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The primary aim of the journal and its mission are to spread information and guidance relevant both for authorities responsible for the effective land administration (local, regional and central), scientists and teachers.

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CHANGES IN THE SPATIAL DEVELOPMENT OF FORMER TOWNS APPLYING FOR CITY STATUS. CASE STUDY OF LUBLIN PROVINCE

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ABSTRACT

Motives: In the past 20 years or more, many towns that had lost city status during the partitions of Poland have applied for the restoration of municipal rights.
Aim: The aim of the research conducted in 2020 was to identify changes in the functional and spatial structure and in the public spaces of four towns that had been deprived of municipal rights: Goraj, Izbica, Turobin, and Żółkiewka. The analysed towns are located in the least urbanised part of Lublin Province.
Results: In the course of the research process, changes in the size of developed areas between 1965 and 2020 were analysed, and the functions of newly urbanised areas, their present functional and spatial structure, and the proportion of agricultural homesteads in total housing resources were determined and identified. Additionally, downtown areas in each studied location were assessed with the use of the "sensory perception curve" method, which is also known as Wejchert's method, and local community members were surveyed. The respondents were asked to evaluate public spaces and the functional and spatial structure of each town, and to assess its chances of regaining city status. Survey results indicate that the functional and spatial structure, as well as public spaces in all studied locations justify the efforts to restore these towns' municipal rights.

Keywords: small town, functional and spatial structure, public space, restitution, Poland

INTRODUCTION

For the last 20 years, at least, there has been a noticeable trend of restoring municipal rights to towns that lost city status when Poland was partitioned. Since 2014, this phenomenon has also been noticeable in the Lublin Province, a peripheral region, one of the least urbanised in Poland and one that has been experiencing some definitely adverse demographic processes. The province has 51 towns and cities, including four with county (powiat) status. As many as 47 towns have a population of less than 50 thousand, including 40 with less than 20 thousand inhabitants.

There are specific criteria referring to space, population, functions etc, but they are enshrined in legal documents. It is evident that newly established towns and cities in Poland do not meet many of these

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criteria. The fact of having city status in the past turns out to be the most important. The role of spatial development in the efforts of a locality to regain city status is intriguing from the scientific perspective. It is extremely difficult to draw a clear distinction indicating when a village does indeed become a town or city.

The objective of the research conducted in 2020 was to identify changes in the functional and spatial structure with a particular emphasis on public spaces of four former towns – Goraj, Izbica, Turobin, and Żółkiewka (Fig. 1) – in the context of restoring their city status. All the localities under study are similar in that they have a small population (from about

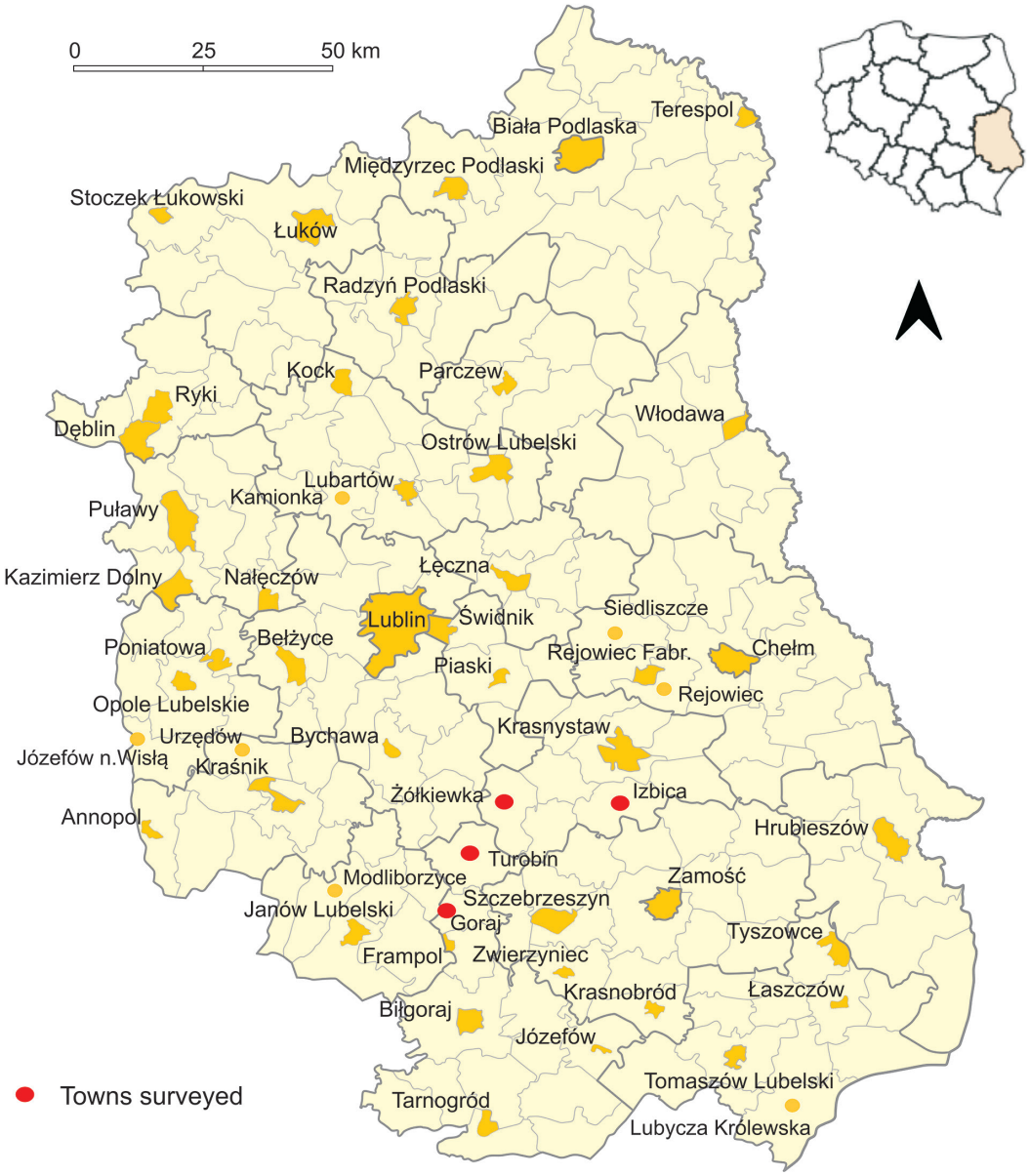

Fig. 1. Location of the localities under study against the network of towns/cities in the Lublin Province
Source: prepared by the authors.

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800 to 1,400 inhabitants) and had been towns from the 15th/18th century until 1869. They are located in the least urbanised part of the Lublin Province, in the Lublin Upland and Roztocze mesoregions. Krzysztofik (2006) believes that these regions are where the idea of urban restitution can be propagated. This is because it is one of the zones of diffusion of the idea of urbanity in Poland, called the Zamosc zone (since the 1980s there has been a trend of restitution of town rights in neighboring towns). It was assumed that the research would answer the question whether the present-day functional and spatial structure (including public space) of these localities could be indicative of their urban character. It should be noted that such research had not been conducted for these localities thus far. However, it is worth noting the study of landscape transformations for selected towns of the Lublin Region (Przesmycka, 2001) and synthetic analyses for the following provinces: Łódzkie (Sokołowski, 2011), Podlaskie (Sokołowski, 2013), the eastern part of Mazowieckie (Sokołowski, 2016), Podkarpackie (Sokołowski, 2017), Lubuskie (Sokołowski, 2018), and Wielkopolskie (Sokołowski, 2022).

LITERATURE REVIEW

The functional and spatial structure of the city

A town is a type of a settlement unit characterised by a continuous built environment and predominance of non-agricultural functions (Szymańska, 2009). From the perspective of Polish law, a town is a locality with municipal rights. However, many authors point out the existence of localities in Poland which do not have the characteristics of a village, but do not have municipal rights either. Przesmycka (2001) describes them as "small towns" and defines them as settlements having or acquiring urban characteristics. Small towns, functioning as centres serving the surrounding rural areas, are a significant element of the settlement structure of a region (Bański, 2022). These settlements usually have a local impact and assume the role of centres serving the neighbouring agricultural areas, usually within a district whose authorities are based in these settlements (Wiśniewska, 1999). However, according to some authors, including Gzell (1996), this basic function of small towns disappeared after World War Two, as a result of which they lost their former development potential.

The spatial layout of a town usually results from its historical origins (Przesmycka, 2001). Szymańska (2009) distinguishes two primary kinds: a regular layout, with strong geometrical trends, and an irregular layout, often determined by difficult terrain conditions. Given that most of the towns in the Lublin region originate from the Middle Ages, it can be stated that the grid layout, characteristic of mediaeval towns, is the predominant type of spatial layout there (Gzell, 1996). The low degree of spatial development of small towns is the reason for a phenomenon, perceived as very positive, namely the existence of a clear boundary between the continuous built environment and the surrounding agricultural areas. A small town is an intermediate form between a typical village and a typical urban environment in terms of building density. Chmielewski (2001) considers this to be a favourable phenomenon considering the need to provide comfort of living to the inhabitants.

The market square or town square is the key public space of a town while also serving as the economic centre of the town and district. It is here where many commercial establishments and services as well as public institutions are usually located (Nowakowski, 1990). In nearly every district town in the Lublin region, the market or town square (or its substitute) is the venue for the weekly fair that combines the economic and social functions. The town square is also a place where most of the cultural and social activities take place. Furthermore, it usually plays the role of an urban and functional dominant feature (Nowakowski, 1990). Besides, assuming that an optimum living space should ensure a sense of familiarity (Pawłowska, 2001), an appropriately developed and utilised town square seems to be a very good basis for creating "small town atmosphere" (Kobylarczyk, 2012).

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In a model functional and spatial structure of a district town, one should strive to segregate services. In general, most of them should be located in the centre, i.e. usually in the vicinity of the town square. Many authors, however, also identify onerous services, such as the sale of building materials, services for agriculture or car repair shops. Many entities providing such services require areas that are quite large in relation to the centre of a town. Other services generate undesirable noise. Therefore, such facilities and entities should be located outside the centre of a town. Furthermore, it is advantageous to concentrate these service providers within a specific area in order to avoid spatial conflict (Kachniarz, 1970). The same principle applies to the location of functional and storage areas in the space of a town. Many authors also indicate that the location of schools and other entities related to education in the vicinity of the town square is undesirable. They should rather be in a location allowing convenient access from the residential areas of the town (Banaszak & Izdebska, 1994).

Since they cover a small area, small towns favour the development of inner pedestrian and cycling traffic. This seems self-evident to a certain degree, but sometimes it is the appropriately organised spatial structure of a town that determines giving priority to motor or pedestrian/cycling traffic. This is of particular importance in towns located along busy national or provincial roads. Prioritising pedestrians and cyclists makes it possible, to some extent, to implement the idea of a compact town (Gehl, 2014).

Restitution of towns

In the middle of the 20th century, after wave of the town degradation had subsided, some towns regained city status. After World War Two, the award or restoration of city rights occurred almost exclusively in localities where industrial facilities existed (Krzysztofik, 2005). In the 1980s, and particularly in the 1990s, following the change of the political and economic system, many former towns in the Lublin region began making efforts to regain city rights (Przesmycka, 2015). According to Krzysztofik (2006), the Lublin Province ranks third in Poland with regard to the number of new towns (the number of towns increased by nearly 20%). Some of them completed their efforts within a few years, a relatively short period, while other towns have undergone this process gradually. These efforts are often manifested in the attention devoted to urban and architectural features typical of small towns, such as the town square and its surroundings (Krzysztofik & Dymitrow, 2015). Krzysztofik (2005) also notes that one of the reasons for that wave of urban restitution was a greater sense of local identity and prestige, and enhanced self-governance, which in turn resulted in the emergence of bottom-up initiatives seeking the restoration of city status to a given locality (Szmytkie, 2015). This occurred and is still taking place sometimes in spite of the demographic and economic trends occurring in these towns. Another interesting phenomenon is the transfer of the idea of the restoration of city rights from town to town (diffusion of the idea of urbanism).

In Poland, the granting of city status to a district or locality is regulated by the Ordinance of the Council of Ministers of 9 August 2001 on the procedure for submitting applications for the creation, merging, division, abolition, and determination of the boundaries of districts, the granting of city status to a district or a locality, the determination and change of the names of districts and the headquarters of their authorities, and the documents required in these matters. The first step towards granting city status is taken by the district council that must submit an application to this effect to the minister responsible for public administration, via the provincial governor. Such an application should contain numerous documents, including the results of public consultation on the matter, a historical outline of the district or locality, information on the employment structure, architectural monuments, as well as an extract from the local spatial development plan containing information on the transport and urban design layout and technical infrastructure.

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The power to grant city status is vested in the Council of Ministers. The explanatory memoranda to the ordinances granting municipal rights show that, for several years, the Ministry of the Interior and Administration (MIAA) has been using five basic criteria to determine whether a district council's application for municipal rights is approved or not. These criteria are as follows: a population of more than 2,000; more than 60% of the inhabitants making their living from non-agricultural activity; a distinct central area of the locality, within which the existence of agricultural homesteads is excluded; having municipal rights in the past, and having basic technical infrastructure such as waterworks and sewerage. Public support, verified during a mandatory public consultation process, is also a very important element in the efforts to achieve city status (Rajan, 2010). However, the criteria to be met by a potential city, as set out by the Ministry of Internal Affairs (MIA), are often very loose and are followed to a varying degree depending on the individual nature of the case (Szmytkie, 2018). Krzysztofik (2006) points out that the requirements mentioned above are followed more strictly when municipal rights are granted to localities that have never had them before, whereas the fact of having held the status of a town in the past is usually the deciding factor for the restoration of municipal rights despite the other criteria not being met. Given the latitude in adhering to the above criteria in the process of granting municipal rights, many authors highlight other factors in favour of granting these rights, such as a sufficient number of historic buildings (Dawidejt-Drobek & Drobek, 2015).

Revoking city status has not occurred in Poland since the 1970s, while the process of granting municipal rights to various rural localities has continued with varying intensity (Fig. 2). Over the last decade, these have been exclusively localities that lost their city status in the past, mainly in 1869/1870 pursuant to the tsarist decree, which was widely regarded as revenge for the participation of Poles in the January Uprising (the surveyed localities also belong to this group).

Many experts believe that prestige is the primary reason why many localities seek city status. When a district town gains municipal rights, the district changes its status from rural to urban/rural, and the district head becomes mayor. It is an honour for the local authorities and residents of such a locality (Dawidejt-Drobek & Drobek, 2015; Szmytkie, 2015). Many district heads seeking the restoration of city status for their localities openly admit that they have high hopes for keeping young people in the district. It is also argued that towns more often attract the attention of potential investors who can help improve the economy of a given district and

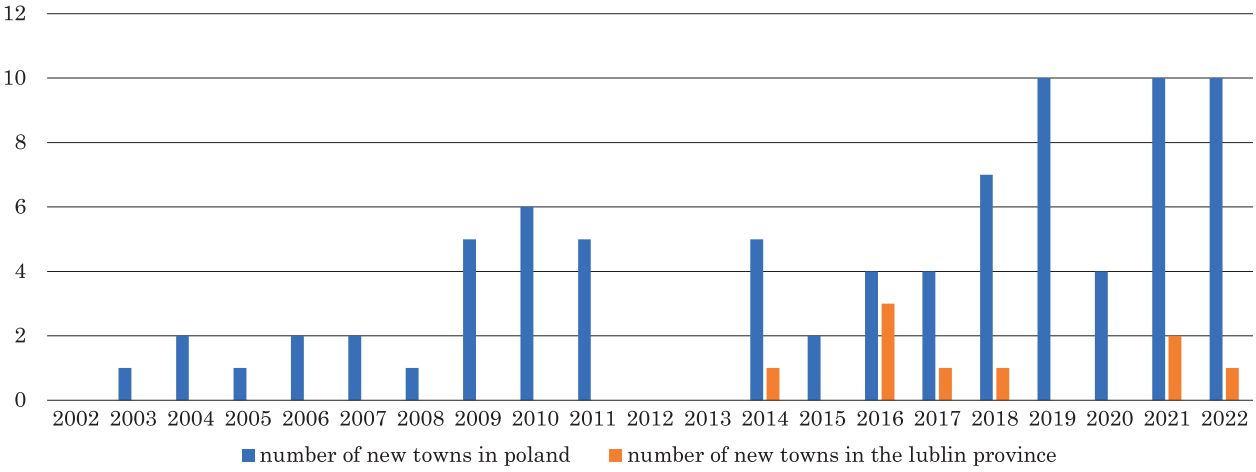

Fig. 2. The dynamic of granting city status in the years 2000 to 2022 in Poland and the Lublin Province
Source: prepared by the authors.

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improve the local job market (Cudo & Rydzewski, 2017). In a town with a newly acquired municipal status, the value of land and properties rises and new transport links can be developed. The availability of EU funds remains a matter of debate. Some experts claim that villages and rural districts have greater chances of obtaining such funding than a town or urban/rural district, while others assert quite the opposite – that the granting of municipal rights increases the availability of external funding (Cudo & Rydzewski, 2017). Residents of some of the towns with restored city status often regard this restitution as an act of historical justice and do not expect their lives to noticeably improve following this change. An example of such a locality is Opatowiec (Świętokrzyskie Province) that regained its city status in 2019, after 150 years, and has a population of just slightly more than 300 people. This shows the flexible attitude of the Ministry of Home Affairs and the Interior towards the criteria to be met by a locality granted municipal rights (Szmytkie, 2018).

According to Sokołowski (2022), what primarily differentiates former towns with a chance to regain city status from other former towns and most rural localities are the following characteristics: relatively high population density, urban spatial layout and built environment, well-developed social and functional links with the surroundings, multifunctional character of the economy (clear majority of people working outside agriculture), above-average (in relation to most villages) development of social infrastructure establishments, and technical infrastructure facilities. Localities having most of the characteristics listed above stand a real chance of being included in the 'cities' category. Gaining city status, however, involves meeting several requirements, including demographic criteria (2,000 inhabitants is the informal threshold), spatial and urban planning criteria (e.g. having an urban spatial layout and urban character of the built environment, an enacted local spatial development plan, an adequate level of technical and municipal infrastructure development), functional (having institutions with supralocal functions, at least two thirds of the population employed outside agriculture), and social criteria (support of the local community).

MATERIALS AND METHODS

In the first, preliminary stage of research, the local determinants affecting the localities under study were analysed based on, among others, planning and strategy documents as well as field inventory-taking. The main stage consisted of several parts. The first one was about examining changes in the functional and spatial structure of Goraj, Turobin, Żółkiewka, and Izbica in the years 1965 to 2020. This time frame was chosen due to the limited access to archival spatial data, including large-scale topographic studies. Changes in the size of the built-up (developed) areas and the dynamic of these changes in the periods 1965–2003 and 2004–2020 were analysed within the cadastral districts of Goraj, Turobin, Żółkiewka, and Izbica. This was carried out using QGIS software, while a 1:10 000 topographic map from 1965 (provided via the Mapo Tero application) and orthophotomaps from 2003 and 2020 (provided by geoportal.gov.pl) were used as base maps. Then the present-day functions of sites located in areas urbanised after 1965 were examined using data obtained from the Topographic Objects Database as well as the authors' own observations.

The next step was to analyse the present-day functional and spatial structure of the localities under study taking into account the development type, i.e. residential housing, services, functional/storage areas, and public spaces. This analysis was carried out based on the Topographic Objects Database as well as the authors' own observations. Since some public spaces located in the localities under study did not meet all the criteria defining them, the authors distinguished semi-public space as well. In view of some indications in the scientific literature suggesting an intermediate form between public space and private space, the authors refer to a space used by the local community only on certain days, i.e. closed on a daily basis and not fully accessible, as semi-public space.

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An attempt was then made to estimate the share of agricultural homesteads in total housing stock in the centres of the localities under study. It is assumed that the central part of each locality comprises the immediate surroundings of the town square/market square, of comparable size, bounded by the streets adjoining the square, where there is a strong concentration of central functions such as service and retail establishments or public institutions. The analysis was carried out based on an up-to-date orthophotomap from geoportal.gov.pl as well as a field inventory.

The sensory perception curve method, also known as Wejchert's method (1984), was then applied. The key assumptions of this method were adapted to the needs of assessing the functional and spatial structure and public spaces of a given fragment of space of the localities under study. At first, the assessment path was determined. In each of the four cases, it was a 500-metre stretch of the main street of a given locality, running along one of the sides of the town square/market square. The score-based assessment was performed at ten equidistant points, taking into account six criteria (accumulation of public institutions, urban centre services, onerous services, aesthetics of the landscape, harmonious composition of all landscape elements, presence and attractiveness of public spaces). The rating scale ranged from 0 to 10, where 0 denoted an undesirable state and 10 denoted an ideal state. In the case of favourable factors, such as the accumulation of urban centre services, a high score meant a high level of accumulation, whereas in the case of the only negative factor among the six, i.e. the accumulation of onerous services, a high score meant a very small number or absence of such facilities. Urban centre services are understood as those kinds of activity whose concentration in the centre of a locality leads to mutual benefits, i.e. the service-providing establishment enjoys having more clients while its vicinity becomes a place for intensive human interactions in the economic and social sphere (e.g. grocery stores, hairdressers, florists, pharmacies). Onerous services are construed as those kinds of activity whose location in the centre does not impact the profitability of an establishment, but it generates effects that are harmful to the environment and its users, such as noise, pollution, non-aesthetic appearance (e.g. building depots, car repair shops, agricultural produce dealers, agricultural machinery dealers). The results of the research conducted using a modified Wejchert's method were compiled using Microsoft Excel in the form of line graphs. They present the averaged score of the evaluation by each criterion at each point of the surveyed centers. In addition, the average score was calculated for the entire assessed route in each center.

The final stage of the research consisted of conducting a survey among the inhabitants of the localities under study. Twenty persons from each locality were surveyed. The survey consisted of six questions. In the first, the respondents were asked to evaluate the development of public spaces. The next two questions were aimed at examining how the respondents evaluated the functional and spatial structure of their locality and what problems they saw in its functioning. The further two questions were about the evaluation of the chances for regaining city status and residents' perception of their locality as a town, village or something in between. The last question offered an opportunity to give a free response to the proposed changes in the space of the localities under study.

RESULTS

The analysis of local determinants in the localities under study unequivocally demonstrated that the functional and spatial structure and public spaces are what clearly sets each locality apart from the neighbouring rural localities. Since these localities are situated in areas subject to depopulation, it should be noted that, unlike in the neighbouring villages, the abandoned houses there converted into shops and other service establishments (particularly in the centres). On the other hand, significant changes had occurred in the appearance of the localities under study as a result of wooden buildings being displaced by brick buildings after World War Two. Due to these

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changes, the buildings characteristic of small towns disappeared from these localities to a large extent, giving way to the often chaotically distributed Modernist single-family and multi-family housing. What is also quite significant is a low coverage with local spatial development plans (only Goraj is fully covered by such a plan) and the superficial nature of the provisions in the existing plans. The path that is most frequently chosen by district authorities is the preservation of the current state of spatial development, which undoubtedly has an adverse impact on the formation of spatial order. Summing up the topic of spatial planning in the localities under study, it is also worth noting the way that district towns are distinguished from other localities in spatial development conditions and directions studies. Goraj, Turobin, and Izbica were indicated in these documents as single-family housing areas and main service centres forming the urban zones in the space of districts. In the case of Żółkiewka, on the other hand, there is no tendency to highlight its "urban nature": single-family housing is interspersed with agricultural homesteads.

The analysis of the changes in the functional and spatial structure in the years 1965–2020 clearly demonstrates that all the localities under study saw an increase of developed areas but the changes had a slightly different dynamics, direction, and character, and the intensity of building activity varied in the particular periods within the time frame under study (Fig. 3). While the intensity of building activity in Izbica (where it reached the highest level), Żółkiewka, and Goraj recently increased, it decreased in Turobin. On the other hand, taking into account the entire study period, the highest degree of spatial development can be observed in Turobin alongside Izbica. Żółkiewka is at the other end of the spectrum, with the lowest, virtually negligible increase of developed areas in the study period. Such a gap between the fast-developing Turobin and Izbica and the slowly developing Goraj and Żółkiewka is confirmed by the analysis of the functions of the newly-built structures in areas urbanised after 1965. In Turobin and Izbica (unlike in Goraj and Żółkiewka), relatively many new single-family houses were recorded. Besides, a lot of outbuildings were built in all the localities under study. This resulted from the addition of garages, halls, and sheds to the existing homes; these additions can hardly be viewed as a manifestation of spatial development because they did not correspond with an increase in the number of homes and settlement of new residents.

The analysis of the current functional and spatial structure provides a picture of the distribution of public spaces and service areas in the space of the localities under study. In all of them, functional and

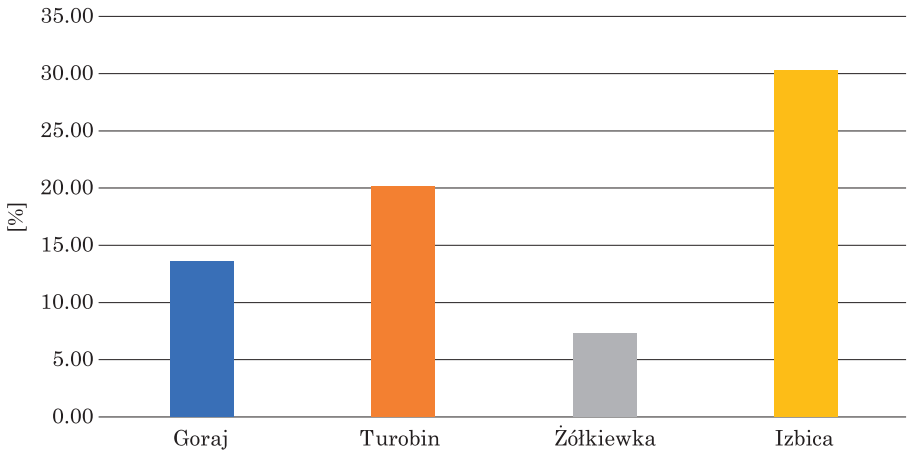

Fig. 3. Changes of urbanized area of Goraj, Turobin, Żółkiewka, and Izbica in the years 1965 to 2020

Source: prepared by the authors.

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storage areas, in accordance with good planning practice, are clustered in one place and relatively isolated form the rest of a given town. Service areas, on the other hand, are located in the centres of the localities under study, with the greatest concentration in the vicinity of the market square in Goraj, Turobin, and Izbica. Furthermore, Turobin and Izbica also feature a few other, smaller service centres located at some distance from the main town square. The situation in Żółkiewka is slightly different in this respect because services are clustered, sometimes chaotically, along Żółkiewskiego Street, rather than around the town square. With regard to public spaces, the best situation occurs in Turobin and Izbica where there is more than one attractive public space (it is the so-called Fire Station Park, apart from the town square, in Turobin, and recreational grounds by the Wieprz river in Izbica). The town square is the only space of this kind in Goraj and Żółkiewka. However, it is worth mentioning that the inhabitants of Żółkiewka have access to public space located in the recreational area by the artificial lake in Żółkiew Kolonia, less than one kilometre from the town square in Żółkiewka. During the analysis of the functional and spatial structure of the localities under study, it was observed that the absence of local spatial development plans led to a high degree of dilution of the built environment in Izbica.

Another analysis, aimed at estimating the share of agricultural homesteads in total housing stock in the centres of the localities under study, confirmed the dichotomy dividing the localities into two pairs: Goraj and Żółkiewka versus Turobin and Izbica. In Goraj and Żółkiewka, the share of homesteads the centre, though never higher than 15%, was clearly higher than in Turobin or Izbica (Fig. 4).

The authors' assessment of the functional and spatial structure and of the public spaces in the centre of each of the localities under study (along with the town square), modified with Wejchert's sensory perception curve method, demonstrated certain differences in the perception of the functioning of the specific parts of the centres as well as all the studied localities compared to one another (Fig. 5). In Goraj and Turobin, and partially in Izbica, it is the town square and its immediate vicinity that undoubtedly stand out thanks to the presence of all the characteristics of the centre of a small town. In Żółkiewka, this assessment is more evenly distributed due to the lack of a distinct centre and the distribution of services and public institutions along Żółkiewskiego Street. The town square does not stand out from its surroundings. In all the other localities under study, the high score of the town square and its vicinity results from the fact that the town square is the most attractive and often the only

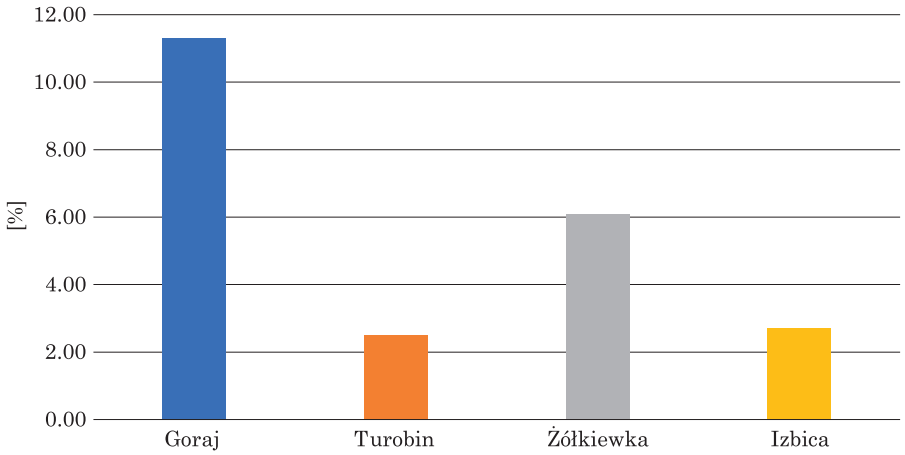

Fig. 4. The share of agricultural homesteads in total housing stock in the centre of the localities

Source: prepared by the authors.

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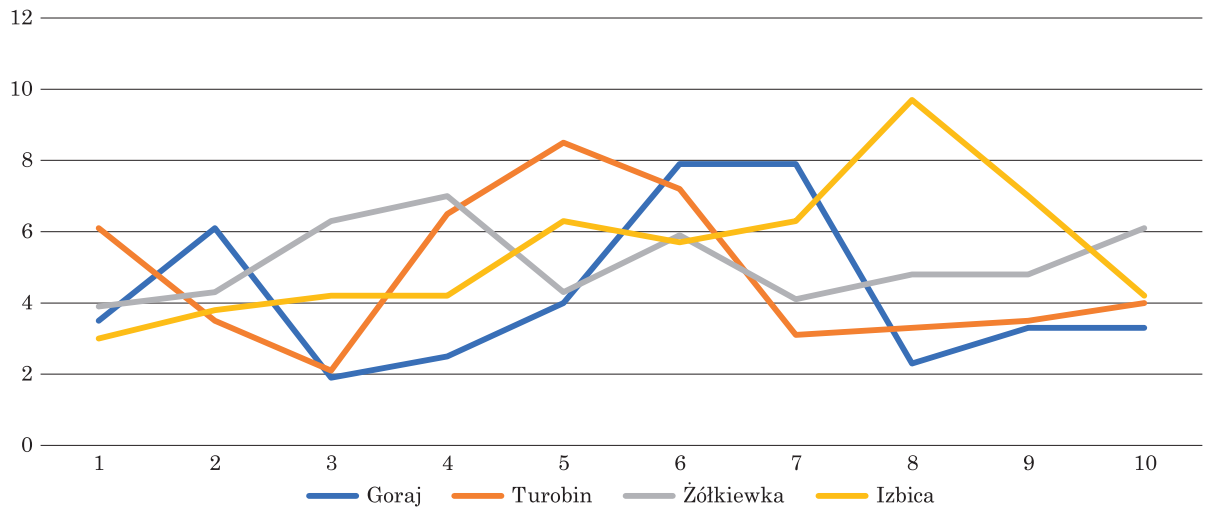

Fig. 5. The sensory perception curves of the averaged index of assessment of the functional and spatial structure of the studied centers

Source: prepared by the authors.

so intensively used, multifunctional public space. On the other hand, if the mean score for the entire route assessed is considered, Izbica ranks first (mean score: 5.45 points) and Żółkiewka ranks second (mean score: 5.13 points). Without a doubt, this is influenced by the distribution of urban centre functions in these localities along the main streets: Lubelska Street in Izbica and Żółkiewskiego Street in Żółkiewka.

The survey results revealed what residents and users thought about the space of the localities under study. The residents of Izbica were the most satisfied with public spaces, which may result from the diversity of such spaces, e.g. existence of recreational areas by the Wieprz river, in Izbica. The inhabitants of Goraj, Turobin, and Izbica had a positive view of the functional and spatial structure of their locality. On the other hand, the chaotic distribution of services and lack of a distinct centre were reflected in the much poorer opinions expressed about Żółkiewka. Despite a generally favourable perception of the space of Turobin, the respondents there indicated the greatest number of issues in its functioning, the most common being the lack of an appropriate town or market square and lack of places for recreation. This may be due to the fact that the regular Turobin fair, taking place in the very heart of the town and regarded as the biggest in the area, which leads to many spatial conflicts and dissatisfaction of residents and users of the space of Turobin. The lack of places for recreation is a problem that was almost unanimously pointed out by the respondents in all the localities under study, which suggests a general trend in society to practice sports and keep physically fit, as well as the need for recreation in the open air. This is a hint for planners and local governments which should seriously consider ensuring the effective development of recreation areas in the future.

The respondents in Izbica showed the highest level of awareness of living in a town. This corresponds with the high mean score given to the centre in Izbica according to the modified Wejchert method. Żółkiewka is at the other end of the spectrum in this respect. Goraj stands out with regard to the assessment of chances for regaining city status since nearly all the respondents expressed the view that Goraj would soon become a town. According to the authors, this is directly related to the fact that when the survey was conducted, the efforts for the restoration of Goraj's city status were already well under way, of which the inhabitants were surely aware of. The respondents in Turobin were slightly more sceptical on this subject. In Izbica, and particularly in Żółkiewka, the prevailing view is that the granting of municipal rights is a remote prospect. According to the authors, these

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patterns in the respondents' answers are largely linked to how the question of regaining municipal rights by a given locality is viewed by local governments as well as whether and to what extent local governments take steps towards the restoration of municipal rights.

Despite some differences observed between the localities under study in the course of the survey, it should be noted that in many cases these are minor differences. Although these differences quite clearly translate into the distinction between localities with a more and less "urban" character, they should not lead to conclusions about which of these localities have a chance and should become towns, and which should not. The present survey makes it possible to determine the order in which these processes should occur. The survey results also show how much effort the local governments of the localities concerned should make, and in which areas, so that the functional and spatial structure of these localities corresponds to the structure of a small town. In view of the above, Izbica has the best chance of regaining municipal rights, of course considering the spatial aspect only, while Turobin comes in second. In these two cases, the influence of exogenic factors, particularly the location, is significant. Izbica owes many of its developmental factors to its close proximity to Krasnystaw and Zamość, which can result in a more effective flow of capital and people. Turobin, on the other hand, with its more peripheral location in relation to medium-sized towns than the other localities under study, can be viewed by many as a potential place of concentration of economic activity and possible development of residential functions for the neighbouring rural areas.

Goraj lags behind Izbica and Turobin in many respects such as poor spatial development, absence of some institutions (e.g. post office, secondary school), and high percentage of agricultural homesteads in the centre. On the other hand, in terms of aesthetics, Goraj has the most attractive central area along with the town square (Fig. 6). Finally, although Żółkiewka has some potential, it shows a lack of "urban" aspirations

Fig. 6. The 600th Anniversary Market Square in Goraj
Source: own photo.

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among its residents and district authorities, which is also reflected in the spatial policy.

