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Landmarks as Cultural Heritage Assets Affecting the Distribution of Settlements in Rural Areas—An Analysis Based on LIDAR DTM, Digital Photographs, and Historical Maps

Barbara Prus *, Magdalena Wilkosz-Mamcarczyk and Tomasz Salata

Department of Land Management and Landscape Architecture, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Kraków, Balicka str.253c, 30-198 Kraków, Poland; magdalena.wilkosz-mamcarczyk@ukr.edu.pl (M.W.-M.); tomasz.salata@ukr.edu.pl (T.S.)

* Correspondence: b.prus@urk.edu.pl; Tel.: +48-12-662-40-17

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Abstract: The final decision of the owner of the plot who plans to build a house depends on many factors most of which are of legal and financial nature. The authors demonstrate that the decisions regarding specific location within the plot of land are influenced by intangible components as well, namely the intention to have the best view. The view is often related to the occurrence of landmarks with prominent visual impact in the landscape that determine visual connections. The rural landscape is determined by the spatial arrangement including the buildings, the shape of public spaces, ownership divisions, and the land distribution. Being an element of rural cultural heritage, the arrangement of buildings is influenced by a vast number of factors such as geographical, historical, physical, and socio-economic ones. This article focuses on determining the interaction between the settlement locations and zones with an excellent, unique view of characteristic, well-known architectural landmarks. Mapping of viewsheds of many features is a critical element of the landscape planning process and facilitates the protection of cultural heritage assets. The analysis involved LiDAR DTM (Digital Terrain Model created in Light Detection and Ranging technology), digital photographs, and historical maps. In terms of the administrative subdivision, the area comprises 20 localities. The landmark visibility analysis for locations of the buildings covered a 140 km^2 area of Carpathian Foothills in southern Poland. The article combines experiences in the field of landscape architecture, spatial planning and the use of Geographic Information System (GIS) technology. The examples show that the modern development layout refers to the historical structure and the development of a new settlement tissue has a cultural background and is influenced by spatial landmarks.

Keywords: spatial-settlement analysis; GIS tools; remote sensing; landscape identity; tall architectural landmarks; space preservation; arrangement of buildings

1. Introduction

Individual decisions regarding the location of buildings on plots are affected by multiple factors. Apart from topography and financial aspects, it is the formal requirements of the local law that have the most significant impact. The final decision regarding the selection of a plot and location of the building on the plot is for the owner to make. It is they who make the decision regarding the view from the building and the landscape around it. The intangible aspect, the intention to have the best view, is usually considered as well. The view is often related to the occurrence of landmarks with prominent visual impact in the landscape that determine visual connections.

A landmark is the main, fundamental feature, which stands out and dominates the surrounding environment [1,2]. The role of a landmark in the landscape has been researched by numerous authors.

In architecture and landscaping, this is the element with the strongest visual impact that dominates the rest to the composition. In the panoramic view, a landmark stands out from the background with its distinctive form, colour, and height. In the landscape, it can be an eye-catcher, which is an architectural object that catches the viewer's eye even from the furthest distance [3,4]. In some cases, a landmark has a significant location and formal, social, and economic assets; it affects the clarity of the urban planning scheme, and designates places that are important in the space, enabling their location and perception.

The identified recurring pattern of location of religious buildings confirms the principle that landmarks used to be located in places of landscape significance, such as a central, important place that towers over the surroundings and is well visible. The landmark usually exerts leading visual impact and dominates the whole landscape composition, such as in a panoramic view [4]. The positioning of religious structures was usually carefully selected, which is related to the symbolics of the landscape. It is often characteristic of a specific cultural area. Symbols change in time, also through symbol content changes. The landscape symbolics is embodied in the occurrence of symbolic structures and relationships between built structures and their surroundings. Religious buildings have been essential parts of the landscape. They represent carefully selected ideas. Signs (such as the form of a building) make it clear through their content that they have special meaning [5] Religious structures such as Calvary shrines, churches, chapels, and ways were situated in an attractive landscape, usually mountainous one in order to copy the Jerusalem setting (they were often founded by knights returning from Crusades to the Holy Land [6]. Jerusalem and other locations associated with Christ are usually mountainous. Kalwaria Zebrzydowska includes the historical context of the defensive function of the Lanckorona Mountain hosting ruins of a Mediaeval castle and a Benedictine church and monastery complex. The designed landscape in Kalwaria Zebrzydowska contains an authentic transposition of the urban pilgrimage arrangement of Jerusalem as accounted by Andrichomius in 1584 into a Calvary arrangement, i.e., the topography of Kalwaria Zebrzydowska [6].

