to minimalize water pollution is controlled drainage. It is used successfully in many countries The results are enhance water productivity and to reduce pollution (Skaggs et al. 2012, Peng et al 2013, Lu et al. 2016). Water quality parameters with high-resolution satellite imagery are recommend analyses in different study areas at different seasons of the year in order to get a wider range of values of water quality (Yigit Avdan et al. 2019). All these propositions could be used on studded areas, especially on plots adjacent to surface waters (spatial-landscape units as W1, W2, W3), taking care of vegetation at existing watercourses and water reservoirs located in agricultural areas.

CONCLUSIONS

East part of Kalwaria commune is characterised by mosaic types of land use from natural to antropogenic ones, which have got impact on values of natural elements of landscape.

The Authors confrmed the hypohesis that commune has got areas with valuable natural values which should be proper protected and shaping. It was formulated directions how to minimalize the negative impact of anthropogenic pressure on studied areas. Formulated directions could be used on similar analysis area.

It was presented in literaturę very usefulness natural evaluation methods, but they are not constans in whole application. Some stages of evaluation should be modificated becouse of the purpace of evaluation or types of landscape elements, what it was presented

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in this paper. The proper modification of evaluation method, and sucessful approach give many information about natural values important for regional and local planning policy.

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