CONCLUSIONS

The survey results demonstrate that efforts aimed at the restoration of city status are justified by the functional and spatial structure and public spaces of all the localities under study. The justification is not limited to historical justice, but it is also based on the fact that in most cases the functional and spatial structure of these localities is definitely different from that of a typical village. Typically, new towns are not artificial entities elevated to city status exclusively thanks to the political efforts of their mayors. The restitution process is largely based on restoring their former rank and setting the future development of these localities on the right track.

Taking into account the spatial/functional and social criteria, it has been concluded that Izbica has the best chance of regaining city status, followed by Turobin. Goraj has the most aesthetically attractive public space and an up-to-date local spatial development plan. Besides, the inhabitants clearly expressed their support for the restoration of municipal rights.

The survey was conducted in 2020. Since then, two of the localities under study have already regained their municipal rights: Goraj in 2021 and Izbica in 2022. This can be evidence of the diffusion of the idea of urbanism (cf. Krzysztofik & Dymitrow, 2015), particularly if the other localities – Turobin and Żółkiewka – regain their city status in the years to come. According to the 25 July 2022 Ordinance of the Council of Ministers, 15 localities are to be granted municipal rights on 1 January 2023, but the application submitted by Turobin in 2022 was rejected. The applications from Milejów and, earlier, Końskowola, were unsuccessful too. However, these rejections resulted from administrative or social issues rather than an inappropriate functional and spatial structure. The functional and spatial criteria, as well as the social criteria reflected in the support from residents, should be a significant part in the efforts to obtain city status. Having an adopted local plan is also important (cf. Sokołowski, 2022). The fact of having municipal rights in the past is insufficient. City status offers opportunities for real development, but can also lead to the stagnation of a town (cf. Cudo & Rydzewski, 2017). Idealistic beliefs ("city status equals greater prestige", "something to be proud of") are often a manifestation of the aspirations of the local authorities. A clash between such aspirations and strong rural traditions can lead to divisions among residents. Therefore, it is crucial to secure the backing of the population and define the prospects of development after obtaining city status. The surveys made it possible to identify centers whose residents express support for the restitution of urban rights. In addition, they made it possible to assess public spaces and identify problems in their functioning. Public spaces are part of a place's identity and, according to Zaniewska et. al. (2015), it is important to take care of a local identity in efforts for restituted towns which is undermined by investment projects inconsistent with the landscape and by the liquidation of historical sites. A new identity should not be understood exclusively in terms of tourism development even though the latter does offer opportunities (cf. Kosiński, 2000).

Finally, it should be noted that while the present research consists of case studies, it shows general trends occurring in all of Poland, similarly to efforts to gain health resort status (cf. Bernat & Harasiumiuk, 2019). The method used in this research makes it possible to assess the chances of a locality to regain municipal rights from the structural and functional perspective. It can be used for other localities provided that a greater percentage of inhabitants takes part in the survey.

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THE USE OF CAMERA TRAPS FOR IDENTIFYING VARIOUS TYPES OF FOREST RECREATIONAL ACTIVITIES ON THE EXAMPLE OF WDECKI LANDSCAPE PARK

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ABSTRACT

Motives: Unlike nature monitoring, recreational activities in forests are not monitored regularly over wide areas. Therefore, research studies involving various methodologies are needed to generate valuable data for forest management.
Aim: The aim of the present study was to identify different types of forest recreational activities in Wdecki Landscape Park based on data recorded by seven camera traps between 12 December 2019 and 12 December 2020.
Results: The collected data revealed that walking, biking, and mushroom picking were the most popular recreational activities. Most activities were undertaken by single visitors or groups of two visitors between 10:00 a.m. and 4:00 p.m., mostly on weekends and in the autumn.

Keywords: recreation, tourism, forest, forest visits, visitor monitoring

INTRODUCTION

The perception of the role of forests has changed over the centuries. Until the beginning of the 20th century, the forest was perceived mainly as a place for timber production (Paschalis-Jakubowicz, 2005). Nowadays, model of multifunctional and sustainable forest management provides opportunity for forest areas to fulfil three different functions in the same place and time: production, protection and social. As numerous scientific studies show, social function is very important in society's opinion (Gołos, 2013). That function covers a wide range of issues, including those related to recreation and tourism (Roovers et al.,

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2002). The explanation for the great importance of this function can be seen in a generally increasing interest in contact with nature. The natural environment, mainly forest areas, has a positive effect on well-being and can be a key factor in improving and restoring mental balance disturbed by fatigue (Furuyashiki et al., 2019). As indicated by van den Berg et al. (2003) and Staats et al. (2003) natural environments more than urban environments allow regeneration. Moreover, scientific studies developed over the years show that contact with nature reduces stress level (theory of psychophysical stress reduction) (Ulrich, 1981; Ulrich et al., 1991; Hartig et al., 2003), distances from business activities and family matters (attention regeneration theory) (Kaplan, 1995) or has a positive effect on improving concentration (Tomalak, 2006). According to Gołos (2003), a forest is a place where the inhabitants, especially of urban areas, can fulfill one of their basic needs i.e. contact with nature. This need was also noticeable during the COVID-19 pandemic (Derks et al., 2020; Ugolini et al., 2020). Recreation in forest areas can take various forms of active and passive recreation. Among the most popular forms of activities walking, running, nordic walking, biking or gathering forest fruits should be listed (Ciesielski & Stereńczak, 2018). The demand for recreational activities is also changing. In addition to the above-mentioned "traditional" forms of activity, new forms of recreation such as bushcraft or geocaching are becoming more and more popular nowadays (Samołyk, 2013; Ciesielski & Stereńczak, 2018). The State Forests, which manage more than 77% of the forests in Poland, undertake numerous activities to adapt the recreational infrastructure to the needs of different user groups. The development of the infrastructure aims, among other things, to protect natural resources from overexploitation by recreation and tourism (Hadwen et al., 2008; Lyon et al., 2011). To take appropriate action, State Forests need tools and data to make decisions that minimize the negative impacts of recreation on forest ecosystems. The data and tool are especially important for agencies that manage forests in agglomeration and near major cities as well as forests in areas of high natural and landscape values.

LITERATURE REVIEW

In order to provide the agencies responsible for forest management with information on the time and place of activities in forest, research has been conducted for many years in the area of recreational use of forest. The most popular method used in the research have been the questionnaires taken on samples of different sizes and characterized by different socio-demographic profiles of the sample, and with different scale of study (local, regional, country) (Pietilä et al., 2015; Gundersen et al., 2017). Data were collected on-site using variety of techniques (including written surveys, direct questionnaire interviews [PAPI – Paper & Pen Personal Interview], personal interviews supported by computer techniques [CAPI – Computer Assisted Personal Interview]), as well as by telephone (CATI – Computer Assisted Telephone Interview) and via the Internet (CAWI – Computer Assisted Web Interviewing) (Cessford & Muhar, 2003). With the help of questionnaire surveys, a diagnosis of the temporal and spatial distribution of activities in forest areas was made. Based on the answers of the respondents, it can be stated that the recreational use of forests is various and depends on the time of a day, a day of the week or season, as well as the form of the activity (Roovers et al., 2002; Arnberger, 2006; Janeczko & Woźnicka, 2009). Surveys were also used to identify: the need for recreation in the forest (Dudek, 2016a), factors influencing the attractiveness of forest areas, factors disturbing recreation (Gundersen & Frivold, 2008; Nielsen et al., 2012; Gołos, 2013), and preferences regarding recreation infrastructure and forest management (Verlič et al., 2015; Dudek, 2016b). In some studies (Gołos, 2013), respondents indicated which areas they preferred to visit based on a direct questionnaire, but it is not certain that this is true. Kienast et al. (2012) used a grid of 1 km x 1 km base squares to indicate the places that respondents visit for recreational purposes. Respondents indicated areas where they were spending time for recreational purposes on weekdays and weekends. In the work of Meijels et al. (2014), in addition to answering the questionnaire, respondents were asked to record their

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movement route through the forest complex using a GPS device. The information recorded by GPS made it possible to indicate the spatial distribution of the subjects, the distances they travelled, and the locations and times of stops (Taczanowska et al., 2008). A few studies also used pyroelectric sensors (Taczanowska et al., 2017; 2018) and video cameras (Arnberger, 2006) on forest areas. Pyroelectric sensors have been used much more frequently in the analysis of tourist traffic in national parks in Poland (Spychała & Graja-Zwolińska, 2014), e.g., in Stołowe Mountains (Rogowski, 2017; 2020), Bieszczady (Prędki, 2012), and Tatra (Hibner, 2014). As Willberg et al. (2021) point out, more accurate information about the location and timing of activity can be obtained with data from GPS recipients than with data from surveys. According to Lupp et al. (2021), an alternative source of quantitative and qualitative data on recreation in forests can be data from camera traps. They provide continuous data 24/7 and, most importantly, do not require the availability of large numbers of people to operate them and are easy to use. So far, camera traps have been used mostly for research related to wildlife monitoring, but according to Lupp et al. (2021), they can also be used as a data source for describing recreation. Data collected by Arnberger et al. (2005) showed that the difference between the number of people detected by counting in the field and the data from camera traps was 15%.

Monitoring of recreational use of the forest is rare, and most forest management agencies in Europe do not conduct this type of monitoring. Therefore, any research in this area, even for the smallest forest complexes, can provide the basis for effective management of these areas (Cessfor & Muhar, 2003). Taking above into consideration, the aim of the present study was to determine the recreational use of forest areas in the Wdecki Landscape Park area based on data collected by seven photo-traps. The study attempted to answer the following research questions:

1. At what time of the day, week and year do recreational activities take place in forest areas?
2. How often and when do different user groups participate in recreation activities?
3. Are forestry activities carried out during the periods of lower recreational use?

MATERIALS AND METHODS

The research area was located in one of the largest forest complexes of Poland – Bory Tucholskie. More precisely, in the southwestern region of the Wdecki Landscape Park. The park was established by Regulation of the Voivode of Bydgoszcz on February 16, 1993 (Regulation, 1993). The park with its buffer zone covers 23786.39 ha, including 4609.15 ha buffer zone. According to the land survey, 69.6% of the park is covered by forests, 27.2% is agricultural and urbanized land, and 3.2% is water. The forest areas of the park are located in the following forest districts: Osie, Trzebciny, Dąbrowa, and Zamrzenica. There are 3 nature reserves (Dury, Brzęki and Miedzno) near the camera traps, where there are many rare species of plants and animals, which are protected under the active protection of endangered species program. Here the influence of two extremely different climates is noticeable: the continental Eastern Europe and, to a lesser extent, the maritime climate of Western Europe. The number of frosty days per year is 100–110. Precipitation averages 450–550 mm per year, with snow cover lasting about 50–70 days, longest in the forest areas. The growing season lasts about 210–220 days, from the end of March to the first days of November. During the growing season, precipitation is about 280–340 mm (Boiński, 1999).

The analysis of tourist pressure in the Wdecki Landscape Park was based on the material recorded by camera traps. Camera traps have been installed in a forest area from approx. 4 km (camera traps – B, C) to 9 km (camera traps A) from the nearest buildings in Osie (approx. 3 thousand residents). These devices were installed in the stand on the tree stem at the intersection of forest paths. The cameras were set to record 30 seconds movies with an interval of 1 seconds. Trigger speed of the cameras was 0.2–0.7s (recommended value from the literature, including Weingarth et al. (2013). Cameras operated around the clock. The cameras collected data from 12.12.2019 to 12.12.2020. After downloading the

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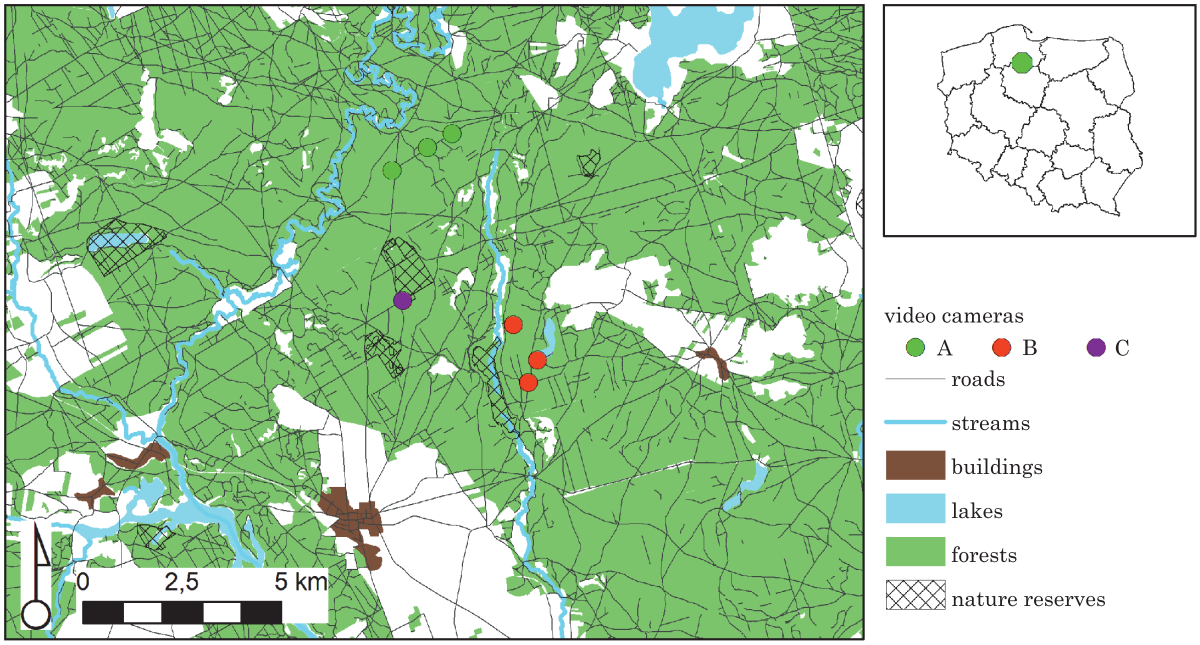

Fig. 1. Location of the study area
Source: own preparation.

data from the cameras about the recorded activities, they were divided into two groups: pedestrians and vehicles. This was then done with Powershell to avoid errors in manually entering dates and times. Finally, only information about pedestrians was used for the analyzes. Then, each record (one activity) in the database was described in detail, including: number of people (single visitors, group of people (2 and more without classification into family, pair etc.), behaviour (forest work, walking, biking, nordic walking, mushroom picking, jogging, hunting, other) and the date and time of registration of the activity. The information collected in the database was analyzed according to the selected periods: hours, days of the week, and months, broken down by registered pedestrian behaviour. Information from camera traps was also analyzed for the selected subareas (A, B, C) (Fig. 1). Statistical analyzes of the differences in the number of registered activities were also performed using the Kruskal-Wallis test. All calculations were performed with the STATISTICA 13.1 package (Dell Inc., Tulsa, OK, USA).

RESULTS

A general overview of recreational activities in the park

During the analysis period, the camera traps registered a total of 1358 people. The most common activity was walking (29%), followed by biking (27%) and mushroom picking (20%) (Chart 1). In the distinguished sub-areas A and C, walking was also the most popular (26.4% and 37.7%, respectively). In area B, 35.6% of activities were related to forest work and 19.5% were walks.

From the detailed data analysis, it was also possible to identify whether the activity was performed by single visitors or in groups (two or more people) (Chart 2). Considering all activities, 50.8% of them were performed by single visitors and 33.1% in groups of two. Mushroom picking and biking were also activities that were mainly done by single visitors (56% and 64%) and in groups of two (22% and 26%). Thirty-nine percent of the registered persons

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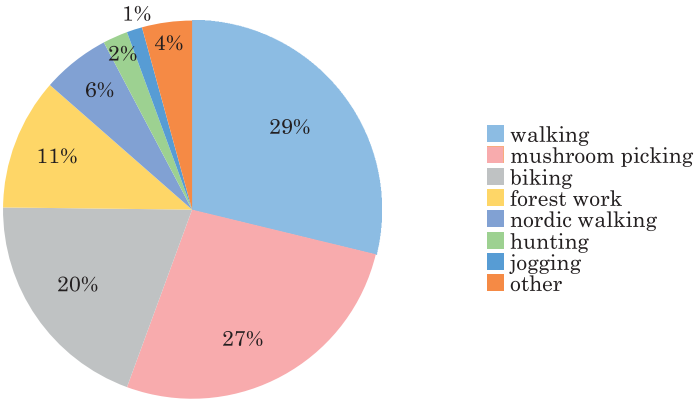

Chart 1. Percentage of people undertaking certain recreational activities
Source: own preparation.

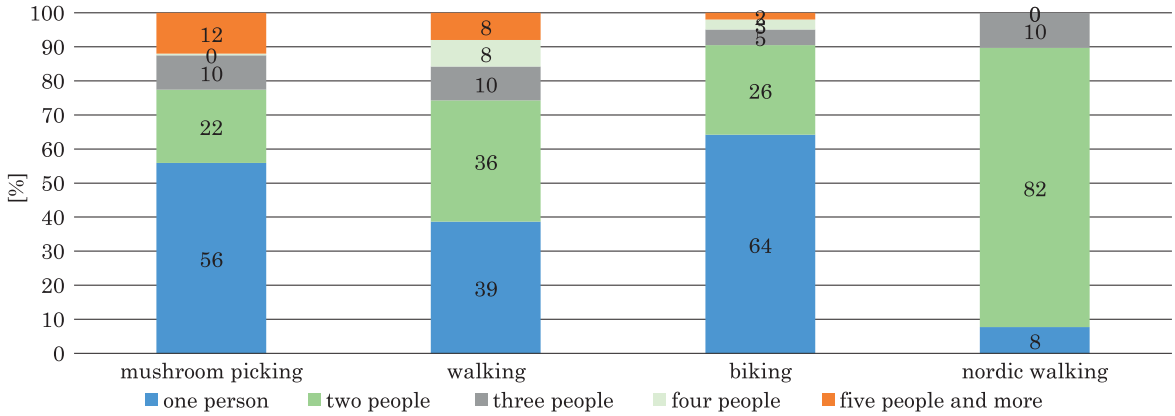

Chart 2. Percentage of people undertaking the selected activity individually and in groups of 2 or more
Source: own preparation.

undertook hiking alone and 36% in groups of two. For nordic walking, only 8% of the people opted for a single activity and 82% for a group of two. Groups of 5 people were observed picking mushrooms (12%), hiking (8%) and biking (2%).

Daily visitation dynamics (visitation per time of day)

The temporal distribution of activities shows that activities were carried out between 4:00 a.m.–9:00 p.m. In the morning hours (4:00 a.m. – 10:00 a.m.), 7.3% of all activities were recorded in the entire study area. 83.6% of activities took place in the early afternoon hours, lunch time and afternoon (10:00 a.m. – 4:00 p.m.). The remaining 8.1% of activities occurred after 4:00 p.m. The peak of activity was reached at 12:00 a.m. (17.9%). In areas A and C, the percentage distribution of activity was similar to the whole area. It should be noted that the percentage of activity in area A at 12:00 a.m. was 22.2%, which is 4.3 percentage points more than the result for the whole area. In the last area (B) the highest percentage of activity was recorded at 3:00 p.m., it was 20.7% (Chart 3). Particular activities were performed at the following hourly intervals: running – 12:00 a.m.–4:00 p.m., nordic walking – 11:00 a.m. – 5:00 p.m., walks – 8:00 a.m. – 8:00 p.m., mushroom picking – 5:00 a.m. – 6:00 p.m., hunting – 6:00 a.m. – 8:00 a.m. and 5:00 p.m. – 9:00 p.m.

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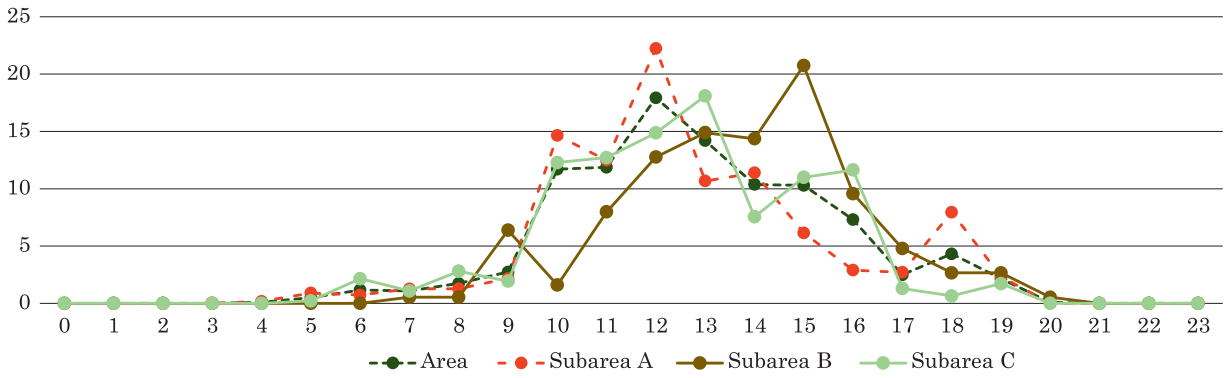

Chart 3. Percentage of people registered by camera traps in particular hours
Source: own preparation.

Weekly visitation dynamics (visitation per day of week)

From Monday to Thursday, the percentage of activities initiated was similar, ranging from 5.3% on Thursday to 9.6% on Tuesday. About 15.9% of all activities during the week were recorded on Friday. Significantly more activities (p-value 0,000) were undertaken on weekends (Saturday–Sunday), when 53.2% of activities occurred (Chart 4). There were no differences between individual areas or between areas and the entire study area. The individual activities were also carried out mainly on weekends. It is only worth mentioning that: 4.6% of forest work took place on weekends, i.e. during the highest recreational activity and 75.9% of all data related to nordic walking were reported on weekdays.

The percentage distribution of activities on a weekly basis was different in the different seasons. In winter, 43% of all activities took place on weekends; in summer, this percentage was similar and amounted to 40%. In spring it was higher and reached 58%, and in autumn 63% of activities took place on weekends (Chart 5).

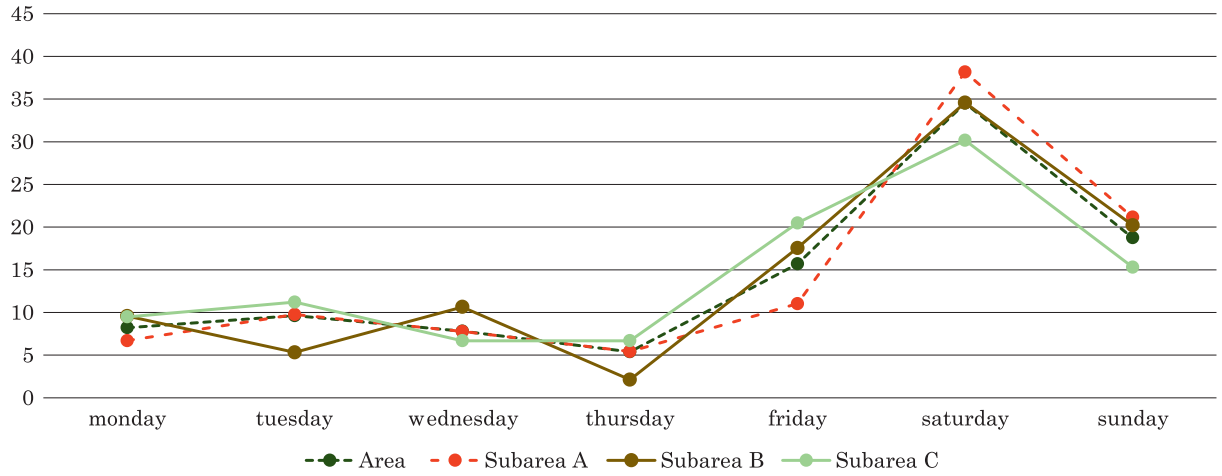

Chart 4. Percentage of people registered by camera traps on individual days of the week
Source: own preparation.

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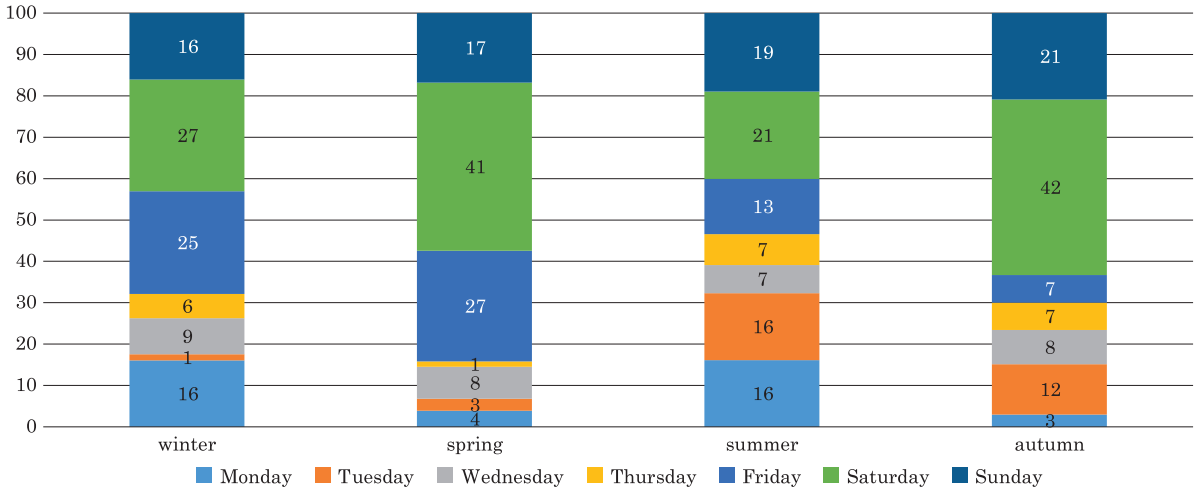

Chart 5. Percentage of people recorded by camera traps on individual days of the week and seasons of the year
Source: own preparation.

Monthly visitation dynamics

The most activity was observed in autumn (36.2%), followed by summer (26.7%), spring (25.7%) and winter (11.3%). The most popular month was October with 29.3% of all activity. Two peaks of activity in June and in September and October were recorded. There were no differences in the number of activities in each month in the distinguished areas A, B, C, except pairs: July–June, July–October, and January–June (Chart 6). There are significant differences in the number of visitors to forest areas in the following pairs: winter–spring (p-value 0,002), winter–autumn (p-value 0,000), summer–spring (p-value 0,002) and summer–autumn (p-value 0,003). Area C in winter was significantly more often used than area A, and in spring area B than area A. Individual activities varied on a monthly basis, i.e:

1. 96.6% of hunting place in the period September-November;

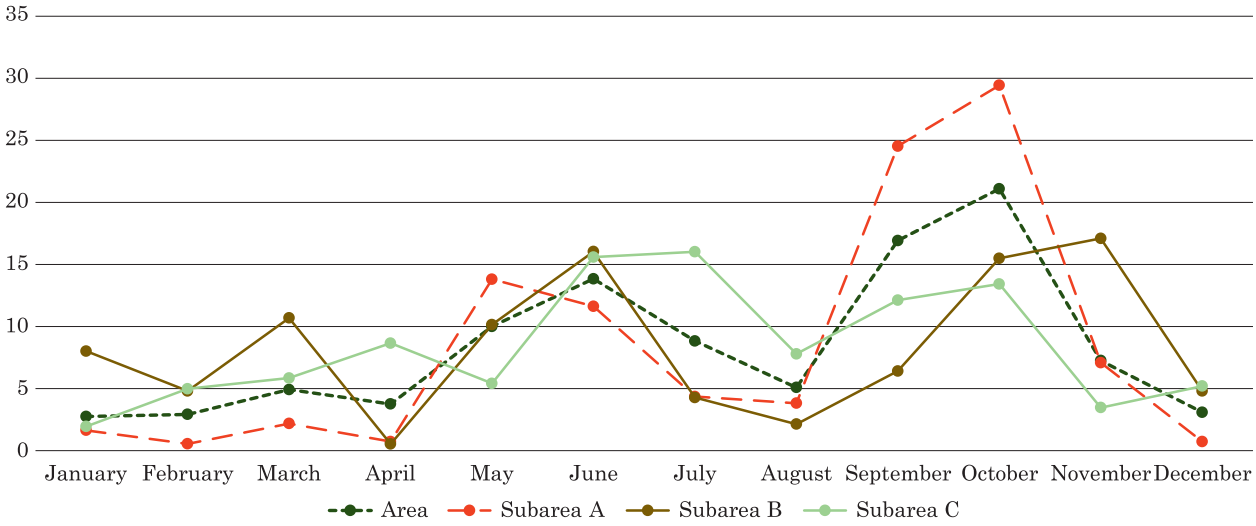

Chart 6. Percentage of people registered by camera traps in months
Source: own preparation.

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2. 75.2% of forest work were carried out in the winter period (December-March), and only 1.3% in the holiday period (June-August);
3. 81.9% of mushroom picking were observed in September and October, and all activities took place from June to November;
4. 80.1% of biking took place from May to September, with the highest percentage in June (21.8%);
5. 39.7% of walking occurred in May and June, and this activity continued throughout the year;
6. 30.4% of all observed nordic walking activity took place in May.

DISCUSSION

The use of activity monitoring in natural areas results from the need to answer five basic questions: where does recreation occur (spatial distribution), when (temporal distribution), who stays in the area and why, and what activity are undertaken. Different monitoring methods allow answering those questions at different levels (Willberg et al., 2021). The indirect monitoring method used in this article, i.e., camera traps, provided answers to 3 of those questions, namely, Where? Who? What? The data from the cameras allowed us to determine the intensity of recreational use (the number of people and the number of people in the group), spatial distribution, and behaviour (activity). In the studies presented, the most common activities undertaken were walking, mushroom picking, and biking. The results obtained in the study are consistent with the results of previous studies conducted in different areas and with different methods (Eriksson et al., 2012; Gołos, 2013). According to Gołos (2013), for 15% of the respondents, the main activity in the forest was walking with the family, while 27% walked with the dog. Roovers et al. (2002) showed that there are differences in the type of activity undertaken by different age groups. The decision on the type of activity is also influenced by the day of the week and the availability of free time (Skłodowski et al., 2013). The authors pointed out that active leisure time dominates on weekdays, while family walks are most popular on weekends and during vacations. It should be emphasized that the activities related to forest work were carried out during the period of lower recreational activity (winter period). Hunting was also carried out in the early morning and evening hours, mainly due to the conditions and activity of the animals. However, considering the potential conflicts with people resting in the forest and hunters, such separation of activity periods is advisable. The issue of conflict between different user groups is prevalent in the literature and was highlighted by Seeland et al. (2002). The authors emphasized that the risk of conflict with hunters is high, which also results from the lack of acceptance for this type of activity. The same applies to timber harvesting. When it comes to safety during forest work, access to the area where the work is carried out is prohibited. Considering the need for recreation in the forests, it is also advisable to schedule forestry work during the period of lower recreational intensity.

The schedule of activities presented in the study showed that the vast majority of them took place between 10:00 a.m. to 4:00 p.m. As in Arnberger (2006) or Ciesielski & Stereńczak (2020), who conducted their research using video cameras and social network data, respectively, the increase in activity took place between 8:00 a.m. and 9:00 a.m., and the highest percentage of people stayed in the forests between 12:00 a.m. – 5:00 p.m. The percentage of activity was also higher in the evening (6:00 p.m. – 8:00 p.m.) than in the morning (6:00 a.m. – 9:00 a.m.), what confirms the results of Janowsky & Becker (2003) in the Stuttgart forest area. In the presented studies, most activities were undertaken on weekends, which is directly related to the availability of free time (Skłodowski et al., 2013; Ciesielski & Stereńczak, 2021). The weekend has also been reported in work using other research methods as the time of greatest activity during the week: video cameras in suburban and urban forests (Arnberger, 2006); pyroelectric sensors in metropolitan areas (Taczanowska et al., 2018); volunteered geographic information data from the Flickr portal for state forests (Ciesielski & Stereńczak, 2020; 2021); survey studies on various research for

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forests in different regions of Poland (Skłodowski et al., 2013; Gołos, 2013).

The data obtained from the camera traps show that recreation in the study area occurs with varying intensity throughout the year, which could be due to the tourist attractions of the area. Variability of recreational use of the forest is also related to weather (Gołos, 2018), psychological and aesthetic aspects (Gołos, 2018), availability of mushrooms and forest fruits (Graja-Zwolińska & Spychała, 2011), among others. Contrary to most studies, where the peak of recreational activity was in summer (Skłodowski et al. 2013; Gołos, 2013), in the presented area the highest percentage of people was registered in autumn and then in spring. This could be due to the characteristic of the area, or influence of the COVID-19 restrictions, which largely regulated the activity of the society in 2020 (Ciesielski et al., 2022).

In terms of the practical application of this type of data collection, the location of the camera traps is important. As indicated by Lupp et al. (2021), the cameras should be installed at a height of 4 m above the ground and aimed at the trail at a distance of 20 m. It is recommended that the path width does not exceed 3 m. According to Weingarth et al. (2013), the difference between data from camera traps and manual measurement can be up to 15%. The location of monitoring sites should take into account the actual situation in a given area. An example of a properly constructed monitoring system, but based on pyroelectric sensors, is the system described by Rogowski (2018) for monitoring tourist traffic in Stołowe Mountains. The author presented the preparation phases (inside and in the field), the current functioning of the system, and the review and modification of the system. The collection of data when using camera traps is also subject to the legal provisions of the General Data Protection Regulation, the so-called GDPR. In this case, the provisions of the GDPR protect car license plates and the faces of passers-by, which must be properly covered. You should also remember to properly secure the collected data, for example, through encryption (the Advanced Encryption Standard system), so that if the equipment is stolen, the thief will not be able to recover the data. Processing data from camera traps is time consuming, especially when we manually review each records and create a database. In this study, we mainly aimed to quantify visitors and the type of activity was additional information. According to Lupp et al. (2021), based on photographs, it is also possible to determine gender (male, female), grouping (individual, two people, family, group, guided group), age classification (baby, toddler, 7–10 years, 10–14 years, youth over 14 years, adult), walking direction (i.e., in-out), and level of attention (i.e., on the trail, in the forest, using a mobile device). The accuracy of determining these characteristics varies, ranging from 50% for sex to 75% for age to 95% for activity. The accuracy of the determination of the characteristics depends, among other things, on the blurriness of the photos.

CONCLUSIONS

Monitoring recreational use of forest areas is not a common topic and there is no single comprehensive monitoring method. It is worth using a variety of methods to obtain data on recreation in forests. The use of data from camera traps collected while monitoring animal activity provided valuable information about recreation in Wdecki Landscape Park. The undisputed advantages of this method include the cost of purchasing and installing the equipment and ensuring 24/7 monitoring. The data provided not only quantitative information (number of people), but also qualitative information representing the type of activity performed. The use of data from camera traps made it possible to indicate the intensity of recreational traffic on a daily basis, days of the week, months, and seasons. The data show that the study area was most frequently visited by recreationists between 10 a.m. and 4 p.m., on weekends, and in the autumn. The most popular activities were also identified, which were: (29%), biking (27%) and mushroom picking (20%). It should be emphasized that the problem of recreation in the forest has a legal basis. Among others, the Forest Management Instruction (Instruction, 2011) indicates that the mandatory

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element of the Forest Management Plan is the chapter on recreation, which is entitled "Identification of needs in the field of technical infrastructure, including tourism and recreation". Therefore, the information obtained from the camera traps can support the decision-making process at the forest district level regarding the development of recreation infrastructure or the adaptation of the forest work plan to the period of lower recreation use.