Most landmarks are monuments. Some date back to the Middle Ages. Their form, architectural style, and spatial relations alone make them cultural heritage assets of over a millennium of the Christian tradition in Poland. Landmarks change as a result of anthropogenic factors. New, higher buildings with greater landscape impact can be built. Sometimes, it can be impossible to fit them seamlessly into the landscape, which can cause the risk of the negative perception of a rural/urban landscape. Landmarks indirectly affect the location of residential estates as well.

In Mediaeval Poland the landscape landmark was a church with a slender tower topped with a spire, or a castle with a tower, symbolizing the secular authority [7,8]. In the centuries to follow and to the present day, new forms of landmarks have emerged in the form of manor or residential buildings, roadside crosses, and elements of secular buildings: fire station towers, mills, industrial infrastructure elements, and other. It is not uncommon for landmarks to determine not only the cultural identity but also the landscape identity of a region in the constantly changing environment [9,10]. Viewsheds, which form abstract lines visually joining characteristic points, are extremely strongly connected with landmarks. They used to be frequently used as a design measure in garden compositions, involving improvement of visual depth and incorporating more distant landscapes extending beyond the boundaries of the actual garden into the composition interplay [4]. Geographical and historical studies indicate that the diversity of types of the concentration and dispersion of settlement has been strongly influenced not only by the natural environmental factor but also by the socio-cultural factor, i.e., tradition, religion and scenic values. One can notice a significant role of visual connections in landscape architecture and their socio-political consequences in the process of landscape designing [11]. Certain regularity can be noticed in the process of land improvement, which consists in taking into account the aesthetic aspect and the visual contact with the landmark in the location of buildings.

Poland is a country with a dense network of small and very small villages, which account for approx. 81% of the total number of rural settlements [12]. Since the beginning of the formation of societies, residents have perceived the landmark as a component distinguishing an area from a larger space to emphasise their presence in this space [13,14]. In the composition of settlement units, one can notice the

principles of hierarchy in which special places, i.e., landmarks, provided the basis for the formation of cultural space with unique arrangement of settlements As the settlement unit developed, new secondary landmarks began to emerge next to the already existing landmarks and took over some of their functions [15].

After the Second World War, the previous development layouts were cancelled, and the agricultural land was developed chaotically. In many regions, the boundaries between the built-up and open areas have become blurred [16]. Poland's settlement network has been developing particularly spontaneously and influencing the transformations of the contemporary landscape following the political transformation in 1989 [17,18]. Some suggest that the dispersion of rural settlement in Poland has been on the increase [19].

The article focuses on determining the interactions between the settlement locations and zones with an excellent, unique view of well-known landmarks, that are characteristic components of the cultural landscape. The analysis was carried out in the southern part of Poland, using LiDAR DTM, digital photographs and historical maps. The article combines experiences in the field of landscape architecture, spatial planning and the use of GIS technology.

2. Materials and Methods

2.1. Study Area

The analyses have been conducted in southern Poland, over an area of 139.92 km^2.