The limitations of the research conducted include:

1. The monitoring period covered one year, so it was not possible to compare results in different years. This is important because the results could be influenced by factors such as weather, events in the study area, and, most importantly, restrictions introduced by the government during the pandemic COVID-19 (Rice & Pan, 2021; Ciesielski et al., 2022).
2. Data were collected in points with a limited number of camera traps. Thus, the data provide information on the recreational use of individual sections of the roads and paths. For future studies, it is necessary to consider increasing the number of camera traps and distributing them in a representative manners within the research area. To obtain comprehensive information on recreational use in the studied area, it is necessary to combine the camera trap data with other monitoring methods.
3. A significant limitation of the monitoring method with the use of camera traps is the great amount of data and the associated time-consuming analysis of the photos and video files (Lupp et al., 2016). In the future, data processing could be accelerated by the use of automated methods for analysing image content.

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TECHNOLOGICAL CHALLENGES ASSOCIATED WITH LAND-USE POLICIES IN POLISH CITIES AND TOWNS

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ABSTRACT

Motives: Land-use policies are legal instruments that are available to local governments. Modern land-use policies require specialized software and spatial data. A survey was conducted in the cities and towns of two Polish regions, and the results were used to describe the challenges facing local authorities in relation to land-use planning.
Aims: The main aim of this study was to verify the use of spatial data formats and specialist software in the decision-making process in Polish cities and towns. The survey revealed differences in spatial data formats used by the analysed cities and towns. The research goal was achieved in the entire study group and in groups of differently sized cities.
Results: The challenges and implications for land-use policy and decision-making in cities and towns were discussed. The survey revealed differences in the way specialist software is used in land-use planning in the analysed towns and cities. The use of open-source software was examined, and the study demonstrated that georeferenced spatial data is generally lacking. The present findings can be used by the authorities to improve the process of formulating their land-use policies, and they suggest that municipal employees should regularly participate in training programs.

Keywords: land-use policy, GIS and CAD software, spatial data, cities and towns

INTRODUCTION

Land-use policy is one of the basic elements in the local development of cities and towns. Technology becomes an element that supports the implementation of land-use policy at these levels, both in preparing land-use management documents and monitoring land-use changes. It is also important to share data generated during work on land-use documents in cities and towns. These data are made available in various formats, which can be used second time in more accessible way depending on the approach used. Suitable data preparation requires both specialized software throughout the individual departments that deal with this process and the possibility of using adequate spatial data (Wang et al., 2019).

Geographical information systems support the design of land-use policies and the decision-making processes related to land-use planning areas (Deslatte et al., 2022; Feltynowski & Szajt, 2021; Masoudi et al., 2021). Computer-Aided Design (CAD) software can also be used (Habib et al., 2019). The quality of the

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findings used in land-use planning should be based on georeferenced materials that can also be processed by less experienced users (Simon et al., 2017).

Activities related to georeferencing source materials (land-use development plans) and, in particular, preparing them in a vector format may be a basis for incorporating the local community in decision-making. This could be done through the participation of residents in creating land-use policy at the preparation stage (Brown & Eckold, 2020; White, 2001; Załęczna, 2018). Public participation must be supported both by laws, which allow residents to create a land-use policy, and technology, which facilitates participation (Holsen, 2021).

Activities related to vectorizing spatial data in European Union (EU) countries result from the Directive Establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), which indicates a clear road map that the member states should follow. One of the INSPIRE road map elements is a topic on land-use development (Jaroszewicz & Piotrowska, 2016). It is one of 34 topics covering the need to collect spatial information in the form of spatial data and share them with local actors. The spatial data sets listed in the INSPIRE Directive are an element of land-use plans and land-use policies created in the member states.

An additional advantage in implementing the INSPIRE Directive is the need to adjust the law of member states and incorporate the Directive into national legislation as an act (Cho & Crompvoets, 2019). These activities helped unify data at the national and the international levels, enabling cross-border research in this field.

The article aims to verify the use of specific spatial data formats and the software used to apply spatial data in decision-making in cities and towns. Based on data obtained in the survey, attention is drawn to the differences between cities and towns in using spatial data formats. This goal is verified in the whole study group and the groups of cities based on size. The other part of the study indicates the software used for land-use planning, considering the division into CAD and geographical information system (GIS) software. It also verified if local authorities use open-source software. Ultimately, the analysis conducted in the study should indicate how software and data formats are used and show the directions of such activities so that publicly emerging data are also available to final recipients – city and town residents.

Based on the results, it is possible to indicate challenges faced by local authorities. These challenges concern both the data format, which should be available as public information for residents, and the skills required to use specialized software in public administration units.

MATERIALS AND METHODS

Cities and towns in the research

The research's primary objects was the analysis of cities and towns, which are simultaneously seat of local government of communes. Cities and towns can be divided into three groups, based on the number of inhabitants living there, i.e., big cities (over 100,000 inhabitants), medium towns (from 20,000 to 100,000 inhabitants), and small towns (fewer than 20,000 inhabitants) (Majewska et al., 2020; Środa-Murawska et al., 2017).

The research was conducted in the Łódź voivodeship (hereinafter Lodzkie) and the Mazovian voivodeship (Mazovia). Lodzkie was selected purposefully for this study, while Mazovia was drawn from the remaining 15 regions in Poland. As a consequence of the selection, it was possible to identify 135 cities that were municipalities capitals in 2020 (Table 1).

Table 1. Number of cities and towns in selected regions in 2020

	Lodzkie	Mazovia
Total number of cities and towns	46	89
Big cities	1	3
Medium towns	14	22
Small towns	31	64

Source: own work.

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Research and data analysis tools

The study used a questionnaire, which was implemented by a professional research agency using a computer-assisted telephone technique (CATI). In each territorial unit, only one person answered the questions. The research tool has two metric questions to identify the surveyed representatives of local government. In the paper two questions from questionnaire together with metric questions are analyzed. The most important questions were those regarding:

a. the preferred data formats relating to land-use policy;
b. the software used, which supports the decision-making process in cities and towns.

For the questions related to the technology used in land-use policies, appropriately prepared multiple choice questions were used (Table 2). In both questions, there was the possibility to mark several answers, which allowed respondents to present the current conditions in the department responsible for land-use policy.

The main results were based on determining the significance of the results, which were measured by the Wilcoxon statistics (Siegel, 1956). This test made it possible to ascertain the significance of individual responses by comparing individual pairs and, consequently, summing up the results for individual responses. Thus, it was possible to identify the data and software that play an important role in the land-use policy of individual types of cities and towns. Wilcoxon statistics are a nonparametric alternative to Student's t-statistics.

The Wilcoxon matched-pairs test shows which pair of answers is more significant. It allows us to sum up the number of occurrences of the alternative hypothesis of the Wilcoxon test. The alternative hypothesis says there is a significant difference between the two variables (Wilcoxon, 1945). In the article cases of preferred data format (D), the value of the most significant answer is six, and for the software related to the land-use policy (S), the value of the most significant answer is three. The lower number shows the lower significance of variable.

The questionnaire data were analyzed using Statistica software version 13.3. This software allowed basic statistical analyses concerning the entire population and individual types of cities and towns.

RESULTS

Basic results

The primary results relate to assessing the percentage of cities and towns in the study. Slightly more than eighty-three percent of the population replied to the questions; 80.4% in Lodzkie, and 85.4% in Mazovia.

Based on the size of the analyzed cities and towns, the highest level of participation came from medium-sized towns, with a response rate of 97.2%. Small towns were characterized by 78.9% participation, while for cities, it was 75% (Table 3).

Table 2. Answers used in questions about the technology used in land-use policies

Preferred spatial data format		The software related to land-use policy	
Response code	Answers	Response code	Answers
D1	vector GIS data with georeferencing	S1	GIS software
D2	vector GIS data without georeferencing	S2	CAD software
D3	vector CAD data with georeferencing	S3	GIS and CAD software is not used
D4	vector CAD data without georeferencing	S4	others
D5	raster with georeferencing		
D6	raster without georeferencing		
D7	analog data		

Source: own work.

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Table 3. Cities and towns participating in the research

		Lodzkie	Mazovia	Total
Small towns	Number in research	22.0	53.0	75.0
	Percent of group	71.0	82.8	78.9
Medium towns	Number in research	14.0	21.0	35.0
	Percent of group	100.0	95.5	97.2
Big cities	Number in research	1.0	2.0	3.0
	Percent of group	100.0	66.7	75.0
Total	Number in research	37.0	76.0	113.0
	Percent of group	80.4	85.4	83.7

Source: own work.

Referring to the data analysis, in Lodzkie, the entire population of medium-sized towns and cities took part in the research, while for small towns, it was 71%. In Mazovia, the highest percentage of participation was found in medium-sized towns (95.5%). Meanwhile, 82.8% of small towns and 66.7% of cities participated.

Data format preferred in land-use policies

The analysis of the responses shows that more than half of the cities and towns in the study prefer data in the GIS georeferenced format (52.21%). A similarly significant rate of responses from cities and towns indicates the usefulness of georeferenced raster data (42.48%). Unfortunately, among the data used in land-use planning, the relatively high usefulness of analog data (33.63%) is still indicated. Other types of data are used to a lower extent. This is especially true of data without georeferencing and all data in the CAD format (Fig. 1).

The analysis of the responses in cities indicates the use of georeferenced GIS data by all units (100%). GIS data without georeferencing (33.33%), raster data with georeferencing (33.33%), and analog data (33.33%) are also used. No other types of data were used to create land-use policies.

In medium-sized towns, the most frequently used data are georeferenced raster data (60%) and georeferenced GIS data (57.14%). The third group of data is georeferenced CAD data (22.86%). As in the case of cities, analog data are also used (17.14%). Non-georeferenced raster data is another element that supports land-use planning (14.29%). The remaining data are less important for the land-use policy in medium-sized towns.

Small towns mainly use GIS georeferenced data (48%), although analog data constitute a significant share of data for land-use policy (41.33%). Georeferenced raster data (36%) are also very useful. Some small towns also use raster data without georeferencing (10.67%). The least useful are CAD data and GIS data without georeferencing (Fig. 1).

The data presenting the level of data used in land-use policies were also assessed for their significance. The results indicate that no important data could be indicated in the group of cities, which resulted from the number of responses and the small number of cities in this group. According to the interpretation of the Wilcoxon significance test, it should be considered that in the case of the entire population, GIS georeferenced data, georeferenced raster data and analog data should be considered more important than other answers. The same is true of the significance of the data used in small towns.

Concerning the data used by medium-sized towns, georeferenced raster and GIS data, show the highest significance level. For this group of towns, the level of significance is slightly higher in the case of georeferenced CAD data (Table 4).

Table 4. Wilcoxon test for preferred data format in land-use policy

	D1	D2	D3	D4	D5	D6	D7
Total	5	0	0	0	4	0	4
Medium towns	5	0	1	0	5	0	0
Small towns	4	0	0	0	4	0	4

Source: own work.

The software related to land-use policy

The respondents could make multiple choice answers to indicate the type of software used in creating land-use policy and spatial decision-making. Of the entire population, 30.97% of cities and towns use GIS software, while only 16.81% use CAD software. Of those, 6.19% indicated that they use

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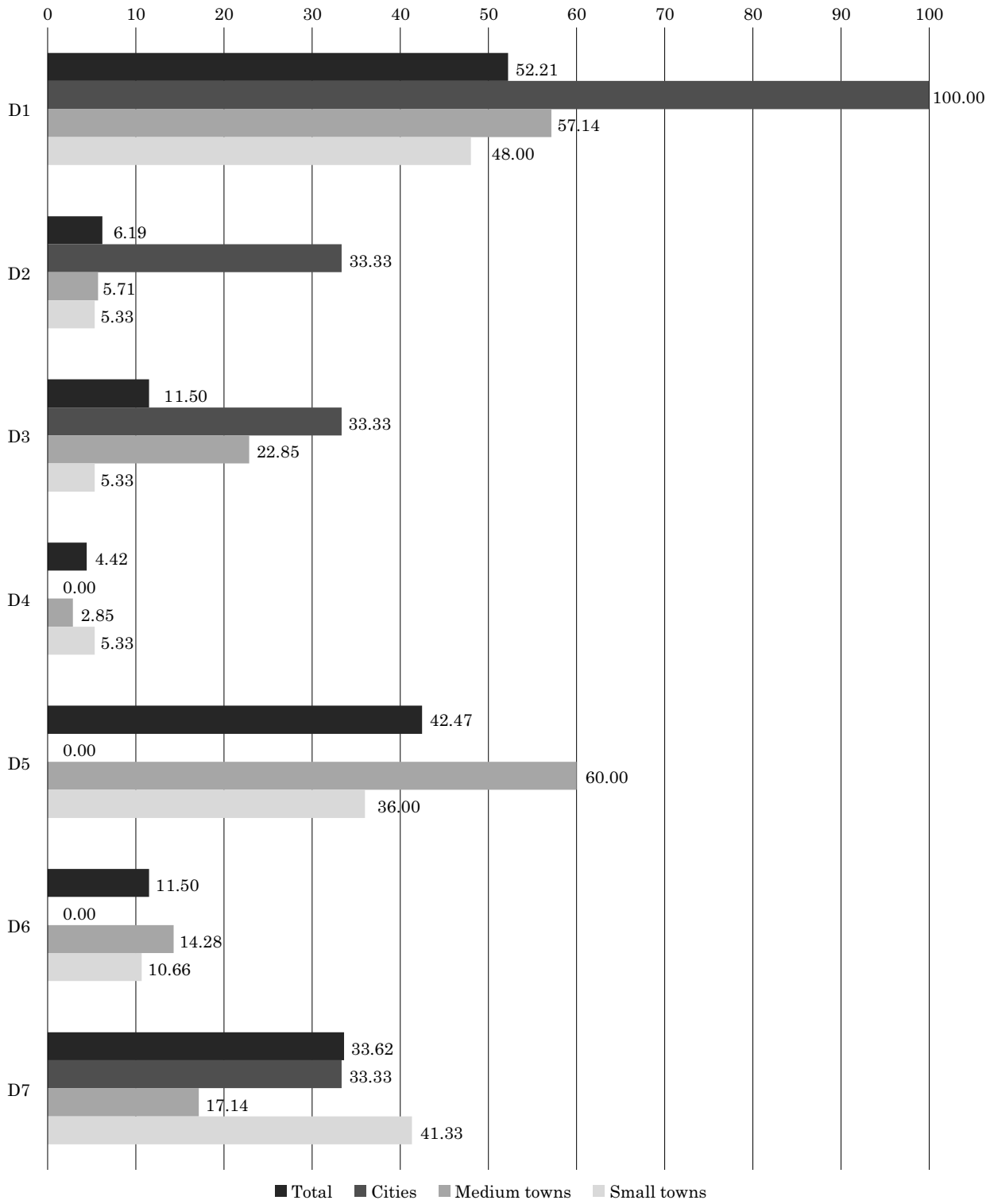

Fig. 1. Preferred spatial data format in cities and towns
Source: own work based on research.

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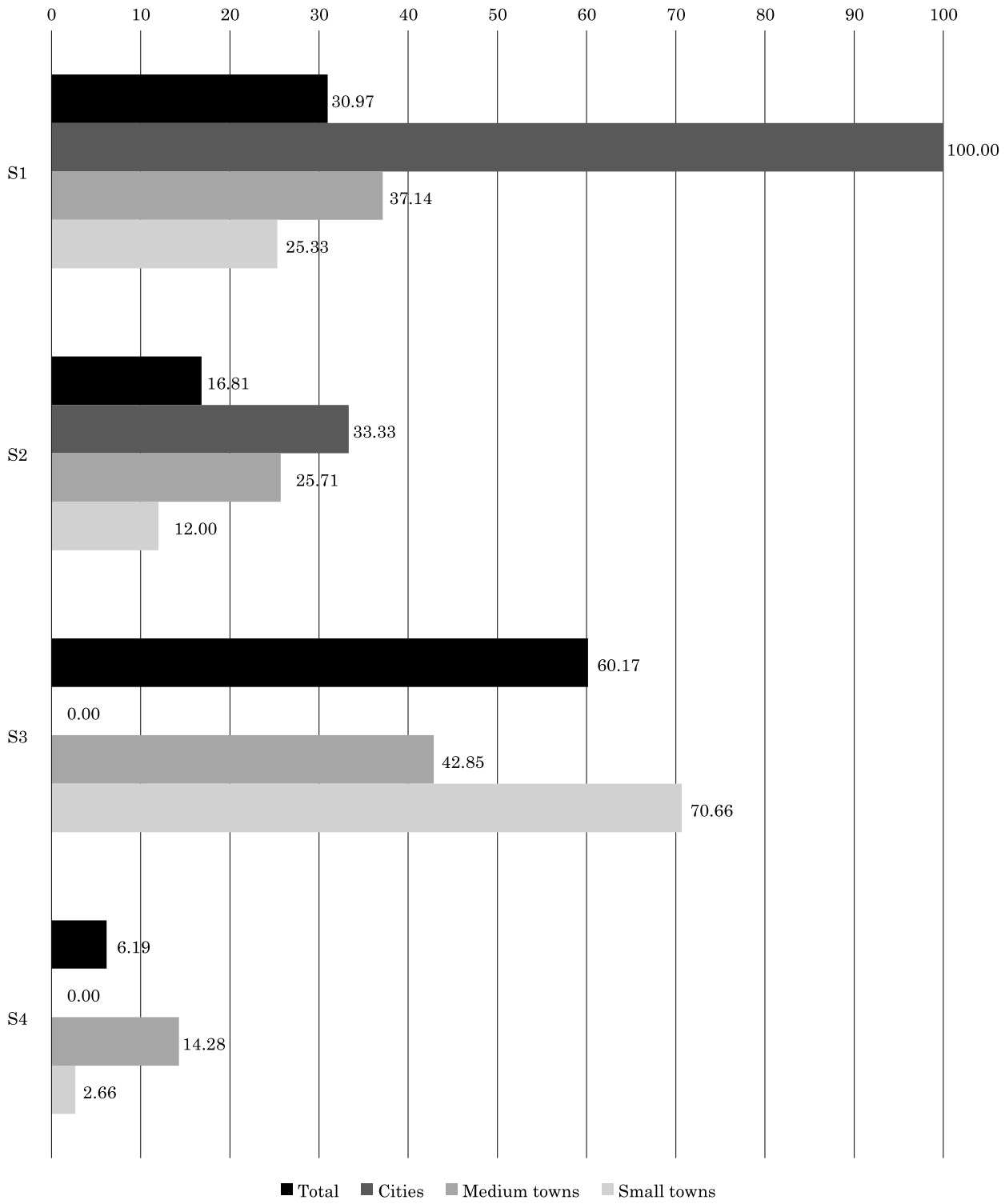

Fig. 2. The software used in cities and towns
Source: own work based on research.

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EWMapa software, which combines the advantages of both CAD and GIS systems. In this part of the survey, the respondents also included responses indicating that activities related to land-use policy, both GIS and CAD software, are outsourced to external entities. Importantly, 60.18% of cities and towns do not use GIS or CAD software in their land-use planning activities. Only 39.82% of cities and towns use software to support the creation of a land-use policy.

All cities indicated that they use GIS software, while only 33.33% use CAD software. The situation is different for the other two groups of towns. In medium-sized towns, GIS software is used by 37.14% of responding units, while CAD software is used by 25.71%. Of these towns, 42.86% of local governments do not use any specialized software. In 14.29% of medium towns, other software is also used to support land-use planning and decision-making. In small towns, the percentage of units using specialized types of software is even lower. Only 25.33% of units use GIS software, and 12% use CAD. Regarding the use of other software to support the creation of land-use policies, only 2.67% of small towns reported such possibilities. Unfortunately, in this group of towns, 70.67% of units indicated that they do not use any software (Fig. 2). It should also be emphasized that only 57.14% of medium towns and 29.33% of small towns use any software.

The assessment of significance using the Wilcoxon test reveals similar conclusions to the preferred data format, where due to the small number of cities, it was not possible to indicate significant answers in the context of pairwise comparisons. Across the entire group, the responses about not using software in land-use policy were significantly more important than the others. The use of GIS and CAD software had a lower level of significance. For medium-sized towns, only the indication about not using software was slightly significant. In the case of small towns, the test showed a high significance of the lack of software use and a slightly lower significance for the use of GIS software (Table 5).

Evaluating software type of license used by the end-user states reveals that with CAD software, all cities and towns used commercial licenses. The situation was different for GIS software. According to the results, 68.57% of cities and towns use open source software, 14.29% use only commercial GIS software, and 17.14% use both types.

Table 5. Wilcoxon test for the software used in cities and towns

	S1	S2	S3	S4
Total	2	1	3	0
Medium towns	0	0	1	0
Small towns	2	0	3	0

Source: own work.

DISCUSSION AND CONCLUSIONS

The need to use GIS and CAD software

GIS software prevails over CAD software in Polish cities and towns. The actions of local government authorities, in particular, in small and medium-sized towns, should be based on improving the skills of employees who deal with land-use planning issues in the commune. This need is noticed in Polish cities and towns, but the problem is also presented in the international literature (Baldwin et al., 2014; Obermeyer et al., 2016). Although knowledge about using GIS and CAD software seems necessary nowadays, research shows a knowledge gap. It should also be noted that this study indicates that local authorities outsource services to external entities, which is reflected in previous research (Rocha et al., 2003).

The conclusions drawn based on the research show that steps should be taken to address the problem, which is caused by a gap in the use software in public administration at the local level. Research clearly shows that city and town size matters for the level of GIS and CAD use. Such software should be employed in rural areas, which are often below the level of development of small towns in this context (Feltynowski, 2012; 2018).

The multithreaded use of GIS and CAD software in land-use planning also supports activities that use aerial and satellite imagery (Hütter, 2018). All activities

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based on new technologies improve the living conditions of inhabitants by properly supporting land-use planning with software (Hoffman & Lemper, 2018; Pollard, 2000).

The need to use data in land-use planning policy

Apart from the ability to use software, data availability is essential. In Europe, the EU first took action in 2007. Despite the passage of time, the use of data in land-use policy is still a barrier. Although volumes of data within national spatial data infrastructures have been opened and made available (and not only to public administration) thanks to the principles of the INSPIRE Directive, it has not significantly affected the use of spatial data (Izdebski et al., 2021; Ronzhin et al., 2019).

In line with the characteristics of the software used in public administration, the most valuable data are the georeferenced vector and raster data. This area of research is indicated as developmental due to the diversity of the public sector in countries that implement INSPIRE (Masser & Crompvoets, 2016). The experience of the EU member states can also be used in other countries, depending on the needs related to the development of the use of spatial information in spatial planning.

Data quality in land-use planning plays a significant role in influencing the value of plans and other documents (Stelmach-Fita, 2017; 2021). Therefore, the people who create, actualize, and use data in land-use policy must know the specifics of the spatial information they use. It is not possible without a practical analysis of these data collections, which in small and medium-sized towns requires further development, especially in terms of the usefulness of spatial data. As with software, it also requires continuous training for commune employees.

Supporting the development of spatial databases will allow them to be better used in the future, both in land-use planning and other areas of local government activity. This type of approach will allow space to be created both in cities and rural areas (Theobald et al., 2005). The generated spatial data will also be the basis for evaluating the changes in cities and towns as land-use planning is an ongoing process.

The need to improve the quality of materials in the decision-making process

Combining the software implementation process and high-quality spatial data is an element that supports decision-making, both in the short and long term. Decisions made by local authorities in various areas increasingly depend on adequate access to spatial information. Activities of this type should also be supported by the participatory creation of land use (Bojórquez-Tapia et al., 2001; Brown & Eckold, 2020; Jelokhani-Niaraki, 2021).

As part of the land-use policy supported by GIS software, it is possible to proper decision-making in the city and town space. GIS has become a tool used to collect data used in decision-making in various fields (Eren & Katanalp, 2022; Everest et al., 2021; Ustaoglu et al., 2021). Data used in the fields of commune functioning allow their implementation in various policies created at the city level (Ferretti, 2021). Thanks to GIS and CAD data, it becomes possible to improve the quality of information on the functioning of the cities and towns, which is a challenge for land management and brownfield recovery (Ferretti, 2021; Omidipoor et al., 2019).

Regardless of where support is used for decision-making that has a spatial dimension, it remains a priority activity for city and town authorities. Thanks to the use of GIS technology, it is possible to prepare land-use planning documents more efficiently. Planning tools make it possible to balance approaches based on competition for specific land uses. At the same time, the use of software and spatial data in decision-making may be one of the factors that eliminate ideas that are least compatible with the preferences expressed by all local actors.

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Open source software

Due to the need to limit the expenditure of budget funds, city and town authorities should decide to use open-source software. This approach makes it possible to use existing technology and implement changes that result from the needs reported by users. Software innovations should improve the quality of services provided by local government authorities.

Cities and towns are important recipients of services provided by open-source software vendors (Bouras et al., 2014), and it should be emphasized that open-source programs make it possible to achieve results comparable to commercial software on the market. An essential element of open source software in public administration is that it affects how institutions operate in technological, organizational, economic, and social areas (Bouras et al., 2013; Shaikh, 2016). It also leads to the development of public institutions in line with global trends.

Research limitation

The limitation of research on using spatial data in spatial planning processes is primarily the costs of their conduct. Some data in this scope are available from a survey by Statistics Poland on the type of data used in spatial planning. There are no systemic studies related to the use of software for spatial planning purposes. Researchers should remember that the software allows for appropriate spatial data processing and supports the decision-making process in spatial planning.

What turns out to be important in this type of research is their extension to all regions in Poland and their implementation in local governments outside Poland, which will allow for a broader inference process in the European and intercontinental context.

In the case of internationalization of research, a limitation may be various legal systems that affect the organization of departments related to spatial planning and the scope of their activities undertaken.

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ANALYSIS OF THE PROSPECTS FOR THE DEVELOPMENT OF 3D CADASTRAL VISUALISATION

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ABSTRACT

Motives: In the past twenty years, considerable progress has been made in 3D real estate cadastres and 3D visualisation technologies. These developments require advanced solutions for the visualisation of 3D cadastral objects.
Aim: The main aim of this study was to propose an optimal 3D cadastre visualisation strategy that accounts for user needs, the types of visualised data, and visualisation platforms.
Results: The optimal 3D cadastre visualisation strategy was determined by performing a SWOT/TOWS analysis. Both internal and external factors that can influence the development of 3D cadastre visualisation policies were considered in the analysis. The results of the study were used to propose an aggressive strategy (based on the identified strengths and opportunities) for the development of 3D cadastre visualisation.

Keywords: 3D cadastre, 3D visualisation, SWOT/TOWS analysis, visualisation platforms, visualisation analysis

INTRODUCTION

The main purpose of the conducted research is to determine the direction in which work on visualization of 3D cadastral information should be carried out. To date, issues related to the visualization of 3D cadastral data have not been sufficiently developed or are at an early stage of development. Hence, it was decided to conduct a study on determining the strategy of 3D cadastre visualization. It was decided that a SWOT/TOWS analysis would be a suitable method to accomplish this goal. The background of the main research is the consideration of user needs, types of visualized data and visualization platforms. The performed work is intended, in part, to fill the research gap in the absence of a clear strategy for visualizing 3D cadastral information.

DEVELOPMENTS IN 3D CADASTRAL ISSUES – OVERVIEW

The subject of three-dimensional cadastre, usually referred to as 3D cadastre, came into being in a wider sense with the organisation of the first 3D cadastre workshop in Delft (the Netherlands) in 2001.

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Since the beginning of the second decade of the 21st century, it has started to become more and more popular, which is mainly determined by two factors. In 2010, the joint commission 3 and 7 Working Group on 3D Cadastres of the International Federation of Surveyors (FIG) was established and a questionnaire on the future development of the 3D cadastre was developed and then made public. The questionnaire was completed for numerous countries. Its aggregated results are described in (Oosterom et al., 2011). In 2011, also in Delft, a second workshop on the 3D cadastre was held. This resulted in a wider appearance of the term '3D cadastre' in the consciousness of those involved in the property management in its broadest sense, such as surveyors, urban planners, architects and lawyers. This is also due to the increasing popularity of various types of software and mobile applications that consider the third dimension, or that enable the creation of own 3D visualisations.

In 2014 and 2018, two similar questionnaires were conducted on the work concerning the 3D cadastre (Oosterom et al., 2014; Shnaidman et al., 2019). These were completed by respondents from numerous countries. They considered developments in both theory and practise in the broader domain of 3D cadastre. Literature on this field has been collected and presented on the website of the Joint Commissions 3 and 7 Working Group on 3D Cadastre (Literature, 2022). A more comprehensive description of modern cadastre concepts can be found in (Bydłosz & Bieda, 2020) and (Bydłosz, 2022).

It is also worth noting that the implementation of 3D cadastre in various aspects can meet numerous barriers – among other things mental, legal, technical and organisational (Ho, et al., 2013).

VISUALISATION OF 3D CADASTRAL DATA – STATE OF THE ART

Despite the intensive work carried out on the development of the 3D cadastre for more than two decades, relatively little time has been spent on the visualisation of cadastral information, especially in 3D. To systematise the current activities concerning the visualisation of the multidimensional cadastre, the article discusses its three aspects:

1. User needs.
2. Type of data to be visualised.
3. Visualisation platforms.

Potential users of the 3D cadastre need to be part of the R&D activities of visualising its data. Pouliot and Wang (2014) show that such users are willing to explore and gain knowledge about the advantages of using 3D visualisation.

Looking in more detail at the results of conducted and published global studies, it can be concluded that, generally, the potential users of 3D visualisation of cadastral information are those who also use 2D cadastral systems, e.g. notaries, lawyers, surveyors, or government and public administration agencies responsible for the land administration system. However, the third dimension contributes to the expansion of this group to include architects, engineers, real estate brokers and developers. Some of the aforementioned consumer groups use 3D models in their work, so access to an integrated 3D cadastre is seen as valuable.

A survey carried out in the province of Quebec (Canada) described in (Pouliot & Wang, 2014) showed that users' expectations of the 2D and 3D cadastre data associated with both cadastres do not tend to differ. The multidimensional visualisation of cadastral data, on the other hand, can help distinguish between private and common parts in residential buildings or in performing 3D geometric analyses such as buffering. It also supports other management systems, including co-visualisation of land taxation, spatial planning or land use regulations. Cadastral data visualised in the third dimension support the calculation of the area or volume of real estate, and become the basis in the analysis of spatial relationships such as overlapping or identification of spatial conflicts in terms of RRR (rights, restrictions and responsibilities).

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User needs

The need for a full representation of data in three dimensions has accompanied researchers since the first 3D cadastre workshop in 2001. However, since then, most countries in the world only have 2D cadastre data and only some limited 3D survey data.

A study by Pouliot and Wang (2014) investigated the need to provide and evaluate how 3D cadastre descriptive data are placed (outside, inside). The survey consisted of a direct interview with possible users of the 3D cadastre. According to potential data users, the placement of information outside the visualised object is of little use. Instead, many specialists advocate the creation of a multidimensional cadastral system that additionally monitors urban development over time, depicts statistics of land use changes and archives them. So far, the biggest challenge for researchers is to develop a 3D visualisation system that would allow the integration of multiple data sources.

Another aspect to consider is the requirements for visualising 3D cadastre data (Cemellini et al., 2018). One of these is the availability of labels with official measurements of cadastral data relating to the geometry of property boundaries. In most cases, this information is certified by surveyors or notaries (Dimopoulou et al., 2018). It has been recognised that direct access to them is crucial for any cadastral visualisation system. Physical objects play a critical role in cadastral data visualisations, as they act as landmarks that are usually easily recognisable by users (Thompson et al., 2018). Thus, the representation of the relationship of 3D legal entities with their corresponding physical objects is crucial because of the facilitation associated with measuring, establishing and comparing their geometry.

Types of visualised data

The variety of semantic and geometric objects in 3D cadastral systems is not surprising. Consequently, many data groups can be distinguished. A distinction can be made between the different types of objects that can be considered for cadastral visualisation. Isikdag et al. (2015) distinguished between physical and virtual objects. While Pouliot (2011) and Wang (2015) found that at least two types of spatial objects are needed as boundaries of legal and physical objects. Vandysheva et al. (2012) proposed the visualisation of underground objects in a 3D cadastre. In summary, the researchers emphasise that not only legal, but also physical representations are important. First, they focus on the need to distinguish between private and public land, but equally important is the combination of spatial relationships and 3D geometric information.

In the state of Victoria, Australia, it has been demonstrated that Building Information Modelling (BIM) environment can enable various physical and legal boundaries to be represented in several ways (Atazadeh et al., 2017). However, it should be recognised that traditional BIM does not provide a guarantee for the correct definition of 3D objects. The visualisation of invisible objects, such as legal boundaries, can be considered in a way similar to underground object boundaries, for which the problem of visualisation is a major difficulty in the operation of current cadastral systems.

The ability to visualise descriptive data as object attributes is an important aspect in cadastral applications. For example, Atazadeh et al. (2016) used the possibilities of managing legal information that is related to private property in a 3D BIM digital data environment.

The relationships between multidimensional legal entities, and in particular the overlapping between them, are crucial in terms of visualisation. These include topological relationships, neighbourhood, orientation relationships and the distance between them. For example, in the case of parts of a multi-unit building such as a ceiling or a wall, all 3D objects must be in contact with each other to form a unified whole. In the case of a classic 2D cadastral map, a topology can be constructed quite easily. In the case of a 3D cadastral visualisation, due to perspective projection and occlusion, it is much more difficult to realise. Equally important seems to be the representation of the relationship between 3D legal units and 2D land parcels, on which almost all cadastral systems are based (Thompson et al., 2016b).

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It is also important to represent 3D legal boundaries, which can be bounded when 3D objects have a correctly defined volume or partially bounded when these boundaries cannot define a finite volume (Pachelski & Góźdź, 2014). The latter type of legal entity should be presented in such a way that users can recognise their bounded and unbounded parts without problems.

An important element in the visualisation of 3D cadastre objects is the spatial representation of the data used. Currently, spatial object geometries are not well supported by current software such as GIS, CAD and DBSM or ISO standards (Shojaei et al., 2017). Ying et al. (2015) followed the definition of a 3D parcel as defined in (Thompson & Oosterom, 2011) state that a 3D cadastral object, can be represented by a polyhedron satisfying the following characteristics: internal connection, correct structure and correct orientation.

The introduction of the ISO 19100 series of international standards for geographic information can also be helpful for the visualisation of 3D cadastral objects. Of particular relevance here seems to be the international standard ISO 19152 'Land Administration Domain Model' (LADM), which provides a reference model for modelling systems containing cadastral information, both 2D and 3D (ISO, 2012). Each cadastral system contains components such as unique identifiers assigned to all parcels of land, attributes describing the geometry of the property (length, area, volume or RRR associated with a parcel of land) or geodetic grid data. The Land Administration Domain Model defines how spatial units should be and how they relate to each other through rights, restrictions and responsibilities (RRR). A simplified diagram of the database storage is delivered by Thompson et al. (2016a). Different types of multidimensional entities are presented there. The class 'LA_BoundryFaceString' is here connected by a composition relation (it is part of and cannot exist without) to the class 'LA_SpatialUnit'.

The equivalent of a 2D pixel in 3D visualisation is the voxel. A voxel, as a volumetric pixel, is a unit of volume with which a numerical value is associated. Representing cadastral data in this way has many advantages, such as, for example, the ability to calculate volumes and record them. An additional advantage is the visualisation of 3D objects through 3D cubes. The disadvantages of this type of representation, a is the complexity of storing the data and its inefficient handling by the spatial database management system (Goncalves et al., 2016).

Another issue of 3D data visualisation is the possibility of using point clouds (Góźdź et al., 2014). Their use in 3D cadastre greatly facilitates the visualisation of the data used. For both 2D and 3D objects, the reference information is stored as vector models. Point clouds can also be used to determine whether a parcel is above, below, or on the Earth's surface. Another application is the creation of 3D parcels to be generated as physical objects with rights, restrictions and responsibilities (RRR).

Visualisation platforms

With the development of 3D cadastre, there has been an increased need for prototypes of web-based system technologies to support the visualisation of multidimensional cadastre objects. There are systems, such as ESRI CityEngine, that greatly facilitate 3D visualisation, but the sophistication required to operate such software may make it unsuitable for many user groups. Open source solutions focussing on the creation of a web-based 3D cadastral visualisation system may provide an answer to this problem. A system based on Google Earth for ePlan/LandXML type data has therefore been developed for use when properties overlap. This is used to illustrate both physical and legal objects. Based on KML from Google Earth and X3D from ArcGIS online two prototype online 3D maps were created for the jurisdictions of Indonesia (Aditya et al., 2011).

User interactions with the objects of a 3D digital environment are at the heart of the success of any 3D system. In a 3D cadastre prototype in the Russian Federation, consumers can drag a 3D model of floors along with a 2D floor plan of a building to overcome occlusion issues. Some prototypes also allow user navigation, attribute queries, or object search (Vandysheva et al., 2012).

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In the Republic of North Macedonia, Dimovski et al. (2011) proposed a highly developed solution for visualising 3D objects. It is based on Oracle and GeoServer databases and Java and NASA World Wind software. This system has the capability to image buildings in 3D, but this visualisation is limited to the ground level part of the buildings only.

The implementation of digital systems using AutoCAD Map 3D, PostgreSQL/PostGIS and a Google Earth plug-in is also an answer to the problems of 3D visualisation. In the 3D cadastral prototype developed for the People's Republic of China by Guo et al. (2011) ArcGIS Server, Skyline (TerraExplorer), SkechUp and Oracle were combined. Unlike Google Earth and NASA World Wind, Skyline also supports underground objects. All the systems discussed are still in the prototype phase and require validation by potential users before formal use.

In summary, visualisation platforms should include features that are enabled by the tools used, such as zooming in/out, changing colour, changing transparency levels, attribute queries, navigation and spatial analysis, among others. However, despite so many possibilities, there are also challenges associated with them. Perhaps the most important of these is that the interface does not always function in full software compatibility, which limits access and implementation options. There may also be problems with the legal and institutional implementation of these solutions.

SWOT ANALYSIS OF 3D CADASTRAL DATA VISUALISATION STRATEGIES.

In order to systematise, collate and in a way summarise the overview of the work on 3D cadastre visualisation, a SWOT/TOWS analysis (Grzelka, 2022) was conducted. SWOT/TOWS analyses were already used in land administration related issues (Bieda & Brzozowska, 2017; Glinka, 2022), as well as in marine cadastre (Dawidowicz & Źróbek, 2014; Bieda et al., 2019).

The analysis was performed in the following 4 steps:

1. identification of the factors to be analysed;
2. identifying the links between the factors to be analysed;
3. analysing individual strategies;
4. selection of the best strategy for visualisation of 3D cadastre data.

To perform the SWOT/TOWS analysis, external and internal factors were identified. The 'Strengths' and 'Weaknesses' were analysed as internal factors and 'Opportunities' and 'Threats' as external factors. Twenty factors were used in the analysis (five for each element). The factors analysed are presented in Table 1.

To determine the links between the factors, the supporting questions developed for determining spatial development directions using SWOT/TOWS analysis (Bieda & Brzozowska, 2017) were used. The questions are presented in Table 2.

The identification of connections between the factors was determined by answering the supporting questions listed in Table 2. Each factor was considered equally important, hence individual factors were not assigned weights. Three grades were adopted to determine the strength of the connections between the individual factors:

2 – strong relationship
1 – weak relationship
0 – no relationship.

Based on the identified factors, SWOT and TOWS analyses were performed. SWOT relationships are presented in Table 3 and TOWS relationships in Table 4.

The summary results of the SWOT/TOWS analysis are presented in Table 5.

The final results of the strategic analysis are presented in Table 6.

Based on the results of the analyses described above, one of four strategies can be chosen:

1. aggressive, in which strengths and associated opportunities dominate;
2. conservative, which is dominated by strengths and their associated risks;
3. competitive, in which weaknesses and associated opportunities dominate;
4. defensive, which is dominated by weaknesses and their associated threats.

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Table 1. SWOT/TOWS analysis factors

Internal factors	External factors
Strengths (S)	Opportunities (O)
Presenting the 3D cadastre data in a multi-dimensional way gives you an idea of space.	Growing number of developments under or above the surface.
Educating the public about spatial real estate.	Opportunity to engage new users.
Possibility to use the spatial parcel simultaneously for various purposes (underground, e.g. metro line, above-ground, e.g. a single-family house).	Development of the spatial property market.
Development of urban spatial infrastructure.	Opportunity for better development of densely built-up areas especially in cities.
Representation of 3D cadastre objects with voxels.	Global commitment to the introduction of global standards for the visualisation of 3D cadastre data.
Weaknesses (W)	Threats
Limited access to 3D data.	A change in the law that may result in unfavourable changes for the visualisation of the 3D cadastre.
Complicity of visualised 3D cadastre data.	Transition from 2D to 3D data modelling with an outdated, incomplete and non-standardised database.
Occlusion in 3D cadastre data visualisations.	Impossibility of creating a standardised international 3D cadastre data visualisation system due to various legal systems in different countries.
Volumetric registration of the parcel without 3D presentation on the cadastral map.	A slowdown in the development of 3D cadastre visualisation due to the inability to use it in the majority of the country's area, as the spatial potential is mainly employed in highly urbanised areas.
Recording of 2D geometric elements containing 3D information.	High cost of the 3D cadastre building.

Source: own preparation based on Grzelka (2022).

Table 2. Auxiliary questions in the factor connection analysis

Questions in the SWOT analysis	Questions in the TOWS analysis
Will strength make it possible to benefit from a given opportunity?	Does the opportunity enhance the given strength?
Will the strength enable a given threat to be neutralised?	Does the opportunity neutralise the given weakness?
Does the weakness reduce the opportunity? Does the weakness intensify the risk associated with a given threat?	Does the threat reduce the given strength? Does the threat magnify the given weakness?

Source: own preparation based on Bieda & Brzozowska (2017).

It is worth realising that the increasing number of building developments both above and below ground provides opportunities for the further advance of 3D cadastre visualisation and thus the possibility of using a spatial parcel of land simultaneously for different purposes, e.g. the construction of an underground line and family houses. The prospect of engaging new users, which enhances the education of the public in terms of knowledge of real estate or spatial objects in general, also contributes significantly to such a development.

It is also worth noting, the introduction of international standards in the field of geographic information, especially the ISO 19152 standard (ISO, 2012).

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Table 3. SWOT connections

	O1	O2	O3	O4	O5	T1	T2	T3	T4	T5
S1	2	1	2	2	1	0	0	0	1	0
S2	2	2	2	1	0	0	0	0	0	0
S3	2	1	2	2	0	0	0	0	0	2
S4	2	1	2	2	0	0	0	0	1	1
S5	0	0	1	2	1	0	1	0	0	1
W1	2	1	2	2	0	1	2	0	2	0
W2	1	1	1	1	0	1	1	1	2	2
W3	0	1	0	1	0	1	0	0	0	0
W4	0	0	1	1	0	1	1	0	1	0
W5	1	1	1	1	0	1	1	0	1	1

Source: own preparation based on Grzelka (2022).

Table 4. TOWS connections

	S1	S2	S3	S4	S5	W1	W2	W3	W4	W5
O1	2	1	2	2	2	2	1	0	1	1
O2	1	2	1	2	0	2	1	0	1	1
O3	1	2	2	2	0	1	1	0	1	1
O4	2	1	2	2	2	1	1	0	1	1
O5	1	1	0	1	1	1	2	2	2	2
T1	1	1	0	1	1	2	2	2	2	2
T2	1	0	1	1	1	1	1	0	1	1
T3	1	1	1	0	1	1	0	0	1	0
T4	1	2	0	0	1	1	1	0	1	1
T5	0	2	2	0	1	2	0	0	1	1

Source: own preparation based on Grzelka (2022).

This also supports the progress of the visualisation of 3D cadastre objects, especially in terms of improving and clarifying its stages, defining the accuracy with which it should be done and the development of software. This is strongly linked to the development of urban spatial infrastructures and their presentation, which makes it possible to increase the knowledge of land parcels or spatial properties.

Table 6. Strategic analysis results and strategy selection

	Opportunities	Threats
Strenghts	Aggressive strategy	Conservative strategy
	Number of interactions	Number of interactions
	136	56
	Weighted number of interactions	Weighted number of interactions
	136.00	56.00
Weaknesses	Competitive strategy	Defensive strategy
	Number of interactions	Number of interactions
	92	88
	Weighted number of interactions	Weighted number of interactions
	92.00	88.00

Source: own preparation based on Grzelka (2022).

Despite both strengths and opportunities, weaknesses and threats have also been identified that may slow down or limit the development of 3D cadastre visualisation. The weaknesses are mainly related to internal factors, and concern the occlusion and complexity of the visualised data. Current work on 3D cadastre has highlighted two main visualisation problems. The first is the volumetric recording of parcels of land while lacking 3D presentation on cadastral maps, while the second is the recording of 2D geometric elements containing 3D information that does not have its spatial representation.

The threat faced by researchers working on 3D cadastre data visualisation is the fact that cadastral

Table 5. Aggregated results of the SWOT/TOWS analysis

Combinations	SWOT analysis results		TOWS analysis results		SWOT/TOWS summary	
	Sum of interactions	Sum of products	Sum of interactions	Sum of products	Sum of interactions	Sum of products
Strengths/Opportunities	66	66,00	70	70,00	136	136,00
Strengths/Threats	14	14,00	42	42,00	56	56,00
Weaknesses/Opportunities	38	38,00	54	54,00	92	92,00
Weaknesses /Threats	40	40,00	48	48,00	88	88,00

Source: own preparation based on Grzelka (2022).

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databases are very often outdated, transitioning from 2D to 3D difficult. Possible changes in the significant legal acts concerning land administration issues may also cause problems in the operation of the 3D cadastre. Additionally, for the vast majority of areas of the countries there is currently no need for a 3D cadastre, on a larger scale, as areas with intensive development are mainly found in city centres and the 3D cadastre itself is getting transferred into 3D land administration (Oosterom et al., 2020).

In conclusion, the development of the visualisation of the 3D cadastre should move towards a greater commitment to the introduction of international standards, allowing the best use of the strengths of the visualisation, as presented in the SWOT/TOWS analysis. It is also necessary to reduce the weaknesses by creating solutions to problems on the technical side of visualisation creation. Additionally, researchers should find solutions to protect the visualisation of 3D cadastre objects from impacts resulting from changes in the law or the lack of up-to-dateness of databases. An aspect that may prove to be crucial here is the number of costs of building a 3D cadastre.

Because of the SWOT/TOWS analyses, based on the results presented in Table 6 and the considerations carried out, it was considered that the development of 3D cadastre data visualisation should be based on the use of strengths and related opportunities. This is equivalent to proposing an aggressive strategy.

DISCUSSION – IMPACT OF VISUAL VARIABLES

Despite the popularisation of the issue of multidimensional cadastre, relatively few experts have focused on the visualisation and symbolisation aspects from a semiotic perspective. Independently, experts have investigated which visual variables are most suitable for depicting 3D cadastral data order to facilitate user perception and interpretation.

In the paper (Bertin, 1983) five basic types of symbols that make up a cartographic representation are identified. These are point, line, area, surface (differing from area in that it exists in 3D space and has no theoretical thickness) and volume. The variables affecting the visualisation of these elements are size, shape, value, colour, texture and orientation. Additionally, Bertin defined their nature through five tasks of visual interpretation:

a. selective – answers the question of whether modifying a visual variable allows users to select one element from a group of objects;
b. associative – when users can easily distinguish the link between two groups of symbols just by using this variable;
c. quantitative – refers to allowing users to quantify the change in that variable;
d. orderly – answers the case of whether, by making a change to a particular variable, a difference in order can be observed;
e. duration – determines how many changes of a particular visual variable can be used effectively.

Bertin (1983) also recorded definitions of the visual variables listed above. A change in the fineness or roughness of an object defined its texture, while a value was described as a different degree of colour intensity between white and black. The explanation of the other variables was literal, e.g., the definition of colour was the use of a hue from the base it specified. The orientation was defined by a similar relationship, as it was defined by changing the orientation of the line. Size, on the other hand, was defined by changing the height or width of the object in question.

Although transparency was excluded in the first list of visual variables created by Bertin, it was later introduced by other experts who investigated its perceptual properties. A test described by (Elmqvist et al., 2007) showed that the use of dynamic transparency to manage occlusion, can significantly improve the user perception. Recently, specialists have done a lot of research in cognitive science to figure out how the perception of transparency is related to physical stimuli, namely, brightness, colour, contrast and shading of 3D visualisations. The experiment described by (Hillstrom et al., 2013) demonstrates that transparency does not cause difficulties with subjects' object recognition.

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Pouliot et al. (2014) tested the usefulness of visual variables such as hue, saturation, position, texture and transparency in their study of 3D cadastre object imaging. Summarising the results, with or without transparency, hue was found to be one of the more preferred solutions compared to the use of texture. Two years later, the tests were repeated, but the focus was solely on testing transparency (Wang et al., 2017). Three different levels of transparency were used during the experiment, thus proving to be an efficient solution that makes it easier for users to delineate property units using their physical equivalents. Applying high transparency to simple legal boundaries compared with physical boundaries results in increased user confidence in the decision-making process. In contrast, setting higher transparency on physical boundaries is much more effective in presenting property concepts to consumers.

A survey performed by Seipel et al. (2020) provided information on rendering attributes. The project itself was based on visual representations of RRR (rights, restrictions and responsibilities) objects in the context of 3D architectural models. An interactive visualisation prototype was proposed, which included both 3D models of buildings and terrain. It was also complemented by newly designed legal representations of objects. Some of those taking part in the experiment found the choice of colours pleasing, while others noted difficulties in distinguishing between them. Respondents suggested several solutions to this problem, such as the development of a common colouring standard, or suggested that it should be up to users to choose colours according to their private preferences. Additionally, the ability to adjust the level of transparency of 3D objects was considered a highly desirable feature.

There is no choice of colours in the visualisation of three-dimensional property rights that simultaneously satisfies preferences, standards and perceptual requirements. Nevertheless, irrespective of the choice of colour palette, software or end user, the colour scheme should reduce the risk, as much as possible, of the user making a mistake, such as overlooking or confusing an object.

Additionally, an essential aspect of the use of colours is the variability of their perception due to lighting or shading. Therefore, it is impossible to directly assign one unique colour to specific objects. It is worth noting that different colour shades are a desirable feature in the spatial visualisation of 3D cadastre data. Problems arise when using transparent rendering, which causes the initially different base colours of objects to take on very similar tones. This is illustrated in Figure 1, which shows four types of simple objects with decreasing levels of transparency. As can be seen, type 1 (2D property unit) and type 2 (3D property unit) objects are similar in colour. Furthermore, in the transparent rendering, the regions occupied by object type 2 contain colours similar to those of object type 4 (easement in use). The type 3 object is simply an easement. In the figure, visualisations a to c show the rendering of 4 types

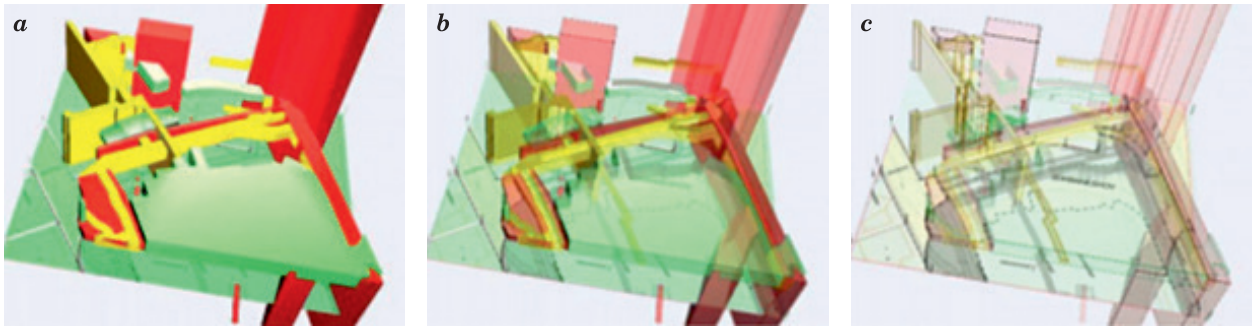

Fig. 1. Three types of legal objects with decreasing levels of transparency: a) no transparency, b) 50% transparency, c) 90% transparency

Source: Grzelka (2022) based on (Seipel et al., 2020).

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of 3D objects with 4 colours (light green, dark green, yellow, red). The first is depicted without using transparency, the second with 50% transparency and the third with 90% transparency.

Size as a visual variable, right after transparency and colour, has the characteristics with the best perception. Its change is very easy to perceive and is therefore considered a very effective visual variable with a significant impact on the user. The orientation, on the other hand, turns out to have the least impact on consumers. It only works well in situations involving relationships between objects as line intersections. The biggest problem with its use in perspective display is the change in the orientation of individual symbols. Because of this, people using these visualisations may be confused whether the difference in the orientation is due to the symbol or whether it is due to the perspective projection.

Additionally, Wang et al. (2017) conducted a survey-based study on the variables used in 3D visualisation of flats on user perception. They then compared the results of this experiment with the suitability of the same variables for 2D visualisation, which were obtained from the subject literature.

Their first conclusion was that there is almost imperceptible difference in the usefulness (hue, saturation) of colour and texture for 2D and 3D visualisation. In the case of the latter variable, which can be similar to the surface of physical objects in the real world, it can give participants the feeling that they are looking at real buildings visualised in 3D. Wang et al. (2017) found that this could be useful in distinguishing physical objects from legal ones. The next finding was the ineffectiveness of orientation as a variable. The perspective view in 3D visualisation made the perception of orientation ambiguous.

A similar conclusion related to brightness, which was minimally effective and not preferred in 3D visualisation. Lorenz et al. (2008) concluded that illumination, shading, texture and transparency influence the perception of brightness in visualised 3D objects. In Figure 2, surface A, may appear darker than surface B. In reality, they have the same brightness value. This may be due to a created illusion caused by perspective perception.

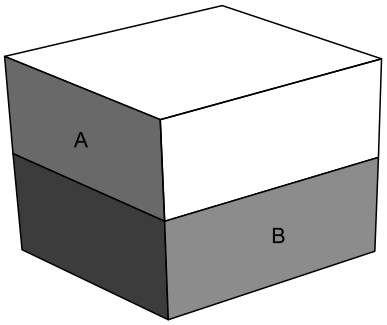

Fig. 2. The effect of a perspective view on the perception of brightness
Source: Grzelka (2022) based on (Wang et al., 2017).

Applying transparency to all surfaces in a 3D model to reduce the occlusion of focused objects is complicated. This can be effective when visualising objects with a single floor; for multiple floors, transparency is ineffective and non-preferred. According to Wang et al. (2017), transparency also affects the user's identification of volumetric objects, specifically their boundaries in 3D models. In summarising this variable, we can conclude that further research is needed. For this, disconnecting certain elements from the object, may be desirable for the potential user. This is based on the argument that it will be simpler to see the part of the object located in its centre. Labels, on the other hand, worked best when placed inside or closest to the symbol being described. The conclusion drawn from the experiment was that the user perception improved when the volume label was placed inside the object. This conclusion agrees with Ware's (2012) assumption that the principle of proximity can help viewers associate text labels with symbols.

RECAPITULATION

The aim of the study was to define the direction of 3D cadastre visualisation. As starting issues, the paper provides descriptions of user needs, visualised data types and the visualisation platforms. It is worth noting here the wide variety of issues that prevail in various countries. Considering user needs, an important issue is the integration of data from multiple sources and the distinction between physical and legal

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objects. With regard to the type of visualised data, the possibility of relying on ISO 19152, BIM issues and the potential use of point clouds are noteworthy. The large number of visualisation platforms in use is also worth noting. For the time being, there is no indication of the dominant popularity of any of them.

The main part of the publication is a study of 3D cadastre visualisation strategies, which was carried out using SWOT/TOWS analysis. The analysis took into account both internal and external factors that can influence the development of 3D cadastre visualisation policies. The result of the analysis is a proposal for an aggressive strategy, based on the use of the strengths and potential opportunities of 3D cadastre visualisation. From this, it can be concluded that this is related to both the development of awareness related to real estate, the property market and urban development and the increasing popularity of 3D visualisation solutions.

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HARMONISATION OF THE URBAN ENVIRONMENT BY MEANS OF VISUAL ART, LIGHTING DESIGN, AND ARCHITECTURE

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ABSTRACT

Motives: This study was undertaken to fill in the gap in theoretical knowledge about the challenges associated with transformations in the modern urban environment, the socio-cultural consequences of external changes in the urban landscape, and growing interest in the urban environment as a unique locus of artistic and creative activity.
Aim: The purpose of the study was to analyse modern methods of optimising the urban environment by means of visual art, lighting design, landscape architecture, and small architectural forms.
Results: A harmonious urban environment was created in Kharkiv through the introduction of sophisticated design elements, art objects, and urban furniture in the architectural context. These elements were integrated to create distinct and high-quality urban recreation areas. Basic modelling principles for optimising the urban environment can be used to analyse and combine the existing methods, and search for new opportunities to implement creative design solutions.

Keywords: creativity of the urban environment, Kharkiv, urban space, small architectural forms, lighting design

INTRODUCTION

A city is not just an architectural phenomenon, but also a socio-cultural creation filled with different patterns of living. In its various functions, a city is a subject of interdisciplinary research of many sciences, especially urban planning, social psychology, ecology, and philosophical sciences: aesthetics, cultural anthropology and philosophical anthropology. Apart from that, the images of a city are reflected in literature, the visual arts, cinema and television. Together, these works of art form a figurative panorama of the city, a technological system of its design in which the city is represented

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by the specific language of a particular art form (Song et al., 2022). Since the environment reflects changing cultural stereotypes and consumer demands over time, it requires changes and responses to life processes. To make the urban environment with the already established architectural and planning conditions and the existing development consistent with the changing needs of modern life, new forms of human and social behaviour at a particular point in time, it is both essential and achievable to reorganise the environment to a new level of content. The material and organisational forms of this reality are transformed, and the idea creates a harmonious environment with respect for the norms and values of culture. By determining the activity of the properties of various design tools and the possibilities of their interaction, it is possible to monitor the process of changing life and society, regulate the renewal of space, and find ways and means to preserve the value of the environment and its modernisation (Wang, 2021; Syrmanova et al., 2021).

The studies cover the general characteristics of the city's architecture and the main trends of its development and changes. Many authors attribute the urban environment to various indicators, primarily aesthetic, architectural, landscape, spiritual, cultural and many others. In 2004, the UNESCO (United Nations Educational, Scientific and Cultural Organization) Creative Cities Network was established to strengthen cooperation between cities, recognising culture and creativity as strategic elements for sustainable socio-economic development. This initiative promoted intellectual interaction between the participating cities, allowed the exchange of cultural and artistic experiences, and enabled the implementation of joint international projects. Today, UNESCO's Creative Cities Network brings together 295 cities from more than 80 countries, representing one of seven creative disciplines (Meseneva, 2020): arts and crafts, gastronomy, design, film, literature, media arts (digital art) and music. UNESCO creative cities have a rich cultural heritage and use the potential of the creative environment for the socio-economic development of the region. Such cities play an important role in creating an atmosphere of openness to creative processes, developing creative clusters and facilitating the gradual transition to market globalisation. The urban environment in cities is formed by synergetic solutions based on a combination of different types of design, music, history and literature, modern information technologies and environmental principles (Narboni, 2020; Goussous & Al-Hammadi, 2018). One such city is Kharkiv. Based on this, the object of this study is the urban environment of Kharkiv, namely its object content.

The analysis of urban environmental issues from a design perspective requires an examination of the trends and dynamics of urban planning tools and the degree of influence of social, economic and environmental factors. Modern Ukrainian society is facing profound changes in the basic principles of life, which are actively influenced by the environment. Therefore, specialists are constantly searching for solutions to create a certain image of the environment. The image of the environment is interpreted as a category whose realisation is the most important task of the architect-designer. A detailed analysis of Ukrainian cities shows that their environment is becoming chaotic due to changing socio-economic conditions, especially commercial pavilions, advertising installations and haphazard evening lighting (Rudenchenko, 2013). In addition to the visual ecology often disturbed in cities, there is also the aspect of sound comfort, which in the modern urban environment can be achieved with the help of design solutions and specialized small forms that create an acoustic effect. Thus, to create a harmonious environment in a modern city, a synergistic approach is needed.

The purpose of this investigation is to analyse modern methods of optimising the urban environment by means of visual art, lighting design, landscape architecture and small architectural forms.

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MATERIALS AND METHODS

The study examines the design technologies that shape contemporary urban space and its environment. As a methodological basis for the study, the following general scientific and special methods have been applied: method of analysis and synthesis, design, scientific objectivity, and systematic approach to the study of urban environment optimisation. This study applies a number of techniques and methodological approaches, in particular systemic, dialectical and comparative approaches. The methodology of this study is determined by the topic evolving at the intersection of several branches of knowledge, such as design, urban ecology, urban planning theory, architecture, architectural design of the urban environment and many others. At the same time, the design of a comprehensive urban design and the spatial environment of a city is characterised by a considerable methodological effort through the design of the surrounding elements, using design techniques and tools developed in the design of architectural environment objects.

The primary method in the study was analysis adopted as the central method of scientific cognition. This method of scientific cognition involves the process of parsing an object into its component parts in order to fully comprehend them according to different parameters. The analysis characterised key judgements related to the study, including "small architectural forms", "harmonisation of the urban environment", "lighting design" and "landscape architecture" and many others. The method of analysis has made it possible to pursue the stated objective of this study, namely to examine the interaction between the available methods for optimising the urban environment by means of the visual arts, lighting design, landscape architecture and small architectural forms. Photographs and sketches of parts of Kharkiv's urban environment were collected for this study. Historical data on some of Kharkiv's architectural sites and future plans for the city's development are also explored. It was brought to light how elements of modern design, street sculptures and small architectural forms contribute to the optimisation of Kharkiv's urban environment.

The design method has made it possible to evaluate the application of methods for optimising the urban environment by means of the visual arts, lighting design, landscape architecture and small architectural forms. It has determined the influence of the entire study on the questions generated by this subject. The design method is divided into several sub-items, as the resolution of the chosen tasks must be consistent and complementary. Emphasis was placed on the explicit use of tools to summarise the findings of the entire research work and to harmonise the results in order to define the novelty and practicality of the work undertaken. The implementation phase of the study on "Harmonisation (optimisation) of the urban environment by means of visual art, lighting design, architecture" allowed for an assessment of the accuracy of the entire study, or to be more precise, the effectiveness of the chosen research methods to be determined. The purpose of this study has been achieved, as well as all theoretical and practical provisions concerning the study of the topic have been clarified. The method of scientific objectivity and classification of the findings was used.

RESULTS

Nowadays, small architectural forms are an important functional, artistic and decorative element filling the modern urban environment, and creating comfortable conditions for residents to live in the city and spend time on the city streets. Creative objects with which the city dweller interacts include landscape architecture, small architectural forms, design installations, sculptural compositions, and urban gardening. Small architectural forms are objects and devices with simple but independent functions that complement the architecture of urban buildings, structures, parks, squares and streets and are elements of their improvement (Rami, 2017). Small architectural forms of modern urban planning are:

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1. Decorative purpose: decorative walls, decorative sculpture, fountains, pavilions, bridges, facade decoration with bas-reliefs and mosaic panels.
2. Mass utilitarian uses: benches, litter bins, fences, signs, stairs, retaining walls, number plates, flower vases and decorations; Light fittings, kiosks, information kiosks, telephone boxes, post boxes, bus stops, network support services, traffic lights, road signs.
3. For recreation, games and sports facilities: tables and benches, swings, carousels, slides, rollers, tents, fencing, lighting systems, etc.

Modern urban planning also includes the following (Florida, 2007; Matrouk & Goussous, 2011):

a. street furniture;
b. furnishing of different places of urban space, squares, parks;
c. devices for defining a particular area (fences, partitions between pavements and driveways, etc.);
d. ground floor structures (dance floors and theatre arenas, graphic elements, art objects).

Structures with small architectural forms, design installations, and sculptural compositions are an important part of any urban environment, making the city more humane and interesting for residents and visitors. Small architectural forms, in their essence and style, represent the most mutable layer of the subjective spatial environment of a modern city. Today, the basic principles of designing small architectural forms in the design of modern urban environment, including those of the city of Kharkiv, are (Shu & Zhong, 2020):

– complexity, which consists in designing not just individual forms of small architecture, but their functional and compositional complexes and interrelated elements of the object-spatial environment (it is worth noting that today, small architectural forms are not considered to be separate, self-sufficient elements, but are included in the planning and organisation of the functional zoning of the surrounding urban space);
– a unique design idea, the design of a group of small architectural forms in a single style based on the stylistic features of the existing image of the urban environment;
– the project incorporates the unique natural conditions and landscape of the urban environment; preserving national identity, succession and respect for cultural traditions;
– creation of an interesting, unforgettable artistic image, adaptation of the artistic originality of small forms to their intended purpose;
– functional zoning, small architectural forms allow the area to be divided into certain zones of different purposes and emphasise them in appropriate places;
– the use of natural materials in urban environments embodies nature and creates a comfortable environment, psychologically close to the person;
– consideration of ergonomic requirements in the design of small forms in urban environments;
– scale and proportion, harmonious combination of part and whole;
– proportion of small architectural forms to the human scale and the surrounding space;
– rational, efficient use of materials and structures.

The struggle against noise in the central areas of cities is made difficult by the existing density of buildings. In this case, the most promising solutions to this problem are the reduction of the own noise of vehicles and the use of new effective noise-absorbing materials in buildings facing the busiest thoroughfares, the use of vertical greening of buildings and increasing the row of window glazing. If we consider highways in new residential areas of cities or expressways between areas of large metropolises, then in these conditions it is possible to build noise barriers, widen highways, and plant trees that reduce noise levels on roads. In order to prevent noise from such highways, there is a need to apply such measures, which would provide a high probability of protection from the entire spectrum of the noise impact of such transport facilities. One of these measures is the construction of acoustic protective walls, which also have an aesthetic function, that is, they are decided on the basis of artistic and design means of design. Such walls are not uncommon in Europe, but they are only beginning to regain their rightful place in the urban environment of Kharkiv (Long-term strategy…, 2015).

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A number of successfully implemented projects can be examples of the successful and effective use of the considered method of sound-insulating screens and barriers. A sound pipe in Melbourne (Australia) is designed to reduce roadway noise without compromising the aesthetics of the built-up area. The noise reduction wall in the Netherlands has a transparent part at the driver's eye level to reduce the visual impact on road users. The proposal "Forest Corridor" took one of the 2 places (professional category) at the open international competition of noise protection screens/fences organized in Hong Kong (Klishch, 2016). The project provides an alternative image of construction for noise reduction in the dense urban environment of the city. Considering the existing buildings and transport network of Kharkiv, it can be suggested to continue to use the redistribution of traffic flows and increase the sound insulation of buildings along transport arteries. For some operated and, especially, for promising highways being built in the modern world, an effective second method is used – the device of sound screens and barriers. Considering the existing municipal projects in Kharkiv for the creation of new large highways connecting the city centre and sleeping areas (in particular, the Saltivsky residential massif and the "Kyivska" metro station, etc.), the most rational is the use of soundproofing structures. The implementation of European and world experience in the arrangement of similar structures in Kharkiv, taking into account their effectiveness and the possibility of application in the conditions of modern Ukraine, will be another step towards creating the most comfortable environment for the city's residents. It should be understood that in Kharkiv, for the existing buildings, the use of screens is possible on the main multi-lane highways only if the design code of the city is taken into account.

Another feature of creative urban spaces is their flow from the external environment to public places where citizens stay, such as various cafes, bars, and fast food places. Their interiors are directly connected with the environment, are a part of it. Therefore, for such objects, the main means of solution will be elements of fine art, wall paintings, which are continued by monumental paintings on the external walls of buildings, elements of landscape design and art objects.

Table 1 presents photos of several art cafés and student projects of future creative facilities. It is possible to identify some common features and the necessary design tools to create such a creative environment. Designed for underground hangouts and cosy gatherings, Kharkiv's art cafés, pubs and clubs are styled according to their name and the preferable theme of the meeting (literature, music, internet, etc.). The authentic designer lamps, which match the overall theme, and the muted, semi-darkened light, which creates an intimate atmosphere and illuminates the performance space, are an absolute must. A characteristic feature of such establishments is the artwork on the walls (paintings, batiks, graphics, art photos) or accessories typical of the establishment's style (musical instruments, books, autographs of famous actors and musicians, etc.). Lighting design techniques are often used to create dynamic stage illumination. The overall colour scheme is most often contrasting, which corresponds to the active trends of rock music and contemporary rap poetry. By studying existing equivalents and relying on personal creative needs, design students try to use the above techniques in a coursework project for food service places to create not just a comfortable and cosy, but also a branded, imaginative, creative, developmental environment. The implementation of such proposals should increase the creativity of the urban environment, facilitate the communication of modern creative youth and accelerate the formation of a new creative class of creative intelligentsia, which is an essential requirement for any city.

Nodal positions of harmonisation of urban environment design by means of small architectural forms in Kharkiv are formed at a proper level, but it is necessary to consider substantially the emerging trends. These trends include complexity of urban environment design, functional and compositional interrelation of all elements of the subject-spatial environment with the environment of the whole

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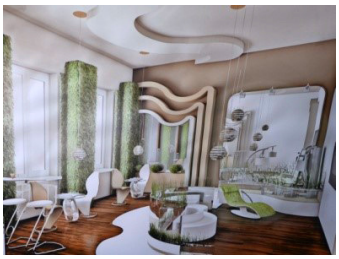
city, the unity of style in the urban environment, originality of natural conditions and landscapes. Today, the emphasis on harmonising Kharkiv's urban environment through visual art, lighting design, landscape architecture and small architectural forms, in line with current trends, is placed on designing (Bankovska, 2015):

- ecological qualities of urban spaces according to an appropriate standard; diverse utilitarian urban environment; friendly and humane urban environment;
- objects that are connected with historical or significant events of the city; urban exhibitions of small forms, art objects;

Table 1. Interior design features of multi-functional establishments

Existing food service facility	Functional purpose	Design tools and techniques	Creative environment student project
 Korova Art Club	Café by day, with live performances by musicians, and poets in the evening	Designer lamps; poster; artwork; privacy and event seating arrangement, colour harmonies	 Music Café
 Pintagon Art Pub	Beer pub, Beer Club; occasionally hosts shows (bards, rock music)	Poster, artwork; event seating arrangement, trendy murals, artificially darkened interiors	 Art Café
 Agata Art Café	Evening café, hosts live performances by musicians, poets, possible discussions and dialogue	Poster, artwork; event seating arrangement, trendy murals, artificially darkened interiors	 Theatre Café
 CUB Literary Café	Operates as a regular café during the day. In the evenings it hosts poetry, music performances, and lectures.	designer lamps; artwork; event seating arrangement, uniformity of shapes	 Literary Café

Source: own preparation.

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– genre sculptural fragments attractive for tourists and city residents;
– design of sports objects of the urban environment, given the massive enthusiasm of city residents for sports.

As for public lighting, it is intended to artificially increase visibility on the streets at night. The most commonly used lamps for this purpose are cantilever lamps with gas or sodium halide lamps or LED (light emitting diode) lamps. At night, the lights are turned on automatically or as directed by the dispatcher. However, whereas in the past street lamps were only used to improve visibility, in recent years a great deal of attention has been paid to their design. Over the years, urban public lighting has become an important element of the appearance of any space, revealing its essence and allowing a better appreciation of its architectural style. Decorative public lighting, the function of which, apart from being functional, is a decorative element that provides street aesthetics (modernity, restyling and unique design) (Inglis et al., 2022). Lighting design is a relatively new industry in the history of art, constantly evolving and covering more and more areas of application. Lighting design is associated with technological advances, this design trend has a long history and plays an important role in the creation of urban environments. One might assume that street lighting with torches, then gas lanterns and street electricity are all signs of lighting design. An important step towards optimising the urban environment was the introduction of fluorescent lamps: neon lights have changed the appearance of the main streets of large cities. Another significant technical advance has been the emergence of LED light sources, which have become the most effective means of designing the urban night scene (Fil, 2020).

Technological and scientific advances have made it possible to create magnificent nighttime laser structures and unique holographic images. The initial goal of modern lighting design is to create a pleasant and communicative urban atmosphere at night. Therefore, it can be argued that lighting design is a way to harmonise (optimise) the urban environment. In Table 2, the best design works of students of the Faculty of Architecture of O.M. Beketov National University of Urban Economy in Kharkiv and students of the Department of Interior Design of the Kharkiv State Academy of Design and Arts were compiled to illustrate the results. These designs have also considered the lighting of the building and its surroundings, as well as the nearby streets, to optimise this aspect of Kharkiv's overall design. Besides improving the usability of the environment at night-time, the solutions presented have important artistic and compositional value. Above all, the artistic image of the building is embraced, and each project has a specific idea.

Visual perception of objects and communicative elements influence citizens through many historical associations, tactile sensations, colours and compositional means. The exterior elements (gardens, parks, squares and recreation areas) provide conditions for recreation, socialising and entertainment through green spaces, ponds, sculptures and industrial design elements: streetlights, letterboxes, and telephones. In recent years, a number of street and park sculptures have appeared, celebrating both real figures and fictional characters. All these elements are systematised according to their location in the urban environment and their influence on its aesthetic perception. Modern urban sculpture is based on historical architectural and decorative traditions, the presence of sculptures on the facades of buildings that are architectural monuments. There are especially many such buildings in the centre of Kharkiv. Along with modern, realistic sculptures, the streets are filled with abstract, sometimes incomprehensible but attractive installations, elements of outdoor advertising for shops, cafés and businesses (Kuptsova, 2020).

The analysis of the literature on the studied topic reveals a lack of studies dedicated to the urban environment of Kharkiv through design. However, it is worth noting that the complex functional-spatial system of the modern urban environment is the subject of many contemporary studies for architects and designers. Today, the issue of organising the spatial social infrastructure of the modern urban environment is crucial for Ukrainian cities.

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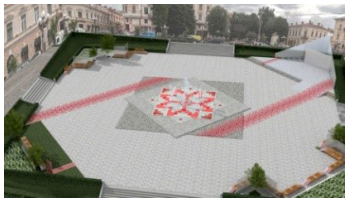
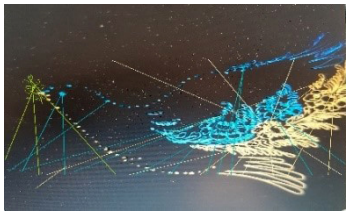
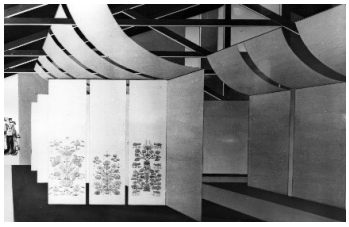
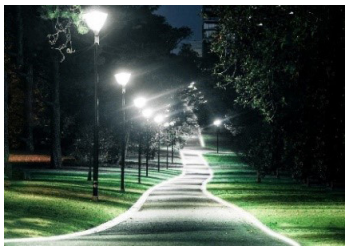
Table 2. Projects of students of the Faculty of Architecture of the O.M. Beketov National University of Urban Economy in Kharkiv and students of the Department of Interior Design of the Kharkiv State Academy of Design and Arts on optimisation of the urban environment

No.	Project layout	No.	Project layout
1		5	
2		6	
3		7	
4		8	

Source: own preparation.

It is important to create more humane recreational and landscape spaces in an urban environment. Commitment to overall renewal, orientation towards the most modern forms of activity and communication are characteristic features of citizens' socio-cultural activities that influence their development in the daily life of the urban environment, significantly changing and emphasising the design of the urban environment. The promotion of similar competencies in these areas will enhance creativity, promote creative lifestyles, increase self-esteem and the competitiveness of young designers and architects in Ukraine.

As an example, many academic sources touch on issues of ethnic self-identification in the urban environment. Ethnodesign of the modern urban environment and its issues have been studied in great detail in the works of many contemporary scholars. Recent studies in this area include those by Grigorieva (2014), who examines the application of ethnic traditional design techniques in the design of modern interiors. According to Grigorieva (2014), today various exhibitions representing folk crafts, traditional art, achievements in the production of folk clothing, decorative items and much more play a significant role

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in the promotion and dissemination of ethnomotives in the design of the urban environment. Apart from tradition, visitors to these exhibitions are also attracted by innovations based on the achievements of the national ethno-culture. The historical values behind contemporary design include traditional crafts such as decorative painting, embroidery, egg painting, ceramics, carpentry and more, incorporating distinctive national ornaments, and ancient tribes.

It is also worth mentioning the studies of Pang and Shen (2022), who have addressed the harmonisation of the contemporary urban landscape. They consider the absolute dominance of architecture in the urban landscape to be accompanied by a reduction in green areas, the monotony of the contemporary urban environment, the aesthetic, intellectual and emotional ambiguity of pedestrian communications and the dissonance between the scale of historic centres and the historic built environment. At the turn of the 20th and 21st centuries, a number of original objects of landscape architecture appeared abroad, where these tasks were solved differently for different natural, climatic, urban, historical and cultural conditions. Historic landscape-natural compositions are based on the subordination of architecture to nature, while landscape compositions are based on the subordination of architecture to nature (Goussous & Al-Jaafreh, 2020). Modern objects of landscape architecture, in which nature blends harmoniously into the urban environment, are already being created according to new construction principles based on the compositional interaction of architectural space with nature. This principle reads as follows: imitation involves the use of artificial materials that mimic nature; interpretation consists of designing the architectural and geometric design of natural elements that are subordinate to the urban context.

The studies of Zhan et al. (2022) address the increasing role of landscaping and greening of urban public areas in the context of today's urbanised environment. Flora plays an important role in improving a person's mental well-being. Floral arrangements and a variety of tree and shrub crowns with brightly coloured accents counteract the aggressive linearity of modern urban development. Such landscape architecture techniques can improve a person's mood, energy level and performance. Plants improve an emotional environment, which positively influences a person's mental state while also affecting emotional and mental tension, has a positive effect on well-being, productivity and resilience to performance, and improves a person's "quality of life". When creating a psychologically favourable living environment for a person, it is very important to have an inner balance. The aesthetic, ornamental function of vegetation in the city enhances the artistic expression of urban development. Plants are a special material in creating landscape objects with common-use areas designed with functionality and power to optimise the environment and make it more comfortable for humans.

In articles published by a number of publicists from other countries, Wang et al. (2021), Badura et al. (2021) the urban environment was considered an art object. The pieces present a classification of the options for creating artistic objects based on existing urban space. The possibilities of synthesising different types of art to create a harmonious and interesting atmosphere in the city are explored, and examples of actual projects are presented: painting, graffiti, use of lighting effects, video broadcasts, and advertising and installation productions. Using any combination of these methods, it is possible to change the visual perception of an object and space without physically changing the building itself. By synthesising the techniques of different art forms, it is possible to create a comfortable urban environment by bringing together different subcultures, thus reducing outbreaks of vandalism and aggression. In modern urban environments, it is common to see a large number of patterns on façade surfaces, concrete hedges, asphalt and more.

Not all of them are of a purely ethical nature and fit harmoniously into the city's composition. However, there are techniques for decorating architectural objects to reorganise space, enhance its socio-cultural significance, create a coherent image, and relieve the visual and emotional tension of residents, which is a synthesis of different types of art in the urban environment. This urban project aims, on the one

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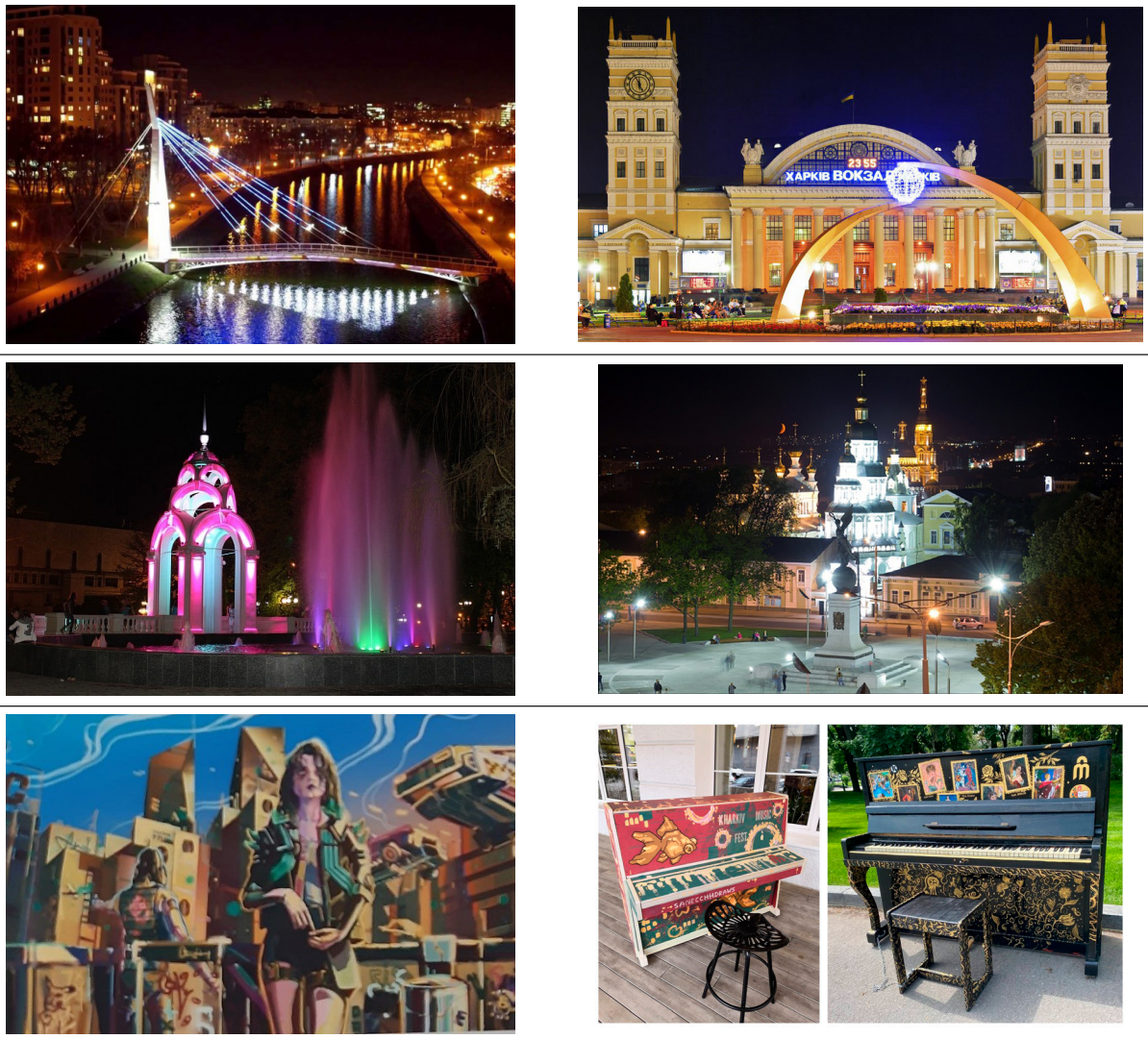
hand, to divide the ownership of space into a dominant social group, and on the other hand, to combine a variety of urban spaces into one. Here are some examples of how art design techniques can be used to transform urban space into an art object (Table 3).

Currently, it is desirable to saturate the urban and suburban environment not only with functionally necessary elements of the architectural and design direction but also with art objects (Fig. 1).

A designer who received an academic art education can also give his projects a bright individuality, bringing them to the level of a work of art. Since the functional component still plays the main role in the design, the design object has a utilitarian purpose. The artist is not limited by the function, he is able to create unique products, giving them a personal life.

The environment actively affects the human subconscious, teaches certain values, adds energy, or, on the contrary, "sucks" it out of a person. The grey identical quarters of the socialist new system level individuals, accustom them to the same thoughts and take away the individuality of thinking. The

Table 3. Techniques for using artistic design to transform urban space into an art object



Source: own preparation.

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Fig. 1. Art objects in the urban environment
Note: *a – bronze sculpture of children; b – green sculpture "Save every tree"; c, d – murals on the walls of high-rise buildings in the city's sleeping areas.*
Source: own preparation.

modern approach to the architectural environment demands a creative individual approach to each environmental object. The active uses of colour in architectural structures, street art – murals and graffiti compositions, elements of land art that differ according to the conditions of the landscape create a variety of environments. Art objects can play an important role in strengthening such individuality: street sculptures, wall paintings, murals and graffiti, flower compositions (Fig. 1). The environment of the centre of Kharkiv can vividly confirm the active influence of this approach on the citizens. The closer to the outskirts of the city, the less suitable elements can be found. Typical playgrounds, of course, satisfy the minimum needs of children's leisure, but the world in which people spend most of their lives should be brighter, more creative, different every time. That's when the creative generation of young people will grow up.

Decorative light design installations, light fountains and interactive laser shows make a strong emotional impression on citizens, have an educational national-patriotic, ethical-aesthetic effect on the perception of urban architecture. All types of lighting enhance the creativity of the urban environment. It is possible to define the role of light design elements in the urban environment as those that have both functional and powerful decorative and aesthetic significance, increase the comfort and creativity of environmental and architectural objects, and have

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an educational and positive emotional impact on city residents. It can also be noted that the urban lighting environment of the city of Kharkiv has wide prospects in the sense of its development possibilities.

The architectural environment of the city is a scene with changing backgrounds, props, where one is both the protagonist and the audience. Buildings and structures are not static; they change, they move. An architectural image can influence a person's emotions, making them experience, think and sense, as the artistic function of space often coincides with its emotional focus, where the utilitarian and practical function dominates. By playing with the above techniques, architects and designers can influence the interaction between people and the city, exacerbating or resolving arising conflicts. By making the urban environment interesting, unusual and comfortable for its inhabitants, it is possible to suppress outbursts of aggression and vandalism, enhance the aesthetic significance of the space and build its plastically correct layout (Badura et al., 2021).

The studies of Xin et al. (2022), Riapolov and Hesin (2020) consider means of visual art as an important means of creating an expressive, modern original architectural image. Although the synthesis of art is very evident today, painting is one of the main elements in the process. Painting has always been a means of completing a constructive architectural image: monumental painting, mosaics, stained glass windows, frescoes of various technologies help to create an expressive image, enrich colour, plasticity and texture. Painting offers a surprising feature of spatial illusions: in Renaissance ceiling paintings the frontal perspective deepens the wall space, while in contemporary 3D ART the architectural solution of the street space allows architects to express their economic and creative status to the full. The understanding and study of architecture as an art form is based on the general laws of art, on the grounds and categories for which artistic painting is necessary. The architectural image for the various schools is supplemented by images that add authenticity and artistic identity to the group. The prospects for a harmonious combination of various architectural and picturesque worlds in modern reality are indisputable. The architect must first have a general vision of the image being created and understand the harmony that the image carries within it. The figurative component of architectural art has always emphasised its uniqueness.

The content-image character corresponds to the distinction between the monumental image, which is a sign of the architectural whole, and the monumental-decorative image, which merely decorates the surfaces of walls, ceilings and facades dissolving into the architecture. Monumental painting is also referred to as monumental-decorative painting, that is, painting that gives the mural a special decorative value. Depending on the function, monumental murals are approached using three-dimensional or two-dimensional decorative compositions. The monumental painting is complete and will only be completed when all elements engage together. For example, a significant phenomenon in the design of the 20th century was supergraphy as a form of active change in the appearance of the urban environment through colour. By supergraphy, experts understand artistic solutions that are superimposed on an independent three-dimensional object (structure, product, surface) based on contrast or coordinated interaction of a structural morphological image, which creates a completely new visual impression. In the visual transformation of three-dimensional form, the main feature of supergraphics is the tectonics of their colour, justifying the use of the prefix "super", which allows them to be interpreted as photography or graphics and colour. Today, the arsenal of artistic paints of the city has expanded significantly. Dynamic artistic lighting of monumental art pieces, architecture, urbanism and landscape, video mapping, laser and LED technology enhance the architectural forms and spatial situations of the city. At this point, supergraphics can only be considered hypothetically. Namely, this would be the 'supergraphic method' or approach in urban architecture and design, which has an active transformation of architectural objects and environments on a visual, transformative and visual level. The origins of this approach go back to the distant past (Riapolov & Hesin, 2020).

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CONCLUSIONS

This study considers the impact of all the above-mentioned forms of optimisation of the urban environment, namely, small architectural forms and elements of landscape and lighting design. In many of its manifestations, contemporary urban sculpture contributes to the comfort and diverse outlook of Kharkiv's urban environment, expands the number of "urban centres" responsible for the ultimate comfort and creative atmosphere, the ground that forms the creative community spirit. Nowadays Kharkiv embodies such a vital and spiritual environment because this space is full of creative street sculpture. Summarising the above, it should be noted that a harmonious urban environment in Kharkiv is based on the inclusion of sophisticated design elements and small architectural forms. A careful combination of these elements creates a distinct and high-quality picture of the city's recreation areas. Based on the basic principles of modelling the optimisation of the urban environment, it is possible to further analyse existing methods, combine them and look for opportunities for new creative design solutions. Design contributes to the expansion of the space of artistic exploration of different aspects of human existence, the introduction of artistic and technical products in many areas of life of modern society serves to meet not only the material but also the spiritual (including aesthetic) needs of people. Thus, it contributes to the formation and development of various aspects of human intellectual culture: orientation towards aesthetic values, aesthetic and artistic taste, humanisation of socio-cultural relations, and life values.

The findings of the study indicate that the contemporary urban environment is seen as a realm of citizens' needs in the areas of residence, work, communication and recreation. Most urban planning is carried out without creative solutions, making it difficult to navigate the city, diluting the positive image of individual historical fragments and creating a negative overall impression of the city. On the other hand, urban planning is currently going through a complex development phase. Modern cities are a unique reflection of the information society, its crises, deadlocks and resurgences. These are the trends of most Ukrainian cities, including Kharkiv. Urban design is essential to a holistic appealing image of the city. Urban planning consists of aesthetic and functional objects. The aesthetics of the urban environment include landscaping, fencing, lighting, sidewalks and much more. Functional objects include small architectural forms (public transport stops, commercial pavilions) etc.

All of this creates a coherent image of any city. On the one hand, its socio-cultural component depends to a large extent on how a particular residential area of a city is designed, while on the other hand, the quality of the urban environment is influenced by society itself. Among other means of urban design, such as lighting design, water design, and landscape design, the following tools can be distinguished: public art and social advertising. The distinctive feature of these design tools lies not only in their aesthetic component but also in their significant impact on the socio-cultural process in the city. Public art in public space is not just art in urban space. It is an ever-changing dialogue between society and the urban environment, not only through static objects but also through the manifold actions generated by that same society. The mission for contemporary designers and architects is to balance the functional-spatial system of a city through the use of small architectural forms, natural and artificial green spaces, which will awaken the interest of citizens in the locations where they live, study or work. The methods and trends analysed in this study represent just a short list of architectural issues that architects and designers tackle when optimising Kharkiv's urban environment.

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THE FOREST FUND AS AN INSTRUMENT FOR ADDRESSING BUDGET DEFICIT IN POLISH FOREST DISTRICTS

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ABSTRACT

Motives: The forest fund was established to ensure the financial stability of forest districts whose operations are financed by the State Forests National Forest Holding in Poland. However, the main role of the forest fund is to distribute funds from high-income forest districts to districts reporting a budget deficit.
Aim: The purpose of this paper was to analyse and evaluate the model of managing forest fund resources in view of the provisions of the applicable legal regulations.
Results: Between 2013 and 2020, the allocation of funds to forest districts reporting losses did not contribute to fair and rational distribution of resources, nor did it eliminate differences in the financial performance of forest districts operating under various environmental and economic conditions and implementing nature promotion and social education activities. The mechanism by which timber sales (operating costs that reduce profit) can be deducted from the forest fund raises serious doubt. Districts that benefit from such write-offs can program the amount of deductions in the forest fund. The above violates the principle of tax equality which states that tax laws should be applied in an identical manner to all taxpayers. A decrease in profits posted by forest districts reduces the central government's revenues in virtue of the taxes paid by the State Forests.

Keywords: forest districts, funding system, public forests, special purpose fund

INTRODUCTION

The forest performs three basic functions, either naturally or as a result of human activity. First of all, the forest performs a protective function, which is closely related to the protection of the air (absorption of pollutants, including dust and carbon dioxide, and the production of oxygen), soil (limiting or stopping soil erosion) and water (regulating water conditions, creating an appropriate microclimate). Secondly, it has a production function, which consists in supplying wood (the basic raw material, which is a renewable energy source) and undergrowth. Thirdly, it also has a social function, which consists in the fact that, on the one hand, the forest is a workplace, and on the other hand, it is a space for rest, recreation or sports for the vast majority of society (Paradowski, 2020). In the Forest Act of 28 September 1991 (Official Journal of Laws of 2020, Item 1463, as amended), the Polish legislator clearly emphasizes the leading role of the protective function of the forest (Ziemblicki, 2015). The concept of ecosystem services constitutes a more

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anthropocentric approach to this issue. It distinguishes three categories of services that can be applied to forests: provisioning services (e.g. food, timber), regulating and supporting services (e.g. climate regulation, flood prevention), as well as cultural services (e.g. aesthetic, recreational, educational values) (Boćkowski & Rogowski, 2018).

Poland is one of the six Member States of the European Union (as well as Sweden, Finland, Spain, France and Germany) with the largest forest areas (Supreme Audit Office, 2021). As of 31 December 2020, the forest area in Poland is 9,260 thousand ha, placing forest cover at 29.6%. Public forests dominate the ownership structure of forests in Poland (80.7%) (Statistics Poland, 2021). The State Forests National Forest Holding (hereinafter referred to as 'the State Forests') is a state organizational unit without legal personality that manages forests owned by the State Treasury. The main task of the State Forests is to carry out sustainable forest management according to the principles of universal forest protection, sustainability of their maintenance, continuity and sustainable use of all the above indicated forest functions and enhancement of forest resources. It operates on the basis of financial independence and covers the costs of this activity from its own revenues (Szramka & Adamowicz, 2017). The main source of income for the State Forests is the sale of wood raw material from the forests entrusted to the management of the State Treasury (General Directorate of the State Forests, 2021).

One of the main principles governing the financial management of the State Forests is "the decentralisation of operations with the simultaneous centralisation of strategic decision-making" (Kuźma, 2018). Pursuant to Art. 35 of the Forest Act, local head foresters independently manage forests in forest divisions based on forest management plans and are responsible for the condition of forests. However, the natural and economic conditions of the activity of individual forest districts, including forest production, are extremely diverse and depend on such factors as: the area and range of forest complexes, the age and species structure of stands, the share of protective forests, the area of stands excluded from harvesting (Wysocka-Fijorek, 2016). Due to the influence of these factors, forest districts managing in favourable conditions achieve a high level of profitability and can be economically independent, while units burdened with additional expenditure on the implementation of non-production functions are not able to generate funds that would enable the principle of self-financing to be maintained (Adamowicz et al., 2014).

In order to ensure the financial stability of forest districts within the financial system of the State Forests, the forest fund was established, which is primarily a mechanism for redistributing funds from high income forest districts to deficit units (Bieluk & Leśkiewicz, 2017; Piekutin & Gruchała, 2006). The state of the forest fund as on 31 December 2020 was PLN 731.5 million, which makes the problem of managing the funds of this financial instrument an issue of significant importance (General Directorate of the State Forests, 2021).

Considering the importance of the research problem indicated above and the fact that sustainable forest management carried out by the State Forests is significantly exceeding the annual accounting period, and the effects of management are largely determined by natural and economic factors (Wysocka-Fijorek, 2016), the aim of this article is an attempt to analyse and evaluate the management of forest fund resources allocated to the implementation of tasks specified in the Forest Act.

LITERATURE REVIEW

Despite the importance of the issues related to the proper conduct of forest management in state-owned forests in Poland based on the resources of the forest fund, it has been a topic raised sporadically in the doctrine and has been limited almost exclusively to articles in Polish scientific journals. Moreover, the research contained therein was limited only to the scope of activities of individual organizational units of the State Forests (research based on the example of the Regional Directorate of the State Forests

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in Wrocław – Adamowicz et al., 2014; research based on the example of the Regional Directorate of the State Forests in Radom – Piekutin, 2006) or to a period of one year (e.g. the research covered the year 2014 – Stebnicki, 2018). Thus, the current scientific studies relating to the matter being the subject of this article do not constitute an in-depth, exhaustive analysis of the subject matter mainly due to their fragmentary nature. On the other hand, in the case of research and analyses concerning long-term periods, it should be stated that the data on which they were based have lost their validity (e.g. they related to the years 2002–2010 – Dyduch, 2012). The analysis of the functioning of the forest fund included in this study, covering the years 2013–2020, is intended to allow for the identification and evaluation of trends in the management of this fund's resources based on the most up-to-date data possible, which may give rise to actions aimed at better use of the production and non-production functions of organization units of the State Forests.

MATERIALS AND METHODS

Research on the theoretical considerations of the analysed problem was carried out on the basis of the literature relating to the research area and applicable law. In order to analyse legislation in the field under study, the formal-dogmatic method was used. The empirical research in the field of forest fund management in Poland, including in particular the structure of revenues and expenditures from this fund, was based on data from the annual financial and economic reports of the General Directorate of the State Forests, official statistical data, as well as post-audit information of the Supreme Audit Office. All relevant data relating to the subject of this article were presented for the whole country and not for a representative sample of state forest units. The time scope of the conducted research covered the years 2013–2020.

RESULTS

In the Polish legal system it is possible to establish, under a separate act, a state special purpose fund, which is an organizational form of management of public finances, used to collect public funds from specific sources for the implementation of separate state tasks. It does not have legal personality, as it constitutes a separate bank account which is at the disposal of the body indicated in the founding act. The costs of the state special purpose fund may be covered only within the financial resources available, including current revenues, subsidies from the state budget and remnants of funds from previous periods (Szołno-Koguc, 2007). Thus, the direct implication of separating funds in the form of a special purpose fund is to ensure sources of financing for a specific area of state activity considered to be of particular importance (Dyduch, 2012). Taking into account the legal nature of the state special purpose fund, it should be stated that in this matter we are dealing with a departure from some general budgetary principles, in particular from the principle of material unity, which requires those involved not to bind specific budget revenues to strictly defined tasks financed from this budget, and from the principle of annuality, according to which the budget is drawn up and adopted for one year (Sadowska, 2015).

The activity of the State Forests and their organizational units is carried out on the basis of an economic account. As part of the management, the following activities are carried out: administrative, economic (in the field of forest management in forest districts) and additional – production and services for forest management, subject to corporate income tax if the expenses related to the production of goods or the provision of services as part of this activity are not higher than their purchase outside the State Forests. The revenues of the State Forests are the sum of revenues of their organizational units. In particular, the sources of revenues are: 1) sale of wood and forest by-products, agricultural, meadow and fishery products, materials, goods and unnecessary fixed assets, 2) leasing or renting of forests, land and other

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real estate, including the leasing of hunting areas, 3) tourist and recreational development of forests, 4) monetary operations and 5) other sources. Forest districts transfer to the account of the General Directorate of the State Forests, determined annually by the Director General, part of the profit from additional activities (Danecka & Radecki, 2021).

In accordance with the provisions of the Public Finance Act of 27 August 2009 (Official Journal of Laws of 2021, Item 305, as amended), the forest fund has all the features of an special purpose fund (Bartniczak, 2009). It was established on the basis of the Forest Act as an integral element of the State Forests financial system. The resources of the forest fund not used in a given calendar year constitute the fund's income in the following calendar year. In Art. 57 (1) the aforementioned act also specified the sources of income for the forest fund. Resources of the forest fund constitute: 1) basic write-off calculated from the value of wood sales, charged to the operating costs of forest districts; 2) receivables resulting from damage: resulting from the impact of industrial gases and dusts, for premature tree felling and for damage caused by fires, mining and geological works; 3) penalties and fees related to the exclusion of forest land from production; 4) budget subsidies, with the exception of targeted subsidies from the state budget for tasks commissioned by the government administration; 5) income from the sale of stocks and shares in companies; 6) other income earned on behalf of this fund (see Table 1). The general manager of the forest fund is the Director General of the State Forests (Bieluk & Leśkiewicz, 2017; Kuźma, 2018).

The data presented in Table 1 show that in 2013–2020 there was a significant increase in the revenues of the forest fund, i.e. from PLN 1,138.6 million in 2013 to PLN 1,687.3 million in 2018. The percentage share of revenues from the sale of wood in the total revenues of the State Forests was as follows: in 2013 – 86.9%, in 2014 – 88.7%, in 2015 – 87.9%, in 2016 – 88.6%, in 2017 – 88.6%, in 2018 – 87.5% and in 2019 – 87.2%. In 2020, the revenues from the sale of wood accounted for 87.7% of the total revenues of the State Forests (General Directorate of the State Forests, 2021). By far the most important source of the fund's revenues was the basic write-off calculated on the value of wood sales, charged to the costs of forest districts – in individual years of the analysed period it constituted from 66.5% (in 2019) to 85.1% (in 2014) of the forest fund's revenues overall.

The amount of this write-off, calculated as a percentage share in the revenues from the sale of wood planned for a given calendar year, was determined for the State Forests every year by a decision of the Minister of the Environment at the request of the Director General of the State

Table 1. Sources of revenues for the forest fund in 2013–2020

Sources of revenues for the forest fund	The amount of the forest fund's revenues (in PLN million)							
	2013	2014	2015	2016	2017	2018	2019	2020
Basic write-off calculated on the value of wood sales, charged to the costs of forest districts	913.1	1,026.9	1,039.0	1,040.5	1,147.7	1,270.5	1,113.1	1,053.4
Subsidiary forest fund income*	42.9	38.2	46.1	42.9	38.0	40.5	41.2	41.7
Penalties and fees related to the exclusion of forest land from production	114.1	119.0	138.8	103.1	254.3	274.8	144.6	137.6
Other revenues related to forests not owned by the State Treasury and national parks	6.2	6.0	4.4	4.5	4.5	3.9	3.2	0.9
Other revenues related to the State Forests	62.3	16.0	15.5	57.8	54.4	97.6	301,6	153.4
Income from the sale of stocks and shares in companies	0.0	0.0	0.0	0.0	71.4	0.0	0.0	0.0
Total	1,138.6	1,206.1	1,243.8	1,248.8	1,570.3	1,687.3	1,603.7	1,387.0

* Financial resources related to the exclusion from the production of forests not owned by the State Treasury and forests under perpetual usufruct of national parks.

Source: own preparation based on the financial and economic reports of the State Forests for 2013–2020. Retrieved from: https://www.lasy.gov.pl/pl/informacje/publikacje/informacje-statystyczne-i-raporty/sprawozdanie-finansowo-gospodarcze-pgl-lp.

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Forests (Danecka & Radecki, 2021). Furthermore, the Director General of the State Forests could determine the amount of the write-off for individual regional directorates of the State Forests, and the directors of regional directorates could determine the amount of the write-off for individual forest districts (Wysocka-Fijorek, 2016). In 2013–2020, the amount of the basic write-off determined by the Minister of the Environment for the State Forests as an organizational unit based on annual financial and economic plans ranged from 14% (in 2016, 2019 and 2020) to 14.87% (in 2018) of revenues from the sale of wood. The above clearly shows that despite the remarks of the Supreme Audit Office regarding the excessively high level of the basic write-off in 2005–2008 (i.e. at the level of 14% of revenues from the sale of wood) (Supreme Audit Office, 2009), in some years of the analysed period, the amount of this write-off increased further. Another important source of the forest fund's revenues were measures related to compensation for the negative impact of economic entities on the condition of forest resources, in particular, receivables, penalties and fees related to the exclusion of forest land from production, and receivables resulting from compensation for damages and premature felling of stands. The share of these revenues in the fund's total revenues in the analysed period ranged from 8.3% in 2016 to 16.3% in 2018. In turn, the income resulting from participation in companies was relatively insignificant in 2013–2020 compared to other sources of funding for the forest fund.

The primary purpose of the forest fund is to provide financial support to deficient forest districts which manage forests in unfavourable natural and economic conditions (Kuźma, 2018). The resources of the forest fund are allocated primarily to forest districts to compensate for deficiencies arising from the implementation of forest management tasks and tasks related to public administration in the field of forestry (Dyduch, 2016). Pursuant to Article 58 (2) of the Forest Act, the aforementioned resources can be used for: 1) joint ventures of organizational units of the State Forests, in particular in the field of forest management; 2) scientific research; 3) creating infrastructure necessary for forest management; 4) preparation of forest management plans; 5) work related to the assessment and forecasting of the condition of forests and forest resources; 6) nature protection in forests carried out using forest management methods; 7) the use by the State Treasury of forests or land intended for afforestation; 8) organization of training in the field of estimating hunting damage; 9) other forest management tasks. The catalogue of purposes on which funds from the forest fund may be spent is therefore non-numerative. As a result, it allows financing a wide range of forest management tasks, as indicated in Table 2 (Danecka & Radecki, 2021).

The analysis of the data presented in Table 2 shows that, in addition to the redistribution of funds between forest districts, the forest fund was also used to finance the creation of infrastructure for forest management, preparation of forest management plans, and joint ventures of organizational units of the State Forests. In the analysed period the share of expenditure on the latter type of tasks in total expenditure increased significantly from 7.3% in 2015 to 10.5% in 2017. Joint ventures included, among others, construction of fixed assets in forest nurseries, pest control, flood removal and IT investments (Supreme Audit Office, 2015). A significant position among the expenditure from the forest fund was also occupied by scientific research (a decrease in expenditure from PLN 65.7 million in 2017 to PLN 31.9 million in 2020), tasks specified in art. 58 (3) and (3a) of the Forest Act (increase in expenditure from PLN 30.6 million in 2013 to PLN 61.3 million in 2017 and 2018), and other forest management tasks (increase in expenditure from PLN 5.7 thousand in 2016 to PLN 107 million in 2017). The remaining categories of expenditure presented in Table 2, i.e. work related to the assessment and forecasting of the condition of forests and forest resources, were significantly less important in the years 2013–2020.

In the period covered by the research it was possible to observe the maintenance of a high level of unused resources of the forest fund at the end of each year, constituting the income of this fund

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Table 2. The use of resources from the forest fund in 2013-2020

The use of resources from the forest fund	The amount of expenditure from the forest fund (in PLN million)							
	2013	2014	2015	2016	2017	2018	2019	2020
Compensation for the shortage of funds generated in the implementation of forest management tasks and tasks related to public administration in the field of forestry, including co-financing of special units	946.6	640.7	925.7	987.6	941.0	1,191.2	1,249.1	1,189.3
Creating infrastructure necessary for forest management	67.3	160.4	140.6	42.6	42.0	25.8	31.3	10.3
Joint ventures of organizational units of the State Forests	102.9	90.5	96.3	103.9	152.1	157.2	170.0	76.2
Co-financing of the tasks specified in Art. 58 (3) and (3a) of the Forest Act*	30.6	34.1	28.9	55.0	61.3	61.3	42.6	44.7
Preparation of forest management plans	61.2	68.6	70.4	74.7	72.7	71.2	69.8	65.0
Scientific research	42.9	45.0	42.1	50.0	65.7	52.9	44.6	31.9
Work related to the assessment and forecasting of the condition of forests and forest resources	0.8	1.0	1.3	0.0	0.0	0.0	0.0	0.0
Other forest management tasks	15.1	7.3	6.5	5.7	107.0	58.7	65.5	50.3
Total	1,267.4	1,047.6	1,311.8	1,319.5	1,441.8	1,618.4	1,672.9	1,467,7

* penalties and fees related to the exclusion from production of forests not owned by the State Treasury and forests under perpetual usufruct of national parks intended, in particular, for afforestation of land not owned by the State Treasury, implementation of trees on land not owned by the State Treasury and other work related to the removal of the consequences of disasters and conducting management in non-state forests, as well as activities necessary for nature protection carried out using forest management methods.

Source: own preparation based on the financial and economic reports of the State Forests for 2013–2020. Available at https://www.lasy.gov.pl/pl/informacje/publikacje/informacje-statystyczne-i-raporty/sprawozdanie-finansowo-gospodarcze-pgl-lp.

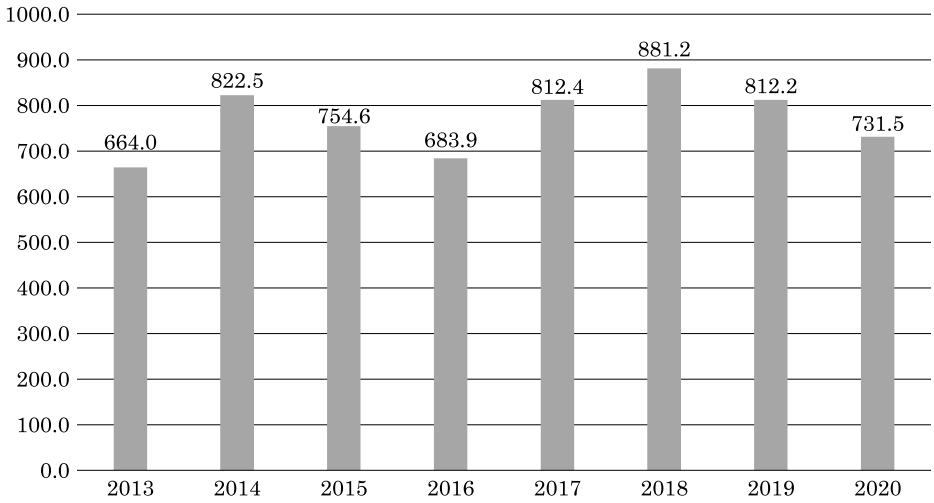

Fig. 1. The amount of unused resources from the forestry fund in 2013–2020 (funds as of 31 December in million PLN)

Source: author's own study based on www.stat.gov.pl

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in the next calendar year (see Fig. 1). According to the information contained in the annual financial and economic reports, the net profit of the State Forests amounted to: PLN 305.0 million in 2013, PLN 421.7 million in 2014, PLN 382.2 million in 2015, PLN 404.0 million PLN in 2016, PLN 435.1 million in 2017, PLN 537.1 million in 2018, PLN 415.0 million in 2019 and PLN 487.6 million in 2020 (General Directorate of the State Forests, 2021). The main direction of spending the resources of the forest fund was the so-called gross subsidy for the activities of non-profit forest districts, which mainly indicates the economic purpose of creating this fund (Bartniczak, 2009). The share of expenditure on compensating for the shortage of funds arising from the implementation of forest management tasks and tasks related to public administration in the field of forestry in the total expenditure incurred from the forest fund ranged from 61.2% in 2014 to 75.7% in 2019. The amount of these funds was each time included in the financial and economic plans of the State Forests (Bieluk & Leśkiewicz, 2017).

In the Polish doctrine of forestry sciences, the principles of forest fund distribution raise doubts as to whether the method of their distribution is rational and fair, and whether it leads to an even development of forest districts throughout the country (Piekutin, 2006; Buraczewski, 2013; Adamowicz et al., 2014; Stebnicki, 2018). On the one hand, arguments are raised that the importance of the State Forests' tasks related to the preservation, protection and enhancement of forest resources is a justification for recognizing the specific nature of forest management, including its financial aspects, and the task of the forest fund – through the appropriate transfer of funds from income units to deficit units – so it is possible to implement the tasks resulting from the Forest Act in an even manner throughout the country (Buraczewski, 2013; Bieluk & Leśkiewicz, 2017). On the other hand, it is emphasized that among highly commercial forest districts with a positive forest fund balance, there is a conviction that the State Forests' organisational units with a negative balance operate at their expense. It is easier for forest districts to obtain subsidies from the forest fund than to try to maximize the economic effects in other branches of activity or to reduce the administrative costs (Stebnicki, 2018). The amount of the write-off to the forest fund and gross subsidies for the activities of non-profit forest districts have a direct impact on the capital of forest districts and their financial result, which significantly affects the development of specific organizational units and the implementation of their natural, social and economic functions (Adamowicz et al., 2014).

It should be pointed out that the minister responsible for the environment, at the request of the Director General of the State Forests, by means of a decision, annually determines the amount of the basic write-off calculated from the value of timber sales for the State Forests, which is charged to the operating costs of forest districts. The Director General may determine the amount of the allowance for individual regional directorates, and the director of the regional directorate of the State Forests can do likewise for individual forest districts. The mechanism of determining the amount of the basic write-off, which is the cost of activity reducing profit, by entities potentially interested in its amount, raises serious doubts as to compliance with the principle of tax equality, which means the obligation to apply tax law in the same way to all taxpayers. This is because a reduction in profit means a simultaneous reduction in revenues to the state budget from taxes due paid by the State Forests. Therefore, neither the Director General, nor individual directors of the regional directorates of the State Forests should have any influence in determining the amount of the basic allowance or deciding on the amount of taxation of the activities carried out by their subordinate units of the State Forests.

The forest fund is an important instrument to compensate for the shortage of financial resources in the basic and administrative activities of forest districts where the costs of forestry activities exceed the revenues from this activity (Danecka & Radecki, 2021). As can be seen from the presented data, a forest fund is a financial instrument that supports the implementation of tasks related to both forest

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production and non-production activities. It should be noted that some forest districts in which the revenues generated are not sufficient to cover the costs of the tasks specified in the Forest Act would not be able to conduct forest management without support from the fund in question (Buraczewski, 2013). However, permanent co-financing of deficit organizational units does not solve the problem of rational equalization of financial disproportions arising as a result of forest management in various economic and environmental conditions and the performance of natural and social functions (Stebnicki, 2018).

The research results showed that in the years 2013–2020 the financial situation of the forest fund was favourable and stable. The main source of its revenues was the obligatory basic write-off calculated on the value of wood sales, charged to the costs of forest districts. Financial resources from the forest fund were spent mainly on compensating for the shortage of funds arising from the implementation of forest management tasks in forest districts with unfavourable environmental and economic conditions for forest management (up to 75.7% of the total fund expenditure). It should also be mentioned that the statutory catalogue of tasks financed from the forest fund is open, which significantly hinders the assessment of the purposefulness of the expenses incurred under this fund, and therefore requires clarification.

Importantly, the above issue was the subject of an audit by the Supreme Audit Office for the years 2011–2013. The audit found that the State Forests did not calculate the actual shortages, and the previously transferred amounts of planned shortages were not settled, which was inconsistent with Art. 58 (1) of the Forest Act. As a result, deficiencies in the financial resources of forest districts were not equalized to the level of their actual size. In the opinion of the Supreme Audit Office, this led to a situation in which forest districts in which the actual deficits in the implementation of forest management tasks in 2011–2013 exceeded the planned amounts did not receive a subsidy from the forest fund for this purpose, for example in the Regional Directorate of State Forests in Wrocław a total of PLN 5.8 million, the Kamienna Góra Forest District, despite the fact that in 2013 it achieved a negative result on forestry activities (PLN -1.8 million), it did not receive funds from the forest fund to compensate for shortages (Supreme Audit Office, 2015). Dyduch points out that the financial means from the forest fund accumulated in the bank accounts of the Directorate General of the State Forests had a significant impact on the high level of financial liquidity of the State Forests (Dyduch, 2012). The reason for the high level of unused resources of the forest fund at the end of each year, constituting the income of this fund in the next calendar year, as shown in Figure 1, could be the lack of an in-depth analysis of the actual demand for resources from the forest fund in order to determine the appropriate level of the basic write-off, determined by the Minister of the Environment at the request of the Director General of the State Forests, which resulted in its overstatement.

CONCLUSIONS

The provisions of the Forest Act indicate both the sources of income for this fund and determine that this fund is a form of managing financial means for the purposes specified in the aforementioned legal act. In order to ensure the financial stability of the forest districts, the State Forests' financing system was based on covering operating costs from the generated revenues. The nature of the funds collected by the State Forests speaks in favour of spending at least some of them under the special-purpose fund, which is the forest fund. The administration of the resources of the forest fund is therefore subject to specific rigours, different from those applicable to other resources at the disposal of the State Forests. In particular, the principles of fund management ensure the possibility of the accumulation of unused funds in a given budgetary year and allocating them for the implementation of tasks in the following years. On the one hand, this ensures that the same tasks are financed from the funds accumulated in this

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way, and on the other hand, it gives more flexibility in managing these funds.

The rules for the functioning of the forest fund have not been precisely defined in the Forest Act, which results in differentiation in the manner of its division (Stebnicki, 2018). In the analysed period of 2013–2020, the role of the forest fund was reduced primarily to the redistribution of funds from income forest districts to forest districts where the funds obtained from the sale of wood did not balance outlays on forest management. Although the application of such a mechanism allowed for the financial independence of the State Forests and contributed to the protection of forest resources in Poland, the main drawback of such a solution was the lack of stimulation of non-profit forest districts to increase the economic effects of their activities. Therefore, the functioning system of co-financing deficit forest districts did not ensure a fully rational form of covering financial shortages resulting from the diversification of forest management conditions. In addition, audits on the financial management of the State Forests carried out by the Supreme Audit Office revealed certain irregularities in the compensation of planned and not actual shortages in the implementation of forest management tasks and irregularities in the distribution of profit, disrupting the principles of financing the activities of forest districts in relation to the rules resulting from the law. In the analysed period of time, a high level of unused resources of the forest fund, constituting the fund's income in the following calendar year, was maintained at the end of each year.

Serious doubts are raised by the mechanism of determining the amount of the basic write-off of the fund from the sale of timber, which is a cost of activity reducing profit. Entities potentially interested in its amount have a direct impact on its level by programming the amount of the write-off to the forest fund, which violates the principle of tax equality that means the obligation to apply tax law in the same way to all taxpayers. The decrease in profit means a simultaneous decrease in the state budget revenues from taxes due paid by the State Forests.

Bearing in mind the data presented in this study, it should be stated that the financial resources of the forest fund should be collected and used to the extent necessary to perform the tasks specified in the Forest Act. However, the method of dividing the subsidy from this fund should encourage forest districts to increase their revenues from sustainable forest management.

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AN ANALYSIS OF URBAN GREEN SPACES – A CASE STUDY IN POLAND AND SLOVAKIA

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ABSTRACT

Motives: Rapid urbanisation and the associated spatial, environmental, and economic changes have shifted the researchers' attention to modern cities. Urban green spaces are a vital component of sustainable development because they reduce noise, purify air, improve the local climate and rainwater quality, and provide numerous recreational and relaxation opportunities for the residents. The implementation of the green city concept can have a positive impact on both the environment and the quality of life in a city.
Aim: The aim of the study was to analyse changes in the landscape and surface of urban green spaces, to present the structure of green areas, and to identify change trends in urban green spaces in the Polish city of Toruń and the Slovak city of Košice. The ecological resilience of the studied areas was also examined.
Results: The results of the study indicate that the area occupied by urban green spaces (including urban green areas, sport and leisure facilities, and forests) continues to expand in the studied cities. The rate of increase was much higher, but still low, in the Slovak city of Košice. The analysis of change trends revealed that most industrial and commercial areas were developed in urban green spaces. At the same time, new green spaces were created mainly at the expense of semi-natural areas. Both Toruń and Košice are characterised by average landscape stability.

Keywords: 2030 Agenda, sustainable urban development, green city, landscape management, resilience

INTRODUCTION

By the middle of the century, up to 70% of the world's population will live in urban areas (UN-Habitat, 2022). Urbanisation and climate change require new solutions to maintain and, above all, improve the quality of life in our cities. Cities and towns are beginning to realise the dangers of climate change (Čepelová & Douša, 2018). Green areas of the city are an inseparable element of a sustainable and smart city. In the era of intensifying climate crises, green areas are one of the elements shaping urban

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resilience and ecological stability (Costanza, 1997; Meerow et al., 2016). The analysis and assessment of ecological stability, which is a fundamental component of the idea of urban environmental sustainability, is the foundation for the planning process of urban development (Yukhnovskyi & Zibtseva, 2019). Today, cities occupy less than 3% of the Earth's surface (United Nations, 2018). They are not only engines of growth of a socio-economic nature, but also the site of dynamic environmental transformations. Global sustainability is largely determined by cities, whose current unstable trajectory in terms of urban ecosystems and landscapes requires a focus on ecology and the environment (Wu, 2014). Urbanisation tends to reduce the ratio of land allocated to public green spaces (Noszczyk et al., 2022). However, in the face of contemporary challenges, concern for the environment is an integral part of moving towards sustainable development.

Green spaces are an integral component of the urban landscape and a foundation for the pursuit of sustainable development (Darkwah & Cobbinah, 2014; Łachowski & Łęczek, 2020). They are also an important aspect of adapting to ongoing climate change, building social cohesion and developing the green economy (Hansen et al., 2017). Especially in highly urbanised areas, they are an important component of the urban space and improve it in terms of aesthetics (Szczepańska et al., 2016). Green infrastructure in cities provides maximum ecosystem benefits hence its development is highly desirable nowadays (Augustyn, 2020). In the literature, one can find many studies and documents on the urban green ecosystem and its benefits to the well-being of society (Anguluri & Narayanan, 2017). Thus, greenery in the city also has a leisure and health function as it provides space for relaxation thus enhancing the quality of leisure activities. Prominent exposure to greenery also benefits the psychological well-being of the public (Wang et al., 2019). Just looking at areas of urban greenery creates a sense of relaxation and, as a result, can have a positive impact on stress reduction processes (Elsadek et al., 2020). Studies based on European cities show that by increasing the amount of green areas it is possible to reduce premature deaths and they also have a positive impact on the transformation of cities towards more sustainable and good to live in centres (Barboza et al., 2021). Urban green spaces, complemented by infrastructure in the form of footpaths and bicycle lanes, also provide a place for recreational activities, the positive and important importance of which was particularly recognised during the pandemic (Venter et al., 2021). Studies show that during the pandemic, forests played an important social role in terms of both mental and physical health (Derks et al., 2020). Urban vegetation is also an effective method to promote the reduction of heat intensity (Marando et al., 2022). Applied on a large scale, green spaces, e.g. forests, can have a positive impact on thermal comfort and reduce the urban heat island effect by shaping the shade-induced cooling effect (Virtudes, 2016; Rogatka et al., 2018). Tree crowns create shade, which, together with evapotranspiration, reduces temparature and thus contributes to the thermal comfort of residents (Sun et al., 2021). In addition, green spaces minimise the risk of flooding within the city by reducing surface runoff (Chiabai, 2020). Moreover, greenery in the city located in appropriate places can reduce the negative impact of pollution by creating a natural biological filter that neutralises harmful components from the air (Daniele & Sciacca, 2021; Gubański et al., 2018).

Urban green spaces play an important role in the creation of urban space and the process of reducing the negative effects of urbanization, by maintaining a balance between transportation infrastructure, buildings and green spaces (Harasimowicz, 2018).

According to research by Čepelová and Douša (2018, 2020), many urban areas are already suffering from the negative effects of climate change and other negative consequences. The effects of climate change on urban living conditions will continue to be dramatic, due to rising temperatures, more frequent rains with consequent floods or, conversely, excessive drought. The most successful cities plan to combine the implementation of action plans and investments. However, stand-alone action plans and investments often fail to take full advantage of the synergies

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between optimal coordination and co-ordination of interrelated strategies, subsequent investments and the involvement of urban dwellers. Strong institutional structures and sound financial mechanisms are needed for cities to pursue their green agendas effectively. Both the surveyed cities in both Poland and Slovakia don't have a comprehensive climate strategy to protect the environment and support green spaces. Cities and municipalities are often blocked from implementing measures due to limited political power, low levels of institutional capacity, low levels of stakeholder cooperation, limited fiscal power, poor financial management and insufficient access to finance. Cities need a strong institutional environment that allows their municipalities to operate more efficiently, flexibly and competitively in order to achieve the ambitious green city agenda.

GREEN CITIES – A THEORETICAL APPROACH

Sustainable development has been the subject of much academic debate since the 1960s. Over the following years, many studies have been written on this issue. For the first time the concept was defined in 1987 in the report 'Our Common Future' as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). The issue is described by, among others: Agenda 21 (1992), the Rio Declaration on Environment and Development (1992), the Eight Millennium Goals (2000) and Agenda 2030, which consists of 17 Sustainable Development Goals (UN, 2015). This article focuses on green urban areas (GUAs), which have a direct impact on the three goals (Siragusa et al., 2020): SDG 11 Sustainable cities and communities; SDG 13 Climate action; SDG 15 Living on land.

Sustainable development should not only be considered at the global level, but above all at the local level (Trovato, 2021), which is particularly influenced by GUAs. This is because cities are characterised by having features that intensify the consequences of climate change and extreme weather events (ESPON, 2020). In a post-indurstial world, there has been a shift in the function of cities from industrial to business, innovation or finance, and contemporary cities are both concentrators of global problems and drivers for their solutions (Niemets et al., 2021). One way to support sustainable practices is to provide access to green spaces. Hence, an opportunity to transform cities towards greater sustainability is the concept of green cities. A green city can be defined as „a city that promotes energy efficiency and renewable energy in all its activities, widely promotes green solutions, uses compactness of land with mixed land use and social mixing practices in its planning systems, and anchors its local development in the principles of green growth and equity" (Brilhante & Klaas, 2018). Ecological stability is also an important element of sustainability. It can be defined as the ability of an ecosystem to resist change during disturbances, which is characterised by low variability, i.e. low deviation from the mean level despite changing environmental conditions.

Ecological stability is important in terms of the carrying capacity of the environment. In order for a landscape to withstand greater or lesser changes (stress, strain, etc.), it must achieve certain levels of ecological stability. The ecological stability of the area can be considered directly as one of the key principles of (environmental) sustainability (National Network of Healthy Cities CR, 2022). The landscape is made up of a set of components (=areas) that put together a landscape matrix. The components can be divided into stabilizing and labile. If any activity is carried out in the landscape that could affect the landscape character or functionality of any of its components or the character of the landscape, it is necessary to be able to evaluate the positive or negative consequences. It is an objectification of the definition of the dynamics of the landscape system = the exact numerical expression of changes in the landscape.

The coefficient of ecological stability (CES) represents a ratio number (coefficient), which determines the ratio of so-called stable and unstable areas of landscape-forming elements in the monitored area (Míchal, 1994). In addition, ecological stability is the

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ability of an ecological system to persist even under the influence of a disturbing influence and reproduce its characteristics in the conditions of disturbance from the outside (especially disturbance by humans). CES this expresses how a certain territory can cope with these influences (Kolejka, 2011).

The aim of this article is to analyze changes in the landscape and surface of green areas, to present the structure of green areas and to indicate the directions of transformations in the studied city in Poland and Slovakia.

MATERIALS AND METHODS

Spatial scope of the research

Two European cities – Toruń in Poland and Košice in Slovakia – were used as testing grounds for the comparative study. The authors chose these two cities because of their similar size and population. Toruń is a provincial city with almost 200,000 inhabitants with an area of 115.72 km². Košice is inhabited by nearly 240,000 people – 243.73 km² area. In addition, both cities are regional capitals (in Poland the Kujawsko-Pomorskie Voivodship, in Košice the Košice Country) and thus play the role of a central centre according to Christaller's assumptions. In addition, the article examines green areas, and their nature depends on the climatic conditions. Both cities lie in the same climatic zone, so the structure of green areas in Toruń and Košice will not be detrimental to zonal factors, and comparative analyzes will be possible. However, the overriding criterion for selecting the cities for analysis was their post-industrial character. In the era of global industrialisation, in the space of both cities one could see thriving industrial units, which due to their space-intensive nature intensively consumed green areas.

According to Kocan (2020), the urban landscape, being a dynamic structure, is the most susceptible to all kinds of changes, both at the social and spatial level. In both analysed cities the industry was very active. It was an important part of the economic structure of Toruń and Košice. In Toruń, there was the chemical plant „Polchem", which generated pollution affecting both ecological stability and the condition of green areas. In the case of Košice, the industrial history of the city is still relevant. The largest Slovak steelworks is located in the city – that is why Košice is called „the steel heart of Slovakia".

Research structure, data and methodology

The study was divided into three main stages, i.e. the introductory stage (I); the implementation stage (II) and the concluding stage (III). The introductory stage included an analysis of the literature on urban green areas and European strategic documents such as Agenda 2030, which focuses on sustainable development, with particular emphasis on the role of green areas and ecological stability. The introductory stage ended with defining the purpose and delimitation of the study area. The core of the study, which filled out the entire executive stage, was two research methods:

1. Spatial analyses using GIS;
2. Coefficient of ecological stability (CES).

As a result of the constantly increasing rates of urbanization and construction in both analyzed cities, these two cities were chosen for evaluation. More than 80% of the European population is expected to live in urban areas by 2030 (European Healthy Cities Network, 2022). On the basis of normative values based on data on the density of construction and the degree of urbanization to the total number of inhabitants of the investigated cities, we expect negative results of the ecological stability of the territory and the decline of natural ecosystems in the investigated time period.

GIS METHOD

First, the authors prepared a vector data set from the pan-European land cover database Urban Atlas. These data were downloaded for two years, 2006 and 2018, for two cities that were the testing ground. On the basis of the prepared dataset, one category of area called green spaces was synthesised and separated, which in its structure included land cover data for areas classified in the Urban Atlas as: green urban areas, sport and leisure facilities and forest.

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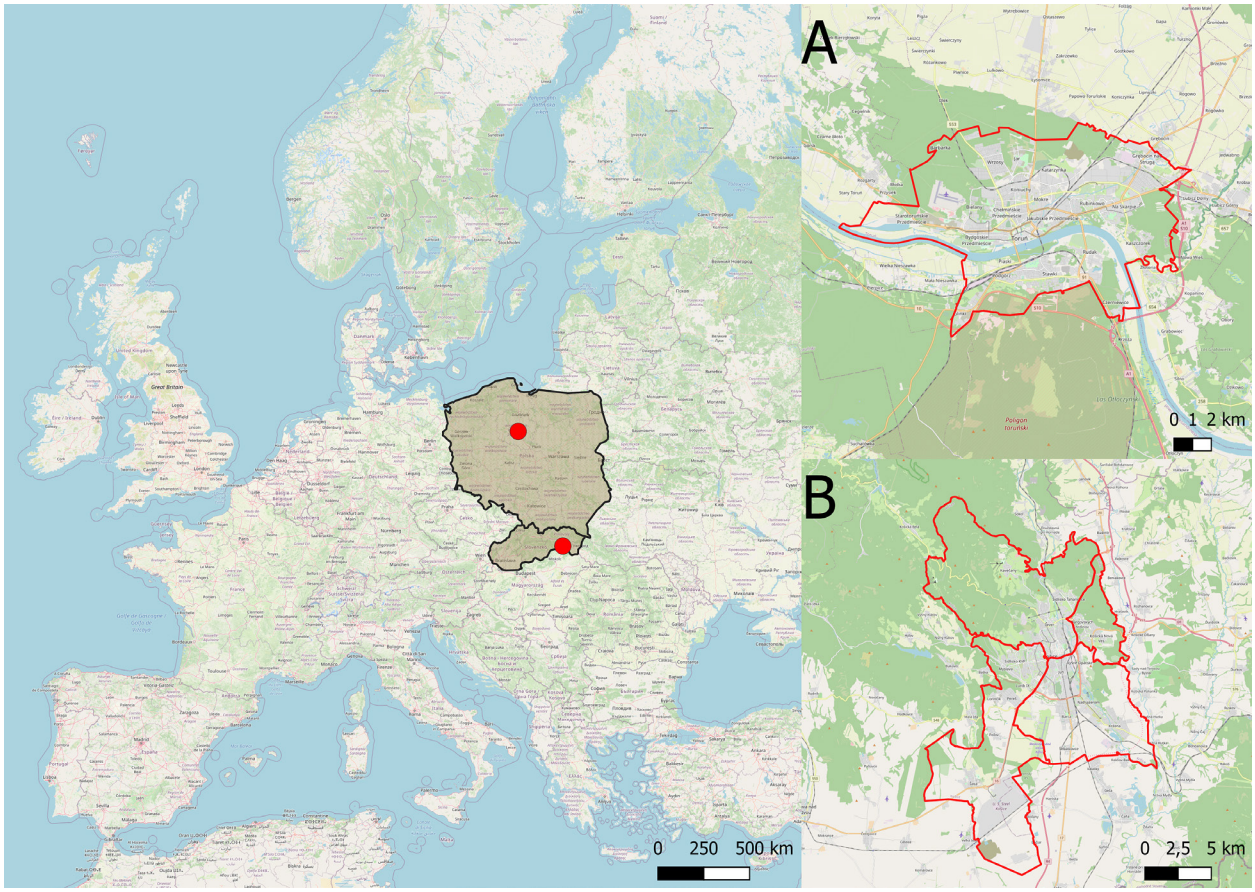

Fig. 1. Spatial scope (A: Toruń; B: Košice)
Source: own preparation.

The prepared vector data were cropped to the borders of the study area, i.e. the administrative borders of Toruń and Košice. In this way, two map compositions were constructed taking into account the coverage of green spaces in Toruń and Košice in the two reference years. Based on these data, the percentage share of green spaces in each city was determined.

In the next step, using geoprocessing tools, an analysis of changes in the area of green spaces in the analysed cities was prepared. In this way, areas which have become green and those which have lost their green character were indicated. Next, on the basis of the prepared map bases, an analysis was made of changes in land cover in selected study plots, i.e. selected urban spaces of Toruń and Košice. The analysis took into account the nature of the change, i.e. in which direction the transformation of green spaces took place. The vector data analysis method was developed and carried out based on the methodology of spatial analyzes with the use of GIS software (Głowacki, 2005).

CES METHOD

Furthermore, qualitative methods were used to fulfil the goal and results, to examine the calculation of the coefficient of the ecological stability of the area according to Míchal (1985) and Miklós (1986). To capture the landscape multifunctionality and to indicate the environmental quality of the area under study, land use provided in parallel by arable land, forests, and bodies of water were studied.

The ratio is determined on the basis of the following elements: Stable elements (WL – woodland;

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WS – water areas and streams; PG – permanent grassland; Pa – pastures; We – wetlands; Or – orchards; Vi – vineyard) and Unstable elements (PL – ploughland; AA – anthropogenic areas; HG – hop-garden). The method of calculating CES is based on a clear and final classification of a landscape element into a group of stable or unstable and does not allow the assessment of the specific state of these elements. The CES value can take the following values and determine the specific ecological resistance:

1. CES ≤ 0.10 areas with maximum disturbance of natural structures, basic ecological functions must be intensively and permanently replaced by technical interventions;
2. 0.10 < CES ≤ 0.30 areas used above average with a clear disruption of natural structures;
3. 0.30 < CES ≤ 1.00 areas intensively used with considerable ecological instability;
4. 1.00 < CES < 3.00 quite balanced landscape in which the technical objects are relatively in accordance with the preserved natural structures;
5. CES ≥ 3.00 natural and nature-friendly landscape (significant predominance of ecologically stable structures) (Míchal, 1985).

At present, there is no longer a purely natural landscape on Earth, because through the changes of the atmosphere, man affects the entire surface of the planet. However, a natural landscape is one whose construction components and processes do not show man-made manifestations.

The tables below contain data on the stable and unstable landscape elements in Košice and Toruń (see Table 1 and Table 2).

The Coefficient of Ecological Stability According to Míchal (1985)

Calculation of CES (in ha) = natural and near-natural areas divided by cultural areas. Specifically, CES = (woodland + water areas and streams + permanent grassland + pastures + wetlands + orchards + vineyard) / (built-up areas + ploughland + hop-garden). The higher the number, the greater the proportion of permanent vegetation areas, the greater the stability of the area (Míchal, 1985). There are many methodologies, but all are based on the same principle. The calculation is always based on the evaluation of the ratio of ecologically stable

Table 1. Stable and unstable elements in the city of Košice district Košice I

Stable elements	Area (in m2)	Unstable elements	Area (in m2)
Woodland	5 154 000	Ploughland	304 000
Water areas (artificial reservoirs, ponds, natural streams)	66 000	Anthropogenic areas (built-up areas)	1 822 000
Permanent grassland	780 000	Hop – garden	not identified
Gardens	391 000		
Researched district area Kosice I. – Džungla, Kavečany, Košice – north, Habitation Ťahanovce, Košice – Old town, City district of Ťahanovce			

Source: The data were obtained from the State Administration of Land Surveying and Cadastre of the Slovak Republic 2022 (The Geodesy, Cartography and Cadastre Authority of the Slovak Republic, 2022).

Table 2. Stable and unstable elements in the city of Toruń

Stable elements	Area (in m2)	Unstable elements	Area (in m2)
Woodland	37 339 335	Ploughland	5 176 207
Water areas (artificial reservoirs, ponds, natural streams)	7 516 318	Anthropogenic areas (built-up areas)	23 824 850
Permanent grassland	28 355 726	Hop-garden	not identified
Gardens	3 593 883		

Source: based on data from The Main Geodesy and Cartography Office (database of topographic objects, DoA: 19.05.2022).

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and ecological labile components of the landscape; individual methodologies differ in the categorization of landscape segments, or in the use of more detailed coefficients.

Miklós ecological stability coefficient (1986)

Unlike the following methodologies, it is not based on the division of areas into stable and unstable, but differentiates their ecological significance by introducing numerical coefficients:

a. pn i – area of individual areas;
b. kpn i – coefficient of ecological significance of areas;
c. p – area of the area of interest (or cadastral);
d. field – 0.14; meadows – 0.62; pasture – 0.68; gardens – 0.5; fruit orchards – 0.3; forests, water, wetlands – 1.00; others – 0.10 (+ lada – 0.62, vineyards – 0.3, rocks – 0.4, line company– 0.4) (Miklós, 1986).

In the last stage of the research – the summary stage, a synthetic analysis of the results of the research was made. This part of the research included mainly the interpretation of changes in the coverage of green spaces in Toruń and Košice and a reference to ecological resilience in both cities.

From the results of the CES of analysed cities in Poland and Slovakia according to the Miklos methodology, they belong into the category of medium stable landscape < 1. Slovak and Poland landscape schools know and use various methodologies. None of them is anchored in the legislation, the closest to the legal norm is the calculation of CES according to Michal, because it is also implemented in the concept of TSES (Territorial systems of ecological stability) = Act No. 114/1992 Coll., § 3 letter a. and landscapes. Because each methodology uses division into different landscape segments and different coefficients, the result may be different, see. result of applied methodologies. Miklós medium stable landscape, Míchal natural and close to nature landscape. However, when planning the use of the landscape and its territory, it is always necessary to pay attention to aspects of sustainable development and try to respect natural structures at the expense of unstable anthropogenic areas.

RESULTS

The results of the research have been aggregated into three thematic blocks:

Block I – analysis of the share of green spaces in general city area
Block II – analysis of directions of green space transformations
Block III – analysis of CES

Block I: analysis of the share of green spaces in general city area

In the base year of 2006, the area of green urban areas in Toruń was 537.84 hectares. In Kosice, on the other hand, green urban areas covered an area of 412.62 hectares. In 2018, both cities saw a decrease in the area of green urban areas, but in the case of Toruń the decrease was much more pronounced. In 2018, green urban areas in Toruń occupied 509.12 hectares. In Kosice, these areas decreased in area by only 2.64 hectares (cf. Table 3).

Another element analysed as part of green spaces was sport and recreation areas. Here, too, both cities

Table 3. Changes in green spaces area

City	GUA 2006 [ha]	GUA 2018 [ha]	Difference GUA 2018–2006 [ha]	SPORT and LEISURE 2006 [ha]	SPORT and LEISURE 2018 [ha]	Difference SPORT and LEISURE 2018–2006 [ha]	FOREST 2006 [ha]	FOREST 2018 [ha]	Difference Forest 2018–2006 [ha]
Toruń	537,84	509,12	-28,72	479,25	466,65	-12,59	3238,27	3380,26	141,99
Košice	412,62	409,98	-2,64	723,53	711,09	-12,44	8130,86	8455,79	324,93

Source: own preparation.

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recorded a decrease in the area of this category of land cover, but in both cities the decrease remained at a similar level, i.e. about 12 hectares.

The only component of green spaces which increased its area was forests. In both of the analysed cities, the area of forest areas increased, noting that in Košice there were more than twice as many forests as in Toruń. All these elements influenced the total share of green spaces in the cities under study.

In 2006, green spaces in Toruń occupied 36.77% of the city area. In Košice, on the other hand, these areas occupied 38.02%. In 2018, the share of green spaces in both cities increased by 0.87% in Toruń and 1.27% in Košice, respectively. This result was mainly influenced by the increase in the area of forests in the cities. Detailed results of changes in the area of green spaces are provided below in tabular form.

Analysing the spatial distribution of changes in the surveyed cities, it should be pointed out that in the case of Košice, these changes were concentrated in the northern and central parts of the city and mostly concerned the creation of new forest areas (Fig. 3). There were no special arrangements and directions in the formation of green spaces. The following figure shows the growth of forests and places where there

Table 4. Green spaces – a comparative approach

City	TOTAL green spaces 2006 [ha]	Share of green areas in the city area 2006	TOTAL green spaces 2018 [ha]	share of green areas in the city area 2018	Percentage difference 2018–2006
Torun	4255,36	36,77%	4356,03	37,64%	0,87%
Košice	9267,01	38,02%	9576,85	39,29%	1,27%

Source: own preparation.

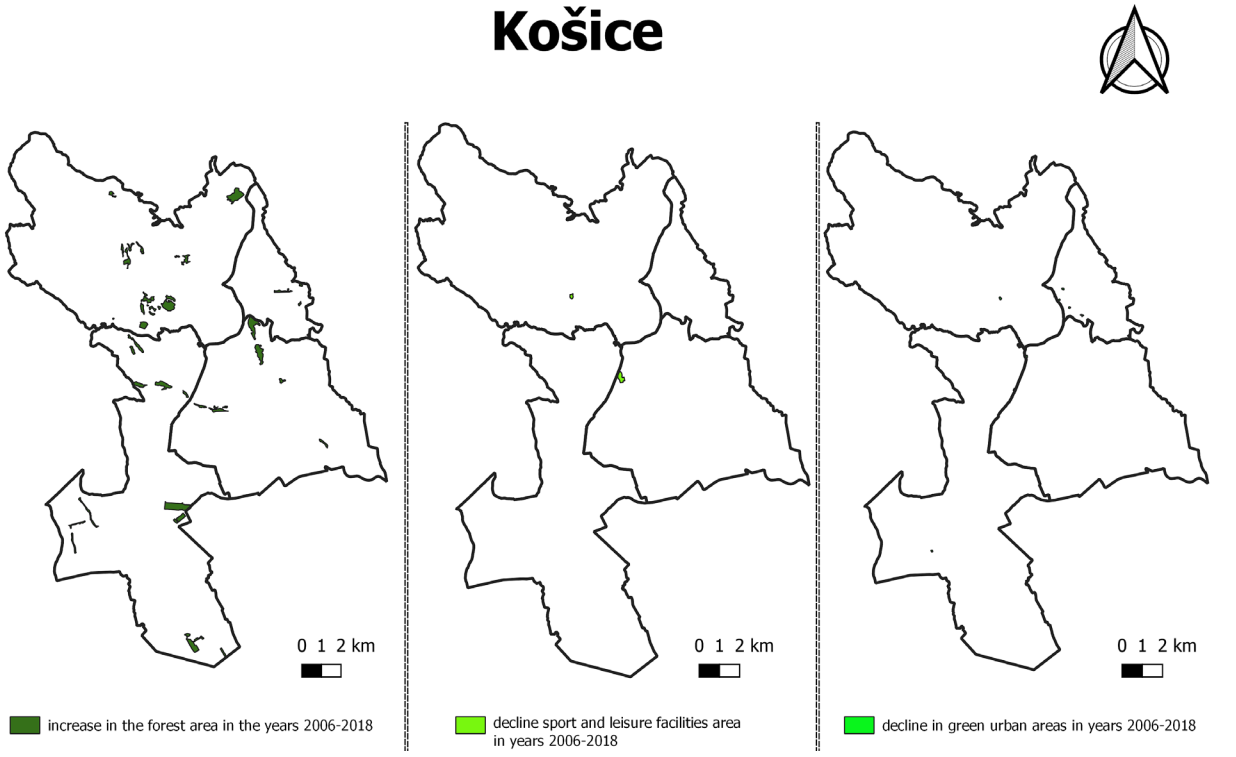

Fig. 2. Changes in green spaces in Košice
Source: own preparation.

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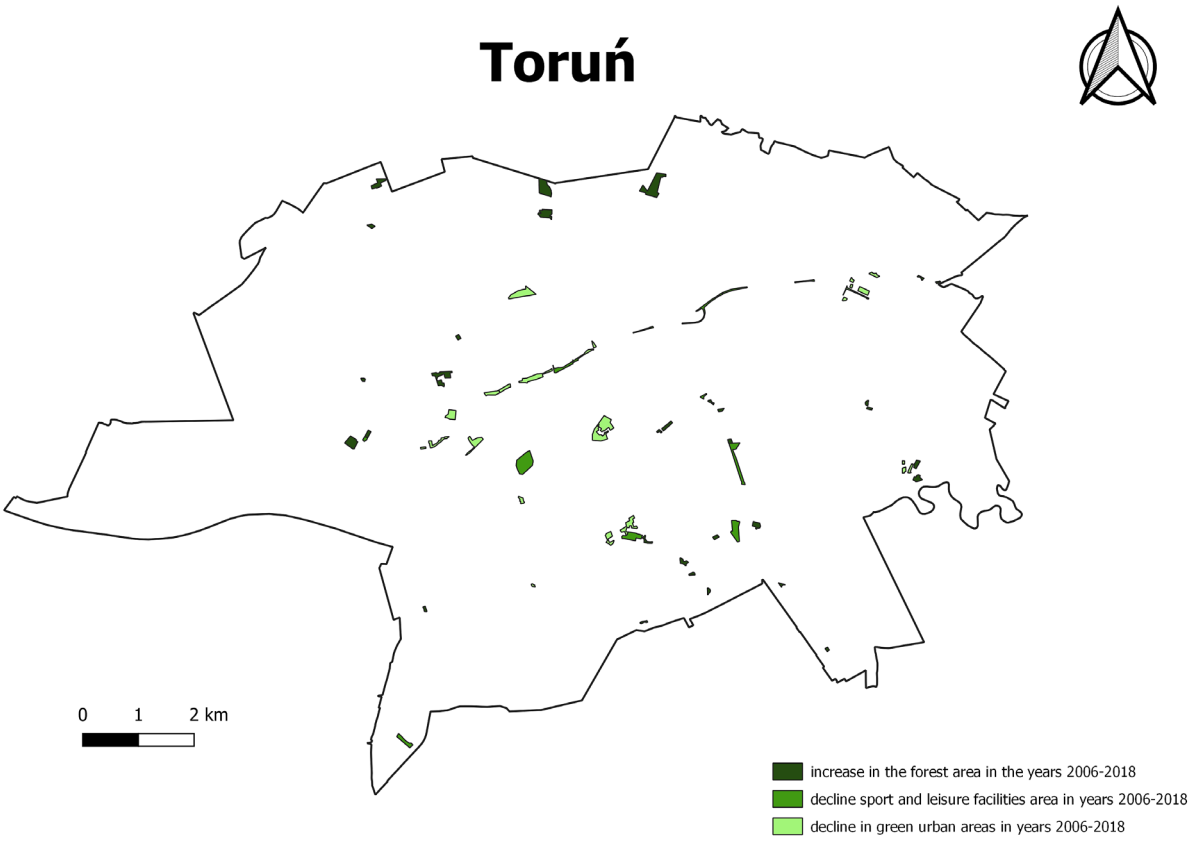

Fig. 3. Changes in the area of green spaces in Toruń
Source: own preparation.

was a decrease in green urban areas and sport and leisure facilities.

In the case of Toruń, spatial regularities in the changes in the area of green spaces were noticeable. As can be seen from the analysis of data in Toruń, the area of green urban areas decreased by almost 30 hectares. When analysing the prepared map bases with changes in the area of green spaces, a linear pattern of changes in the area of green urban areas can be seen (cf. Fig. 3).The authors decided on a different graphic presentation of the changes in the figures, so as to emphasize the relationships between linear changes in Toruń and random changes in Košice. In addition, the changes to the green urban areas and sports and recreation areas were small and hardly noticeable in one graphic.

The linear pattern of changes on the east-west line is due to the investment in road infrastructure in Toruń. The remaining changes in the area of green urban spaces in Toruń are of a dispersed character, without a clear pattern. Below, the figure shows new forest areas and areas where green urban areas and sports and leisure facilities have been replaced by another category of land cover.

To sum up, a negative balance of green spaces was recorded in Toruń and Košice. In the case of both cities, there is a noticeable increase in the area of forest areas, which is related to the natural forest succession. Moreover, in the case of Košice, spatial changes in green spaces are random, while in Toruń the changes are mainly linear.

Block II: Green space transformations

In 2012, there were 30 areas in Košice where the land cover changed into areas other than green spaces. In total, this change covered an area of 30.22 ha.

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This area was the starting area (2006) in relation to the calculation of changes in land cover in 2012.

In the years 2006–2012 in Košice, the first dominant change in green areas was the creation of non-specific areas (38%). The second dominant direction of changes was the creation of areas classified as industrial, commercial, public, military and private units on green spaces (26%). In the third place, in the years 2006–2012, mineral extraction and dump sites were created on green spaces (15%). The remaining changes in the purpose of urban green areas were of a marginal nature, i.e. they covered less than 10% of the total green areas. This fact, near the city's surface, is an almost imperceptible value. In 2006–2012, the creation of new green spaces was incidental and included the creation of new green spaces with an area of 6.84 ha, mainly in semi-natural areas.

In the years 2012–2018 in Košice, a significantly lower dynamics of changes in the creation of new areas in green spaces is noticeable. In the analyzed period, 12.51 ha of green spaces changed their purpose. The main direction of changes in 2012–2018 was the creation of new mining areas and landfills in green spaces (38%). Secondly, as in 2006–2012, industrial and commercial areas were created in green spaces (29%). It is important to underline the fact that in the years 2012–2018 green areas were more intensively transformed into the urban tissue. In total, these changes covered 4.06 ha, which accounted for 32% of all changes. The creation of new green spaces in 2012–2018 also had a small share. During this period, only 3.44 ha of new green spaces were created.

In Toruń in 2006–2012 59.43 ha of land classified as green spaces in 2006 underwent transformation. It is almost twice the changes in Košice, so the intensity of changes in Toruń is definitely greater. The main direction of transformations of green spaces in Toruń in 2006–2012 was the creation of new construction sites. It was they that occupied the largest area of green spaces (36%). As in Košice, industrial and service areas

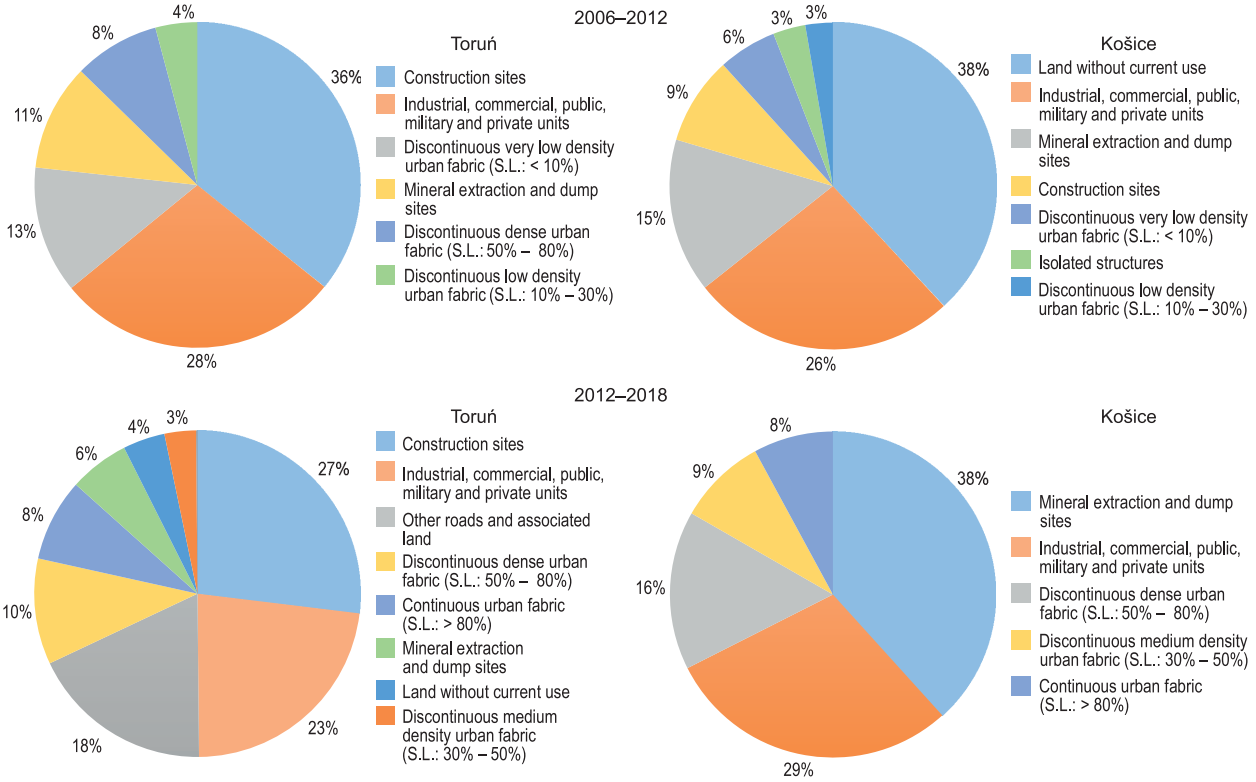

Fig. 4. The share of land developed in green spaces in 2006–2018 in Košice and Toruń
Source: own preparation.

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were built second to green spaces (28%). A share of more than 10% of changes was also recorded in areas with low intensity of urban tissue (13%) as well as areas of landfills and mining (11%). The remaining land cover categories converted to a low degree from green spaces. In the years 2006–2012, 20.04 ha of new green spaces were created in Toruń, which were mainly created in semi-natural areas (89.86%).

In Toruń, in 2012–2018, half of the transformation of green spaces into other areas involved the creation of construction sites as well as industrial and commercial sites (27% and 23%, respectively). A large share (18%) is also the creation of new roads in green spaces, which was indicated in the first block of the results. Compared to Košice in Toruń in 2012–2018, the share of land creation with urban tissue in green spaces is smaller and amounts to 21% in total.

In 2012–2018, the creation of new green spaces did not achieve a high result. In the given period, only 6.75 ha of new green spaces were created. These areas were created from various areas, incl. pastures, storage and industrial areas.

The categories of areas that arose from green areas in the analyzed period in both cities are very diverse. There is no one dominant direction for transforming green areas into another. In both cities, it is possible to point out that the green areas were transformed into industrial areas. However, in Toruń, in the years 2012–2018, a large percentage of green areas was designated for transport areas (roads), which can be seen in the linear system of changes in the area of green areas (Fig. 4).

Block III: CES analysis

The most significant regions of ecological problems are regions with unfavorable ecological conditions (Bratislava area, Košice basin, etc.) and then they are regions (territorial blocks) of ecological stability (eg Brezno, Malé Karpaty, Tokajské vrchy, etc.) (Reháčková & Pauditšová, 2007).

The following unstable landscape elements are in the cadaster of the municipality of Košice district Košice I. CES = The value of CES according to the Míchal methodology in the cadaster of the Košice I. is 3.006, which is assessed as a natural and nature-friendly landscape. There is a significant predominance of ecologically stable structures. In this, let us notice especially the high share of woodland and permanent grassland, occupying almost 6 million m^2 of the total area of the examined cadastral area. Ecologically unstable structures included urban areas to the extent of 1 822 000, i.e., built-up areas. According to Michal, we calculate the CES = 3.006. The following stable and unstable landscape elements are in the cadaster of the municipality of Toruń. CES = 2.648.

The following unstable landscape elements in the cadaster of the municipality of Toruń are quite balanced landscapes, in which the technical objects are relatively in accordance with the preserved natural structures, the result is a lower need for energy-intensive deposits. The value of CES according to the Míchal methodology in the cadaster of the Toruń is assessed as a quite balanced landscape.

It is clear from the results of CES that the city of Košice I. shows values close to natural structures, as stable elements prevail over unstable ones. The city of Torun is similar, but it is defined in the second category as quite balanced landscapes. Following the results of the research carried out in the previous sections, this article also confirmed the fact of an increase in green space in both cities, but in the case of the city of Toruń, this decrease is much more pronounced. This fact is also visible in the result of the CES calculation within the analysed cities, when the city of Košice shows results closer to the natural structures of the area. Another fact that was confirmed to us in the CES calculation is that the only component of greenery that increased its area was forests. In both analysed cities, the area of forests increased, while in Košice there were more than twice as many forests as in Toruń. When analysing the spatial distribution of changes in the surveyed cities, it is necessary to point out that in the case of the analysed area of Košice I., these changes were concentrated in the northern and central part of the city and mainly concerned the creation of new forest areas. In the coming years, attention will need to be paid to the transformation to green spaces in cities. As a result of the constantly increasing urbanisation in both Slovakia and Poland, the population in cities

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Table 5. The value of CES according to the Miklós methodology in the cadastre of the municipality of Košice I. and Toruń

City	Landscape elements km^2					
	Field	Meadows	Gardens	Forests, water, wetlands	Others	Total CES
Toruň	5,18	0,00	3,59	44,86	0,31	0,89789
Košice	0,001504	0,0054	0.391	0,071154	0,000759	0.57288

Source: own preparation.

is expected to double almost twice. The problems in connection with the growing development in cities and the loss of green areas are already evident today, as evidenced by the results of research and statistics from European Healthy Cities Network 2022. Instead of new construction on a green field, the solution within the housing policy can be, for example, the use of old buildings, factories in short, brownfields for these purposes. However, the disadvantage of this solution is the high initial financial costs, which discourages potential investors and the city from making effective use of these spatial aspects of the territory (Míchal, 1985; Miklos, 1986; National Network of Healthy Cities CR, 2022).

Another possible tool that many European cities are starting to use is parking spaces in central parts of cities. These concrete areas are available for the conversion of green areas as part of the displacement of passenger car traffic. Parking houses, on the other hand, serve as points of reference for possible parking on the outskirts of the city, while residents can then get to the city centre via ecological public transport, on shared bicycles or on foot. This concept has been introduced in many cities by, for example, the Netherlands, Belgium, Italy, Norway, Denmark, etc. (National Network of Healthy Cities CR, 2022). In our opinion, this concept within the possible transformation of green spaces in the central parts of the analysed cities would be a suitable way to increase this number of green spaces in the centre of the analysed cities in Poland and Slovakia.

The value of CES according to the Miklós methodology in the cadastre of the municipality of Košice I. is 0.57288 = the area is moderately stable. The value of CES according to the Miklós methodology in the cadastre of the municipality of Toruń is 0,89789 = the area is moderately stable. Košice and Toruń are characterised by good ecological resilience, but the larger forest area in Košice has a positive effect on the CES value. It is therefore necessary to use tools and resources to introduce protective measures in the city's landscaped area and to support the recultivation of the area.

DISCUSSION

As Jirout (2016) and his team point out, the growth of forest areas within the city space is an important element in creating ecological stability. This is confirmed by the research carried out, which clearly shows the increase in forest area in Toruń and Košice in 2006–2018 and the positive value of the CES index. According to Vyleta (2019), in order to maintain the high ecological stability of the urban landscape, it is necessary to prefer spatial development that takes into account the growth of ecologically stable areas, such as green spaces. Such planning primarily respects the assumptions of the sustainable city (DeFries et al., 2007), retains the shape and character of the cultural landscape (Mörtberg et al., 2007) and meets the requirements of the inhabitants (Miller & Hobbs, 2002), which will also translate into the overall ecological stability of the city and landscape. The ecological stability of the city's landscape, apart from the ratio of stable to unstable elements, is influenced by their fragmentation.

Tárníková and Muchová (2018) indicates that the high fragmentation of ecologically stable areas negatively affects the ecological stability of the entire urban system. In the context of this study, it can be concluded that the changes taking place in the green spaces in Košice and Toruń are highly fragmented. Thus, they negatively affect the ecological stability of the city's landscape. On the other hand, Gałaś and Gałaś (2009), when examining ecological resistance, believes that the very idea of ecological stability

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of a landscape assumes that with an increase in both the area share of stable elements, the area becomes more ecologically stable. By being stable, it is more resistant to various types of anthropopressure that destabilize the ecological resilience of the landscape. In the case of Toruń, we can clearly see that strong anthropopressure (creation of a cross-diameter route) expressed in a linear decline in green spaces contributed to a decrease in the CES index in the city. The city, keeping the green spaces in this place, would increase its ecological stability. However, the dynamic development and the pressure to modernize the city's transport network led to the loss of green spaces, which are valuable from the point of view of ecological stability.

According to research by Hruška and Petrovič (2018), ecological stability appreciates forest and semi-natural areas. In 2006–2018, over 320 ha of land classified as forests by the Urban Atlas were added to Košice. This undoubtedly contributed to an increase in the ecological stability of the city's landscape. However, such changes may be associated with a change in land cover categories, and not with the creation of special new forest areas. It is important to underline the fact that changes in the area of creating new forest areas occupy a large area, and therefore their impact on ecological stability will be much greater than in the case of fragmentary changes in Toruń.

CONCLUSIONS AND SUMMARY

As shown by the research, increasing the area of green spaces has a positive effect on the development of ecological resilience. It is refreshing that both cities increase the area of green spaces by increasing the area of forests. The creation of new GUA and sport and leisure facilities would also have a positive impact on ecological resistance, however, in the limited space of the city, the process of creating these areas is difficult.

In the analyzed period, there was an increase in the area of green areas in both cities. This increase was definitely influenced by the increased forest succession, as the largest number of these areas was increased. In Toruń and Košice, a downward trend in the construction of new green urban areas and sports and recreation areas is noticeable. The main direction of the transformation of green areas in Košice is the creation of new warehouse space in green areas, while in Toruń, green areas mainly include areas related to the creation of new industrial or commercial areas. It is disturbing that the creation of new green areas in Košice and Toruń is negligible. Košice and Toruń are characterized by good ecological resistance, but a larger forest area in Košice has a positive effect on the CES value.

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URBAN TRANSPORT, LOGISTICS, AND TOURISM: REVIEW OF A CUTTING-EDGE SOCIALLY-ORIENTED APPROACH TO INDUSTRIAL DEVELOPMENT

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ABSTRACT

Motives: Rapid urbanization has increased public awareness about logistics support for urban traffic flows. Given this interest, the relevance of this research is beyond any doubt.
Aim: The study aims to identify the most cutting-edge approaches for facilitating traffic and tourism flows using various urban transport modes, and to define the opportunities for their application on the domestic market.
Results: The results of the conducted analyses suggest that the development of rail transport is the most promising and vital step in improving urban transport and logistics infrastructure, including in the tourism sector. The study established that intelligent transport systems in urban areas, including public transport, logistics flows, tourist flows, parking, and road traffic control, are complex management systems. A critical examination of several cases supported the identification of regularities in factors that affect the dynamics of urban traffic flows. In view of the rapid development of transport and logistics infrastructure around the world, development opportunities in rural areas bordering large cities were identified. The most effective approaches to resolving logistics problems in a period of war were determined.

Keywords: innovative approach, traffic management system, tourist flow, flexible logistics support system, military escalation

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INTRODUCTION

Urban areas have increased dramatically, which generated the need for new development strategies for city transport infrastructure. The predominant solution is to introduce intelligent transport systems in urban areas. This system represents a complex management system, including public transportation, logistics flows, parking, and road traffic control. In addition to the above, the authors of this article believe the intelligent transport system should involve the tourism element. Tourist flows are inalienable elements in the urban transport systems, and their successful management largely contributes to the logistic support for urban transport flows. Currently, the tourism industry is still trying to recoup from negative consequences of the Covid-19 pandemic and restrictive measures and thus requires the most cutting-edge socially oriented and legal approaches to hasten this process. Porta et al. (2006) studied various urban networks in detail and suggested a number of models for each particular case. An intriguing scientific accomplishment was made by the authors, who compared some structural features of double graphs and looked for substantial resemblance and replication between clusters of various cases.

Daganzo (2007) suggested a new adaptive strategy, which could enhance urban mobility and minimize congestion at the district level. It provides for monitoring and management of cumulative traffic congestion. Since the suggested dynamic models are simple to operate and require the observation of initial data, they have precedence over various similar tools. Geroliminis and Daganzo (2008) conducted the study and found a distinct feature of extensive urban areas. It is a macroscopic, fundamental diagram that provides an immediate connection between the space-mean flow, density, and speed. Furthermore, space-mean flows are characterized by a stable relationship across the network. The urban flow estimation required taking data from minibusses equipped with GPS assistance. Further examination showed that the previously proposed analytical theories were inferior for analyzing the relationships between network structure and a macroscopic, fundamental diagram for urban areas since they did not consider the influence of turns (Geroliminis & Boyacı, 2012). The authors of this article believe that the methodologies suggested in this research represent a significant theoretical and practical advancement because they allowed for the consideration of variability for cities and signal structures. Bo et al. (2019) assessed the introduction of the management system for freight traffic.

Guo and Lu (2016) examined unweighted and undirected models of road networks and suggested two modeling approaches based on complex network theory and data trajectory filtering. The authors also established that urban transport development has a partially arbitrary nature. Galkin et al. (2019; 2020) consider the following research areas as the most promising ones in logistics: virtual management, logistics 4.0, and delivery technological scheme modeling. Since congestion is a frequent issue for intelligent transport systems, it is necessary to consider the effects of various solutions on urban traffic flow, which becomes possible with the creation of the most applied mathematical apparatus. Zambrano-Martinez et al. (2017) believe the improvement of congestion modeling should start with a heuristic technique. Notably, only some roadway segments fall within the scope of the general traffic flow theory, which ensures adequacy through quadratic regression, while other categories are typical in different situations (Zambrano-Martinez et al., 2018). The network centralization assessment system developed by Zhao et al. (2017) is applicable for a more in-depth road network analysis since it considers its topological features and geometric properties.

Wang et al. (2018) studied how the demand for urban transport changes during peak hours and found this distribution is not equal at various crossings and roads, while peak-hour flows and daily flows correlate. The authors' model of the relationship between urban road structure and function is a truly innovative idea that has to be put into action. In general, one of the principal cutting-edge strategies for supporting logistics in terms of urban transport flows is the involvement of systematic traffic management. These studies

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provoke interest due to information solutions designed to assess urban traffic flows. Lu et al. (2018) developed a technique for selecting tools that would facilitate urban traffic and established such a feature of the urban road networks as spatial correlation. In their monumental study, Zhang et al. (2021) designed a spatial network of traffic flows with the indication of their cold and hot zones. The study found the division of such networks into communities by two criteria – centralization and density. The authors of this article believe this study provides a better examination of the characteristics of urban traffic flows.

This study aims to identify the most cutting-edge approaches for facilitating traffic and tourism flows using various urban transport modes and define opportunities for their application in the domestic market.

MATERIALS AND METHODS

In order to optimize urban transportation and logistics, it is essential to strike a balance between societal and commercial interests. Society always strives to make living comfortable, which inextricably entitles confidence in food security, ecological safety, and transport accessibility. Urban delivery, in turn, is a critical factor for many logistic and transport businesses. Urban delivery is frequently subject to considerable delays and correspondingly high expenditures. Since the delivery segment plays a crucial role in the logistics industry, it is necessary to implement cutting-edge solutions while reducing costs. This is advantageous for the general public because it facilitates the movement of heavy vehicles in cities and allows for better customer service and better societal integration. Lu et al. (2014) developed a two-parameter community dynamic model for designing social networks within the framework of their research. As the criteria, the authors accepted communication speed and exchange rate. The authors believed their research could confirm by experiment that the suggested model was efficient for developing networks as they became capable of qualitatively and significantly simulating the networks of social contacts.

The implementation of any new social practice requires accurate knowledge about the level of education among the population since it is closely tied with the further adoption of this practice. It is necessary to consider a systematic approach as a mean to determine the level of education among the population, and the analysis and assessment of results obtained should be in the context of information society development (Martynovych et al., 2019). Consumers more often consider mobility a determinant when assessing the tourism offering, i.e., the ability to move around when traveling becomes the quality factor, particularly in big cities. The level of tourism predetermines the demand for public transport and, consequently, promotes its development. However, urban residents often face the issues of congestion and lack of supply (Albalate & Bel, 2010). Hącia (2019) supported the above statement and emphasized the need for a study focused on resolving these issues by creating efficient tools.

Yang et al. (2019) conducted an experimental study and established the difference between the impact of air and rail service on two-way tourist flows, where the latter was less. The authors also determined that the effects of transport links and multimodal transport competition directly depend on the general distance between departure destination points. Gutierrez and Miravet (2016) established an intriguing regularity in tourists' demand for public transport. The group of tourists, who flew by plane and were supposed (according to their profile) to travel by public transport rarely, resorted to it the most. The second group used their cars as the primary means of transport even if it was more opportunely to travel by public transport. The tourist profile consequently loses some of its importance; instead, it is crucial to determine if the travelers will drive their vehicles. The tourism industry largely depends on numerous laws and rules governing transportation services, lodging, food service, consumer protection, e-commerce, leisure development, tourism facilities, etc. Particular locations have established standards for living and food, the observance of which significantly affects the location itself.

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The following regulatory legal instruments govern tourist services within the European Union: Directive (EU) 2015/2302 on package travel and linked travel arrangements, Directive (EU) 2011/83 on consumer rights, and the EU Regulation on platform-to-business relations. The study of Russo et al. (2021) is worth considering as it focuses on defining the adequate approach to developing urban courier and express delivery logistics centers. The authors applied a linear optimization model as the mathematical instrument of their research, and the criterion was the maximum utility with the optimum allocation of joint infrastructure capacities in terms of the subjects of the courier and express delivery market. Altuntaş Vural and Aktepe (2021) study urban logistics in the context of sustainable innovations. The authors believe they are primarily the mechanisms that support the collection-and-delivery sites and thus implement recent market offers. Here, the authors correctly underline the need for other logistical services in addition to collection-and-delivery sites, which will increase the offer and improve its execution.

Logistics modernization is inextricably linked with the application of software, which can significantly facilitate the process. The study of Šourek (2021) focuses namely on these issues. The author employs modeling and computational software to address various planning issues and urban logistics optimization procedures. The suggested strategies work particularly well in simulating typical urban logistics processes, where outcomes are incredibly reliable. In his research, Gardrat (2021) strived to create the foundations for the conception that combines urban logistics growth with other localization dynamics as a primary determinant of the mobility of commodities. İmre et al. (2021) dedicated their research to urban freight fleets regarded through the prism of electric freight vehicles and factors that prevent their introduction. The authors, in particular, found serious issues with the data accuracy on the suggested tools. The study made use of expert analysis techniques, probability theory, formalization and generalization techniques, statistical analysis, etc.

RESULTS

Nations with rapidly expanding and emerging economies usually account for the largest share of land transportation. Urban transportation is on a similar upward trajectory. While industrialized countries – particularly the USA and the EU -make the most effort to lessen the effects of emissions, nations with rapidly expanding and emerging economies are far behind in solving this issue. The main reason is that technological advancement runs slowly in these countries; freight transport produces the largest share of emissions, and the use of outdated vehicles has a very detrimental impact (ITF, 2021). One example of a prosperous innovative approach is the active substitution of electric cars for motorcycles in mail delivery in several Korean cities. According to a cost-benefit analysis, the benefits of employing electric vehicles outweighed the expenditures by 243 percent, delivery time fell by 6 percent, and the mileage was 20 percent lower than that of a motorcycle. Delivery providers from particular cities in China, the United States, and the United Kingdom are also interested in testing similar projects. The results obtained are uncertain, even though the benefits of using electric vehicles for delivery are acknowledged in all research (ITF, 2019).

The COVID-19 pandemic has increased the role of the following processes for market participants: digitization, e-commerce, trade regionalization, use of more dependable and tested supply chains, and accelerated introduction of current technology and business models (ITF, 2021). Additionally, supply chains are becoming more regionalized, and the significance of local deliveries in cities, particularly the "last mile", is growing. The "last mile" delivery will also influence international trade, which is to some extent localized. The ITF freight model analyzes global freight activity in its entirety. At the same time, its content is extensive and involves 27 types of freight for all transportation modes, including urban, domestic, suburban, and international transit (ITF, 2020). This model, suggested in 2015, is subject to regular update and expansion with new modules. The model

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is a way to solve the existing problem in urban transport flows and ensure their logistic support.

Urban transport flow management is a challenging task with various particular issues that require addressing. First, it concerns the need to distinguish formative principles in urban transport flows. Below are listed the guidelines for managing transport flow. As was already said, the tourism industry directly affects urban logistics, and tourist flows are a crucial component of urban transport flows. Infrastructure for urban transportation and logistics is developing as a result of the growth of tourism. The assessment of the satisfaction level among urban residents with public transport requires taking the influence of tourist flows into account to be qualitative (Martyn et al., 2022). The tourism industry is a vast intersectional complex that has the potential to push forward both local and national economies (Sarana et al., 2019). Unregulated traffic on main streets and traffic lights usually complicate side street transport flows. Traffic lights with various operating principles are used, ranging from those with a fixed duration of red and green signals to more sophisticated devices that respond to the presence of moving vehicles.

Vehicles must wait in line, whereas pedestrians can move together even if they gather in large numbers when the right circumstances allow it. The above also falls upon single cars because their delay is unrelated to that of other vehicles. Therefore, if side street transport flows are somewhat infrequent, it allows to avoid the probability of queuing, and the results applicable to pedestrians will also apply to any means of transport. The typical service device of a classical queuing system is responsive; it begins to operate when a new requirement enters the system, along with the accomplishment of the service for a previous one. If such a requirement existed, it would imply that the waiting time is equal to zero for the requirements entering the system at a time when it is free (Horobets et al., 2021). At the same time, this presumption is incorrect in the case of street intersections. Even if there isn't a line when a vehicle arrives, it will still have to wait. The service device is insensitive until vehicles arrive on the side street and occasionally permits the passway if the passway permission process is perceived as a maintenance procedure.

In the case of a turnstile, it is possible to consider it an insensitive service device if only a single object is going through at a given instant. A traffic light can be such a device if there is no regulation of traffic flows on the main street, and several objects pass at once. It is also necessary to keep in mind that a traffic signal system is essential when planning urban logistics. As noted, this study aims to single out the regularities in the effects of various factors on urban transport flows. Thus, in addition to using modern technologies to solve this problem, this includes resolving several theoretical issues. The identification of the said regularities presupposed taking the following cases into account. According to the authors of this article, the queuing theory views blocking free movement as a service, while its duration means the service duration.

However, only a narrow range of problems connected to the traffic flow theory can directly benefit from this hypothesis. It is hardly possible to perceive transport delays at crossing roads as a service operation. According to probability theory, the service duration is not necessarily a random variable distributed under the same law, and they most certainly won't have known distribution densities. In the case of the exponential distribution, it is absolute nonsense for the service duration. The matter is that vehicles start moving at random and keep doing so only after meeting specific conditions. The arrival of delayed objects (on a side street) typically occurs according to Poisson distribution. Determination of either vehicles or pedestrians as objects to delay depends on the probability of a queue forming. Figure 1 represents a scheme for defining regularities in the effects of various factors on the dynamics of urban transport flows.

It is possible to describe the main street traffic flow by two criteria. They are the interval distribution between subsequent vehicles (including initial interval distribution) and the stop sign. The traffic flow on the main street should not affect the arrival of the delayed vehicle. A stop sign presupposes a vehicle avoids

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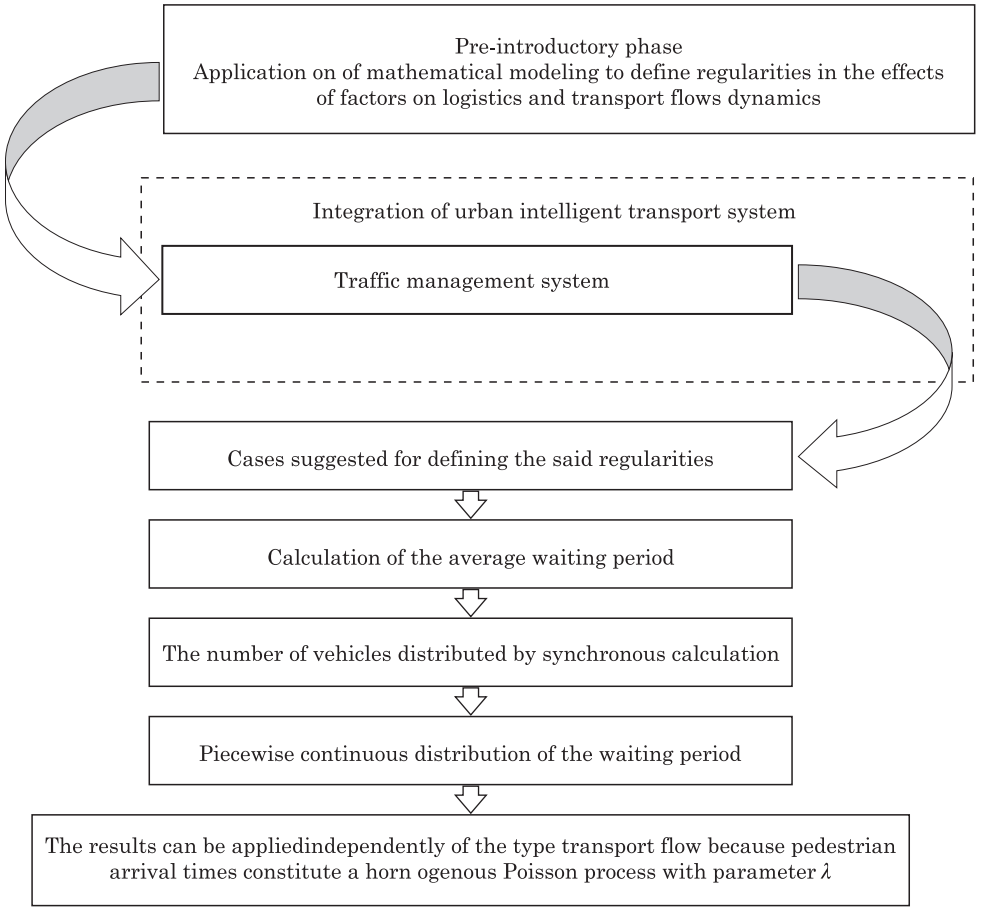

Fig. 1. Scheme for defining regularities in the effects of factors on the dynamics of urban transport flows

Source: Compiled by the authors according to Zhang et al. (2021).

the rapid intersection crossing, which prevents speed differences on a side street. In the case of delay of a vehicle, the difference concerns only their speed-up. It turned out that switching streets to one-way traffic had positive results in terms of less traffic congestion in cities. As a result, there was a decrease in traffic and an increase in average vehicle speed. It is highly encouraging to use this method along with traffic limitations for the central urban areas, particularly on side streets. The seasonal nature of tourist flows makes it hard to predict how they would affect urban transportation and logistics infrastructure. Tourists from resort cities typically arrive in substantial numbers during peak season, although the number is minimal during off-peak seasons. Addressing this challenge demands the development of a flexible logistic support system for urban traffic flows. Figure 2 represents the conditions for its development as a guarantee for tourism growth.

It is not a good practice to ignore the mentioned features of management of urban traffic flows when designing intelligent urban transport systems, even though it is today's realia. Thus, there is a need for a qualitative theoretical justification, which involves a thorough examination of the characteristics of specific components of the urban traffic system. The urban areas closest to the best transport systems typically have light rail transport, which is convenient for passengers and freight transportation. It is a good practice to use this railway to service tourist flows

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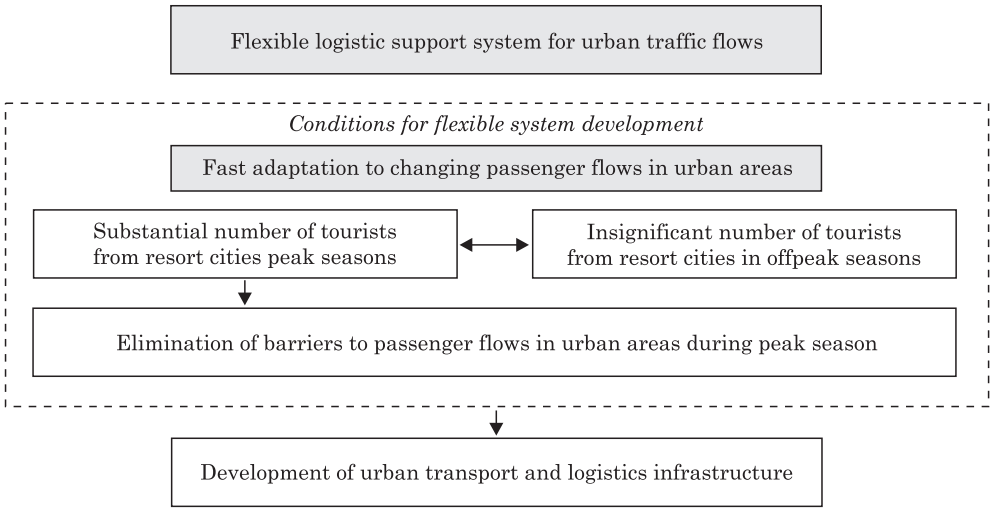

Fig. 2. The conditions for the development of a flexible logistic support system for urban traffic flows
Source: Compiled by the authors according to Gardrat (2021).

during peak seasons. Fast adaptation to changing passenger flows is a principal benefit of urban light rail, which is especially important for resorts where passenger flows change dynamically and enormously increase during peak seasons. Furthermore, a well-integrated city light rail can ensure the fewest obstructions to urban passenger flows during tourist peak season. The necessity to keep the mobility of urban residents at a high level during this season only contributes to the relevance of the above.

DISCUSSION

The degree to which the priorities of those involved in the urban transportation and logistics industry should be taken into account is a contentious issue. In addition, given the growth of the urban transportation and logistics infrastructure, it is significant to assess the prospects for rural area development near such cities. The authors of this article believe the interests of a country and its rural and urban areas should come first, taking precedence over those involved in the transport and logistics industries, including the tourism sector. In order to increase their mobility, society strives to improve urban transportation and logistics infrastructure, which involves the increased technological support for urban traffic, connectivity, and integration of urban and suburban modes of transport, including airports. Transfer of labor to cities requires suburban transport modes not to fall in development behind urban transport and be completely integrated with it.

However, tourist flows should complement sustainable urban traffic flows, and the ease of their mobility in cities should serve as the cornerstone for assuring it. When determining whether the tourism sector is beneficial for a city or a country, it is necessary to consider the satisfaction level among tourists with service, the transportation and logistical support provided, and the money spent. In other words, these factors are tourism success indicators (Al Ani, 2022). Therefore, urban areas make efforts to involve the most affluent tourists who desire a better and more complete product while having the slightest influence on the city infrastructure. The way to achieve this is to build more cutting-edge transportation and tourism facilities, such as hotels, amusement parks, shopping centers, and transportation hubs, including ports, airports, and train and bus terminals. Rural areas bordering large cities can benefit from extending transport and logistics facilities to their boundaries. It will contribute the development of rural areas, intensify domestic tourism, and relocate some urban residents to a "greener" environment (Fig. 3).

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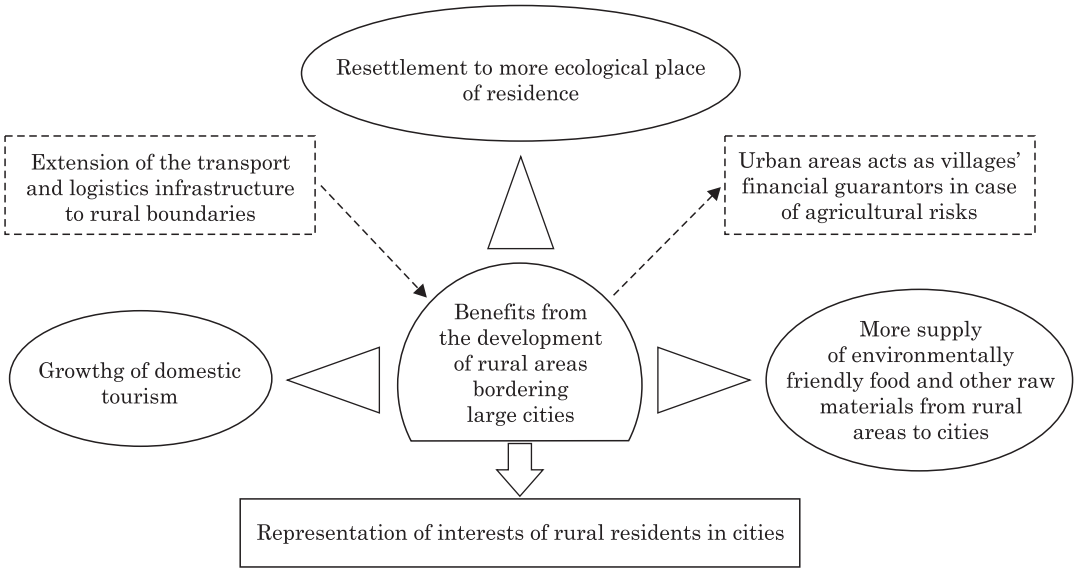

Fig. 3. Benefits from the development of rural areas bordering large cities in terms of extending transport and logistics infrastructure
Source: Compiled by the authors according to Lu et al. (2014).

Additionally, rural areas can step up their initiatives to supply cities with environmentally friendly food and other raw resources, speaking for territorially united rural communities. Urban areas can benefit from agricultural information and rural management principles. Moreover, cities can act as financial guarantors to reduce agricultural risks for villages involved in growing crops.

Tourist and logistical problems of Ukraine in the conditions of war

With the military escalation by the Russian Federation, the temporary occupation of some of the most touristic regions in the summer and the constant civil population bombing, tourism in Ukraine has collapsed. In the first four months of 2022, representatives of the tourism industry of Ukraine paid 18% less taxes than in the same period of 2021 (Zhiriy, 2022). However, as noted by the State Tourism Development Agency, currently Ukraine is just beginning to enter the period of the greatest economic losses. After all, our season actually started in May-June, reached its peak in July-August, and the business season usually started in September-October (State Agency for Tourism Development of Ukraine, 2022).

Along with tourism, the logistics system of Ukraine suffered serious losses. Now the situation is difficult – both in import and export operations. Despite the fact that they are vital for the global economy (Kostyuchenko et al., 2019). Ukraine is a part of the civilized world and is integrated into world trade. Especially since air and sea deliveries do not work, and rail deliveries are limited. However, urban and long-distance logistics, which served as the backbone of the tourism industry, will suffer the greatest losses, due to the fact that: many fleets have been destroyed, bridges have been blown up, logistics routes have become longer, using detours through safe roads, the fuel situation is currently critical, and most of the employees have been forced to leave their homes or are currently at the front.

In such large cities as Kyiv and Kharkiv, the key logistics route – the metro – serves as a shelter during bombings, which significantly complicates the logistics of large cities. During an air alert, the vast majority of transport stops or minimizes its movement, which

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complicates and is also a negative consequence for the implementation and introduction of new socially oriented and innovative practices in the logistics of urban transport flow. A large number of logistics companies were retrained in humanitarian cargo, and air and sea transportation became impossible altogether.

Regarding the call of the President of Ukraine Volodymyr Zelenskyi to businesses to resume work, everything in the logistics industry directly depends on the situation in the country: both the number of drivers and road safety. In order to simplify logistics in our opinion, there are several ways. In particular, to cancel the limit on refueling for carriers – some gas stations have daily limits. If these restrictions are removed, the number of flights will increase. It is still being necessary to create safe routes for logistics companies in cooperation with the Ministry of Infrastructure, Armed Forces of Ukraine and TRD (Territorial defense), so that drivers can bypass dangerous areas. Currently, there is a lack of such information, and it is not easy to form routes.

Currently, initiatives that can be useful for transporters, volunteers and refugees have already begun to appear, for example, the Crisis Logistics Center (2022), VzayemoDiya (2022). The Ministry of Digital Transformation and other relevant ministries should also join this process. In the current situation, it is not possible to limit oneself to the creation of logistics centers and electronic services that facilitate and optimize movement. It is necessary to create conditions where optimal solutions become part of the overall experience. It is necessary to remember not only the need to optimize logistics, but also corruption risks. Therefore, it is needed to combine the advantages of the centralized capabilities of the state, public initiative, feedback mechanisms and the selection of the best organization models should be taken into account.

CONCLUSIONS

A thorough investigation is necessary to determine whether socially-oriented innovative techniques are applicable for the logistic support of tourist and urban traffic flows. The achievement of the defined aim predetermined the need for critical examination of the scientific output of the leading scholars. The authors of this article analyzed numerous theoretical and practical advancements that confirmed partial randomness in the development of urban traffic, contributed to the role of tourism in urban logistics, and highlighted the variable nature of urban traffic light systems for various cities and signal configurations. The authors of this article distinguished that a characteristic feature of city roads is a spatial correlation and substantiated the necessity for a traffic management system – a dominant innovative tool for logistic support of urban transport and tourist flows. It is also necessary to develop the most applied mathematical apparatus in order to assess how various solutions affect the transport flow in urban areas. The authors of this article recognized integrated logistics centers as essential constituents of innovative logistics management in urban areas. Furthermore, they hold that one of the elements that might affect both freight and passenger flows is the urban light rail.

In the course of the research, the authors determined the principles of the formation of urban transport flows, including tourist flows. According to the research conducted by the authors of this article, the queuing theory views free movement as a service, while delay time means the service duration. Furthermore, the service duration does not imply a random variable distributed under the same law, and they most certainly won't have known distribution densities. The authors of this article found opportunities for rural areas bordering cities to develop; these areas should supply urban areas with environmentally friendly food and other raw materials, receive financial guarantees from the cities to reduce agricultural risks, and spread agricultural knowledge and management principles throughout the cities. This study provides

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for the analysis conducted on the state of tourism and logistics industries in Ukraine under the war and suggests ways to improve the current situation.

Author contributions: authors have given approval to the final version of the article. Authors contributed to this work as follows: Roman Sushchenko developed the concept and designed the study, Yaroslav Zapara collected the data, Volodymyr Saienko and Viktor Kostiushko analysed and interpreted the data, Larysa Lytvynenko prepared draft of article, Svitlana Pron revised the article critically for important intellectual content.

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ALTERNATIVE USES OF FORMER COASTAL ARTILLERY MILITARY BASES IN KOSZALIN COASTLAND IN VIEW OF THE GROWING POPULARITY OF MILITARY TOURISM

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ABSTRACT

Motives: In recent years, the popularity of military tourism has increased considerably in Central and Eastern European countries, especially among tourists who have an interest in military history and technology.
Due to the general scarcity of methods and studies examining alternative uses of former military bases, including coastal artillery bases, a reliable method for assessing the value of such sites for military tourism should be developed. The study presents the history of the analysed military bases, and it examines the extent to which the existing facilities could be converted into tourist attractions. An innovative method for evaluating the tourism potential of defunct military bases was proposed and verified, and the required changes for improving the accessibility and applicability of military facilities for educational and tourism purposes were described. Two former military sites in Koszalin coastal region were selected for the study.
Aim: The main aim of the study was to propose an original method for assessing alternative uses of former coastal military bases, and to evaluate the educational and tourism potential of former military bases on the Koszalin Coast (a subregion of the South Baltic Coast) on the example of two former military facilities: Anti-Aircraft Artillery Division No. 68 in Łeba and Anti-Aircraft Artillery Division No. 66 in Naćmierz.
Results: The results of the study indicate that the evaluated military sites have considerable tourism potential, in particular for tourists who have an interest in military history. An analysis of exogenous as well as endogenous (architectural and historical features) factors revealed that both sites could attract tourists, including visitors who are not strictly interested in military facilities. The assessment conducted using the proposed method demonstrated that the Anti-Aircraft Artillery Division No. 68 in Łeba is characterised by high tourist attractiveness, whereas the Anti-Aircraft Artillery Division No. 66 in Naćmierz is characterised by moderate tourist attractiveness.

Keywords: military tourism, military sites on the Koszalin Coast

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INTRODUCTION

Recently, military tourism has been gaining in popularity among tourists, especially those who are interested in military history and technology, and the scope of the term "military tourism" is becoming wider and wider (Venter, 2017). According to many authors, it also encompasses terms like "military cultural tourism", "war tourism", "battlefield tourism", as well as "military installations tourism" (Kowalczyk, 2008; Jędrysiak & Mikos von Rohrscheidt, 2011; Stach, 2013; Stach et al., 2014; Sadowski, 2016; Zienkiewicz & Podciborski, 2019), "military heritage tourism" (Huh, 2002; Chhabra et al., 2003). It is also closely connected with related themes, such as "dark tourism" and "blood tourism" (Raine, 2013; Biran & Hyde, 2013). However, the main reason for practicing military tourism is always the cognitive motivation. This particular form of tourism broadens the mind, increases one's knowledge and general culture (Kwilecki, 2011).

At present, military sites and facilities are becoming new, important destinations for cognitive tourism. Poczta (2008) drew attention to the increased interest in this type of tourism, claiming that one of the unconventional forms of active tourism is military tourism (Poczta, 2008). The development of military tourism was also discussed by: Chylińska (2006), Cynarski (2012), Stach (2013), Stach et al. (2014) and Zgłobicki (2016). Kowalczyk (2008) referred to the issue in a similar way, claiming that military tourism is one of the relatively new forms of tourism, which by Jędrysiak and Mikos von Rohrscheidt (2011) was also called military cultural tourism, war tourism, battlefield tourism or military equipment tourism. It can perform the following functions: historical-educational, martyrological, political-ideological, cultural-entertainment, recreation-sport and adventure (Kowalczyk, 2009).

A different situation took place in the countries of Western Europe. The research conducted by Logan and Reeves (2009) confirmed that interest in the heritage of dark events, both nationally and internationally, has grown and continues to grow among scientists and tourists alike. The main destinations of tourists were: extermination camps, places of massacre and genocide, former maximum security prisons, defense quarters and former dictatorships (Logan & Reeves, 2009).

Huh (2002), Chhabra, Healy and Sills (2003) also drew attention to the particularly dynamic development of military heritage tourism in their works.

The authors of this article have approached the issue of former military bases, which are currently not used for military purposes, located in the geographical region of the South Baltic Coastlands sub-provinces. There are many coastal artillery bases on the Polish coast that could be made available for the development of military tourism. These are facilities such as: bunkers, hangars, shelters, observation towers, radar stations and others. In the light of the literature, research of this type is innovative, because the method presented below takes into account the environmental values of the areas where military facilities are located. In many cases, the facilities situated in the Polish coastal area may be a substantial attraction for military tourist. The majority of the facilities in question are the remains of the Polish, German, and Soviet coastal artillery built in the 20th century in the coastal area between Gdansk and Świnoujście (Jarosz, 2018).

The purpose of the article is to present the educational potential and the possibilities of using former military bases located on Koszalin Coastland and comprising a total of six mezzo-regions, covering ca. 6500 km^2 (Kondracki, 2002). A specific objective of the research is to analyse the attractiveness of individual military facilities, using the point bonitation method – a technique that may prove useful in evaluating other military facilities as well, which are currently not performing their military functions. Another goal is to indicate in what other ways the facilities could be used (outside the terms of ownership and the like) and adjusted to the needs of tourism.

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The subject of the article are two facilities selected for study: the anti-aircraft missile artillery in Łeba (68. Missile Air Defence Battalion) and the anti-aircraft missile artillery in Naćmierz (66. Missile Air Defence Battalion). The authors put forward the following research hypothesis in this article: military facilities located in an area with high landscape and environmental values are better rated as military tourism attractions.

MATERIALS AND METHODS

Study area. The location and characteristics of selected military facilities in Koszalin Coastland

Compared to the Gdańsk Coastland, situated to the west, Koszalin Coastland (Fig. 1) features a smaller number of facilities that used to be artillery and missile bases in the past. The region covers the area from Trzebiatowskie Coast and Gryfice Plain in Szczecin Coastland to Kępa Swarzewska and Kępa Pucka in Gdańsk Coastland. In contrast to other coastlands, its coastline is not varied – it shows only one slight bend between the Pomeranian Wall and Łeba elevation. The coastline was smoothed by the abrasive and cumulative activity of the Baltic Sea, which produced accumulative sandbars with dunes.

This resulted in the formation of lakes and peatlands, cut off from the sea. This coastland area is furrowed by the rivers flowing out from the lake district: Parsęta with Radwia, Grabowa, Wieprza, Słupia, Łupawa and Łeba. This macro-region covers the area of about 6500 km^2 and is divided into: Słowińskie Coast, Białogard Plain, Sławno Plain, Damnicka Upland, Żarnowiec Upland, as well as the Reda-Łeba ice-marginal valley (Kondracki, 2002).

The first facility in this part of Polish Coastlands is the anti-aircraft missile artillery in Łeba – the 68. Missile Air Defence Battalion (68. DR WOPK) (military unit No 3886; Fig. 2).

The complex is located in the eastern part of the city of Łeba, on the sandbar between the Baltic coast and Lake Sarbsko. It includes many deserted yet easily accessible facilities, such as the command bunker with a radar station, or shelters for military vehicles. When it was first built (1974), it was armed with missile anti-aircraft systems (S-125-M "Neva") and remained operational until 1999 (Jarosz, 2018).

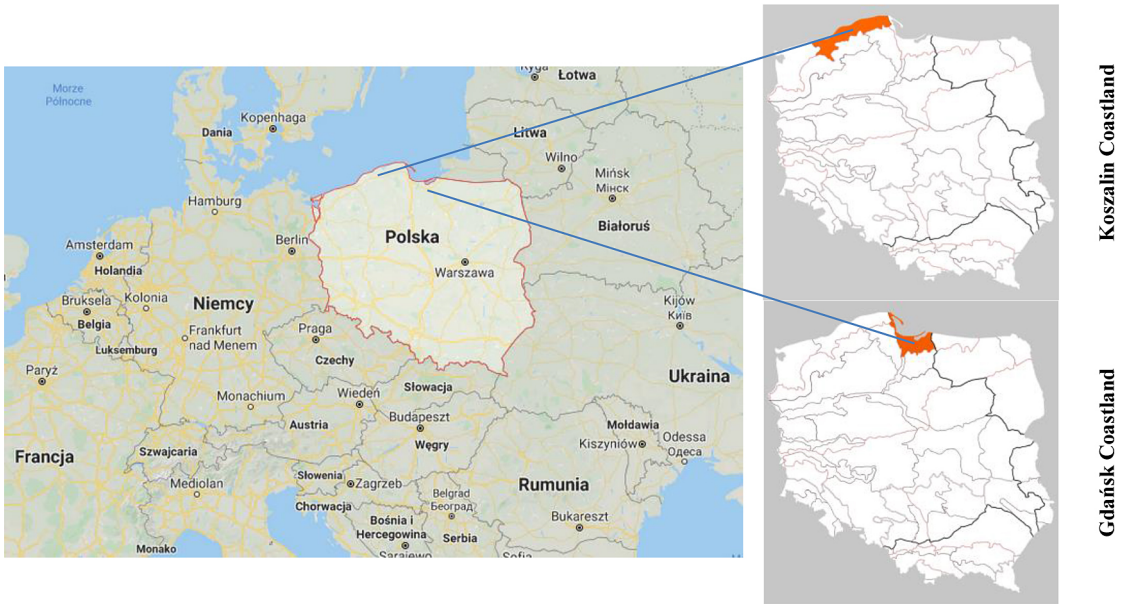

Fig. 1. The location of the Gdańskie and Koszalin Coastland
Source: own elaboration.

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Fig. 2. Łeba – a) Anti-aircraft missile artillery in Łeba, b) 68. Missile Air Defence Battalion
Source: authors' collection.

Currently, a part of the facility functions as the "Power Park Łeba", where people looking for entertainment have access to three go-cart tracks, six different passes in a rope course, a pendulum jump installation, a climbing wall, as well as a paintball field, an off-road and a quad track. One can also find a playground for children, a shooting range and a gastronomic outlet (Power Park Łeba, 2022).

A similar site in Poland is the anti-aircraft missile artillery in Naćmierz (66. DR WOPK; Fig. 3).

Fig. 3. Naćmierz – Anti-aircraft missile artillery (66. DR WOPK)
Source: authors' collection.

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It was also established in 1974, on the premises of a former military unit situated on Obła Mountain (25 m above sea level) in the Postomino commune. Closed down in 1990, it included missile systems similar to those in Łeba. The acilities which are worth visiting here are the command bunker with a radar station and shelters for military vehicles.

The method of evaluating coastal artillery facilities

Due to the relatively limited access to data, the issues of military tourism presented in this article required using specific research methods and techniques. In this study, the authors used methods based mainly on primary data (observation and collecting photo materials). Due to the specificity of the topic, as well as the niche character of military tourism, as well as the lack of appropriate statistical data, the particularly useful methods and techniques were those used in desk study conditions (a historical method).

The article also presents some statistical methods, which were particularly useful while developing and applying a new method of evaluating artillery facilities on the Polish coast.

The purpose of the modified method described below (Zienkiewicz, 2021) was to develop the best possible technique of evaluating former military facilities located on the Polish coast, with respect to education and tourism development. Interest in former military facilities, e.g. bunkers, cannon posts, etc., is becoming increasingly common, even despite the COVID-19 pandemic restrictions. Places of this kind may be visited individually, because they are usually open to the public and unguarded.

In order to define the conditions for tourism development at former coastal artillery facilities, a number of variables were adopted, referring to the natural environment assets, accessibility by transport, as well as regarding the architectonic and historical value of a given facility. They can be divided into exogenic and endogenic factors.

In the opinion of Kowalczyk (2003), historical-military facilities as well as the sites of true military events, can be considered by tourism geographers on several planes. From the perspective of the study presented in this article, a tourist may be interested in mainly two aspects.

Firstly, the general location of the facilities (within the country or region) and their precise location (in relation to the land relief, presence of surface waters, buildings). According to Kowalczyk, "what is particularly important in this approach is the fact that a given facility is treated as an element of landscape. As a result, an interest in tourism geography may develop together with an interest in landscape architecture" (Kowalczyk, 2003).

Secondly, the tourist may become interested in matters strictly regarding the tourist development of a given facility or site and its nearest vicinity. Typical tourist infrastructure includes. For instance, carparks, gastronomic establishments, souvenir shops, sanitary amenities, hotels and many other (Kowalczyk, 2003).

For the purposes of this article, the factors identified in the conception outlined above were classified by authors as follows:

a. the exogenic factors of the tourist attractiveness of a military facility, which include indicators describing the surroundings of and access to the facility or a group of facilities, as well as all kinds of amenities, i.e. tourist infrastructure and services (Table 1);
b. the endogenic factors of the tourist attractiveness of a military facility, which include the features of the facility or a group of facilities, directly resulting from its/their physiognomy, architecture and historical value (Table 2).

The scores presented in the tables below were determined after expert research conducted as part of the preliminary research in the city of Łeba and in the commune of Postomino in July and August 2021.

The indicators presented in the tables were measured or observed during field studies or on "Geoportal" and "Google Maps" Internet portals, because they were mostly unobtainable as secondary data.

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Table 1. Exogenic factors of the tourist attractiveness of a military facility

No.	Indicator	Score/Points	
	Exogenic factors of the tourist attractiveness of a military facility		
1	access to an access road (the distance from the road to the nearest military facility, measured in metres, land signage	– up to 100.0 m – 5 pts – 100.1–150.0 m – 4 pts – 150.1–200.0 m – 3 pts – 200.1–250.0 m – 2 pts – over 250 m – 1 pt	5
2	presence of tourist infrastructure, i.e. gastronomic outlets, carparks, accommodation (number of hotels) closer than 100 m from the main facility	For each facility – one point extra	x ≥ 0
3	the mean distance from a recreational plot of land to the nearest water reservoir (in metres)	– up to 100.0 m – 5 pts – 100.1–150.0 m – 4 pts – 150.1–200.0 m – 3 pts – 200.1–250.0 m – 2 pts – over 250 m – 1 pt	5
4	the percentage of forests and forest land in the overall area of the *gmina* (%), i.e. the forestation rate (%)	– 0–20.0% – 1 pt – 20.1–40.0% – 2 pts – 40.1–60.0% – 3 pts – 60.1–80.0% – 4 pts – over 80.0% – 5 pts	5
5	the number of buildings registered as historical monuments in the *gmina*, calculated per area	– under 2 – 1 pt – 3–4 – 2 pts – 5–6 – 3 pts – 7–8 – 4 pts – over 9 – 5 pts	5
6	population density per 1 km^2	– under 300 persons/km^2 – 1 pts – 300.0–600.0 persons/km^2 – 2 pts – 600.1–900.0 persons/km^2 – 3 pts – 900.1–1200.0 persons/km^2 – 4 pts – over 1200.0 persons/km^2 – 5 pts	5
7	the mean distance between the facility and a higher order unit (e.g. the *gmina* office), in km	– up to 1000.0 m – 5 pts – 1000.1–3000.0 m – 4 pts – 3000.1–5000.0 m – 3 pts – 5000.1–7000.0 m – 2pts – over 7000 m – 1 pts	5
8	the number of tourist accommodation facilities in the *gmina*	– up 40 – 1 pts – 40–80 – 2 pts – 81–120 – 3 pts – 121–160 – 4 pts – over 160 – 5 pts	5
9	the number of beds in accommodation facilities in the *powiat* per 1000 people	– under 100 – 1 pts – 101–200 – 2 pts – 201–300 – 3 pts – 301–400 – 4 pts – over 400 – 5 pts	5
		Exogenic factors TOTAL (without extra points)	40

Source: Authors' elaboration.

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Table 2. Endogenic factors of the tourist attractiveness of a military facility

No.	Indicator	Score/Points	
	Endogenic factors of the tourist attractiveness of a military facility		
1	visual attractiveness of the facility as a fortification (a subjective indicator) – evaluation comprises first of all elements of construction: the state of the foundations, walls above the ground, the flat roof, flooring, stairs, elevations, interior plasters, possibly woodwork and wiring	– very attractive (9–10 pts) – attractive (7–8 pts) – fairly attractive (5–6 pts) – not very attractive (3–4 pts) – insignificantly attractive (1–2 pts)	10
2	historical assets – understood as the year of building the facility, as well as its major functions and the historical periods it survived	– before 1920 (9–10 pts) – 1920–1940 (7–8 pts) – 1941–1960 (5–6 pts) – 1961–1980 (3–4 pts) – after 1980 (1–2 pts)	10
3	the number of facilities forming the artillery base – the whole complex or its elements (ruins)	– under 2 – 1 pts – 3–4 – 2 pts – 5–6 – 3 pts – 7–8 – 4 pts – over 9 – 5 pts	5
4	presence of historical objects, artefacts	For each accessible collection of artefacts (display) – 1 point extra	x ≥ 0
5	the degree of dilapidation (%)	The degree of dilapidation (subjective assessment): – 0–20.0% – 5 pts – 20.1–40.0% – 4 pts – 40.1–60.0% – 3 pts – 60.1–80.0% – 2 pts – over 80.0% – 1 pts	5
6	physical accessibility of the facility – easiness/difficulty in visiting the facility (passages between buildings, etc., marking the buildings, tour direction)	– very good accessibility of the facility and individual buildings and installations (9–10 pts) – good accessibility (7–8 pts) – medium accessibility (5–6 pts) – poor accessibility (3–4 pts) – very poor accessibility (1–2 pts)	10
		Endogenic factors TOTAL (without extra points)	40

Source: Authors' elaboration.

The researchers analysed the military facilities in question, using the point bonitation method.

The stages in the research proceedings were as follows:

1. Stage 1 – defining a number of variables that potentially affect the attractiveness of former military facilities, as well as dividing them into individual themes: natural environmental assets, accessibility by transport, selected services and tourist and quasi-tourist installations, historical, architectural assets, as well as the general popularity of a given facility;
2. Stage II – a thorough analysis of all features and the links between them considered from the factual and logical point of view. All in all, the study comprised 15 out of 18 factors. Due to the difficulty in data acquisition, the following elements were excluded from the study: the number of tourists in the *gmina* where a given facility was found, the area occupied by the facility and its popularity on the Internet;
3. Stage III – sorting out and preparing primary data for analysis;

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4. Stage IV – preparing a matrix of point bonitation data with reference to the attractiveness of military facilities;
5. Stage V – summing up the points gained in the process of evaluating military facilities as well as assigning the results to the final score:
   a. 71 and more points – very attractive artillery facilities, touristically;
   b. 41–70 points – attractive facilities, touristically;
   c. 21–40 – facilities of average tourist attractiveness;
   d. 20 points and under – facilities of poor tourist attractiveness.

Table 3. Tourist attractiveness of selected military facilities located in the area of Koszalin Coastland

No.	Indicator	Anti-aircraft missile artillery – 68. DR WOPK (Łeba)	Anti-aircraft missile artillery – 66. DR WOPK (Naćmierz)
	Exogenic factors of the tourist attractiveness of a military facility	Score/Points	
1	access to an access road (the distance from the road to the nearest military facility, measured in metres, land signage)	5	1
2	presence of tourist infrastructure, i.e. gastronomic outlets, carparks, accommodation (number of hotels) closer than 100 m from the main facility	2	0
3	the mean distance from a recreational plot of land to the nearest water reservoir (in metres)	3	1
4	the percentage of forests and forest land in the overall area of the *gmina* (%), i.e. the forestation rate (%)	3	2
5	the number of buildings registered as historical monuments in the *gmina*, calculated per area,	5	4
6	population density per 1 km^2	1	1
7	the mean distance between the facility and a higher order unit (e.g. the *gmina* office), in km	5	1
8	the number of tourist accommodation facilities in the *gmina*	4	1
9	the number of beds in accommodation facilities in the *powiat* per 1000 people	2	4
	Exogenic factors TOTAL (without extra points)	**30**	**15**
	Endogenic factors of the tourist attractiveness of a military facility	Punctation	
1	visual attractiveness of the facility as a fortification (a subjective indicator) – evaluation comprises first of all elements of construction: the state of the foundations, walls above the ground, the flat roof, flooring, stairs, elevations, interior plasters, possibly woodwork and wiring	7	5
2	historical assets – understood as the year of building the facility, as well as its major functions and the historical periods it survived	3	3
3	the number of facilities forming the artillery base – the whole complex or its elements (ruins)	5	4
4	presence of historical objects, artefacts	0	0
5	the degree of dilapidation (%)	1	2
6	physical accessibility of the facility – easiness/difficulty in visiting the facility (passages between buildings, etc., marking the buildings, tour direction)	6	5
	Endogenic factors TOTAL	22	19
	TOTAL	52	34

Source: Authors' elaboration.

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RESULTS AND DISCUSSION

Tourist attractiveness of selected military facilities located in the Koszalin Coastland area

The research demonstrated that both coastal artillery facilities selected for analysis received the total score of 34–52 points. Practically speaking, this means that, according to the classification presented herein, they are facilities of medium and high tourist attractiveness (Table 3).

As a result of the assessment using the metrics presented in Table 1 and 2, it was found that the anti-aircraft missile artillery site in Łeba (68. DR WOPK) received 52 points, while the anti-aircraft missile artillery site in Naćmierz (66. DR WOPK) received 34 points.

The relatively high and average tourist attractiveness of the sites in question, however, indicates that in order to become significant tourist attractions, they require more effective management and better equipment in recreational and tourist infrastructure.

As a result of the field visits and the assessments and analyses carried out, it was found that basic tourism infrastructure, such as well-defined paths and proper site signage, is practically non-existent in both cases. There is also a lack (especially in the case of the 66. DR WOPK in Naćmierz) of basic installations and quasi-tourist services, such as toilets, food outlets or souvenir stores.

Within the framework of the results of the evaluations and analyses received, the following recommendations were made:

a. marking the area more effectively;
b. ensuring elementary sanitary conditions (providing toilets – also for the disabled);
c. opening (at least seasonally) catering outlets;
d. opening (at least seasonally) information points.

CONCLUSIONS

Using the author's method of assessing the potential for alternative use of former coastal artillery military bases presented in this study (based on descriptive techniques, as well as scoring boning methods), the educational potential and the possibility of using two former military sites located on the Koszalin Coast for military tourism purposes is presented: 68. DR WOPK located in Łeba and 66. DR WOPK located in Naćmierz.

As a result of the assessments and analysis, the study shows that both of the assessed coastal artillery sites deserve the attention of tourists, especially those interested in militaria. According to the authors of the study, due to the high level of exogenous tourist attraction factors present at both sites, as well as specific architectural and historical features (endogenous tourist attraction factors), both sites can be of interest to tourists who do not only prefer military tourism. This can be evidenced by the fact that the remains of the two military sites represent an important contribution to the history of the defense of Poland's borders. Therefore, their tourist attractiveness is assessed as medium and high.

As a result of the assessment using the metrics presented in Table 1 and Table 2, it was found that the anti-aircraft missile artillery site in Łeba (68. DR WOPK) received 52 points – tourist attraction facility, while the anti-aircraft missile artillery site in Naćmierz (66. DR WOPK) received 34 points – facilities of average tourist attractiveness.

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