In terms of administrative subdivision, the area includes 20 localities (see Figure 1). Nineteen of them are villages and one is a town in Wadowicki and Suski Poviats, in municipalities of Kalwaria Zebrzydowska, Lanckorona, Stryszów and Budzów, on the borderline between the Wielickie Foothills and the Maków Beskids, which are parts of the Carpathian Foothills. The study area was chosen because it is located in the vicinity of the town of Kalwaria Zebrzydowska where the main landmark is located (the Bernardine monastery tower). It is the most distinctive architectural element within this area with an advantage over the other ones due to its height, bulk, and location on a hill. Besides the landmarks, the authors took into account secondary landmarks as well (another element affecting the composition following the landmark in the hierarchy of importance). The investigated area has hosted furniture- and shoe-making industries since the 17th century. They contributed to the wealth of the residents. Therefore, it has had a higher population density than other areas in the region. Hence, the regular development of settlements, mainly residential ones.

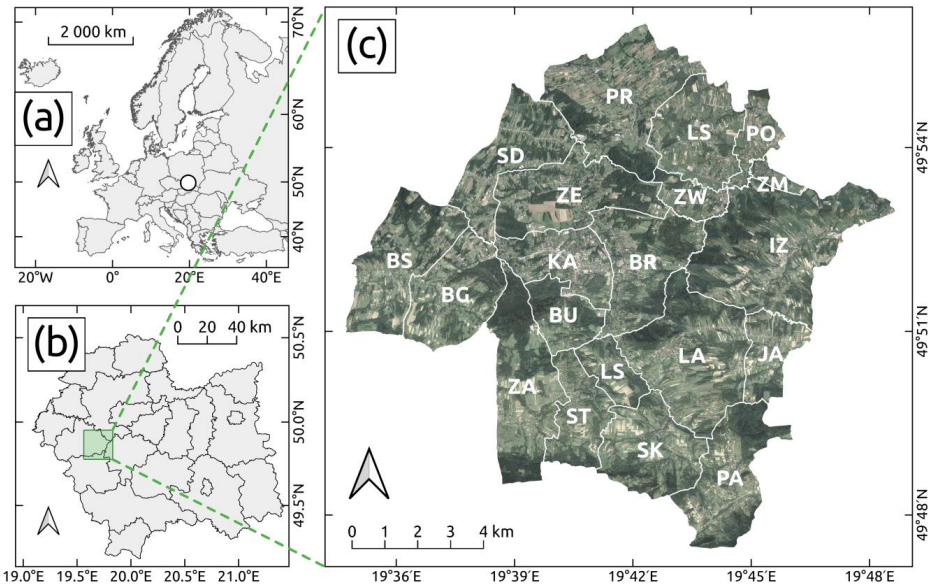


Figure 1. The study area against the administrative subdivision (**a**) in Europe, (**b**) in Małopolska Region and (**c**) against land cover visible in the aerial photo. Source: Centre for Land Surveying and Cartographic Documentation in Warsaw (licensed).

2.2. Data Processing

The study was carried out in several stages. The first stage included a field survey aimed at a preliminary analysis of the topography and land cover, the selection of the study area, and the selection of landmarks dominating in terms of height. The fieldwork involved site visits to all thirteen investigated objects. Historical and technical data were obtained from people who managed them to build their profiles. If no data were available in the documentation, physical measurements were carried out, including of the altitude of towers. GISs were used to determine the visual reach, viewshed (in km^2) of landmarks in a digital terrain model. The research area was about 140 km^2. Selected data in the form of characteristics of selected landmarks and determined area of the range of visibility (km^2) within the study area are summarised in Table A1 (Appendix A). Next, each visibility determined with GIS tools was confirmed in situ during a site visit and naked-eye assessment, which included confirmation of natural obstacles for view connections from buildings to landmarks. Inventory drawings of the buildings and view profiles were performed in the field to pinpoint the particular landmark view. Research of the literature on the subject and archival materials was carried out, i.e., DTM, and Austrian cadastral maps on which the distribution of buildings in the locality of Lanckorona around the market square and the streets leading to it were analysed with a religious landmark, a parish church in the north-western part (see Figure 2).

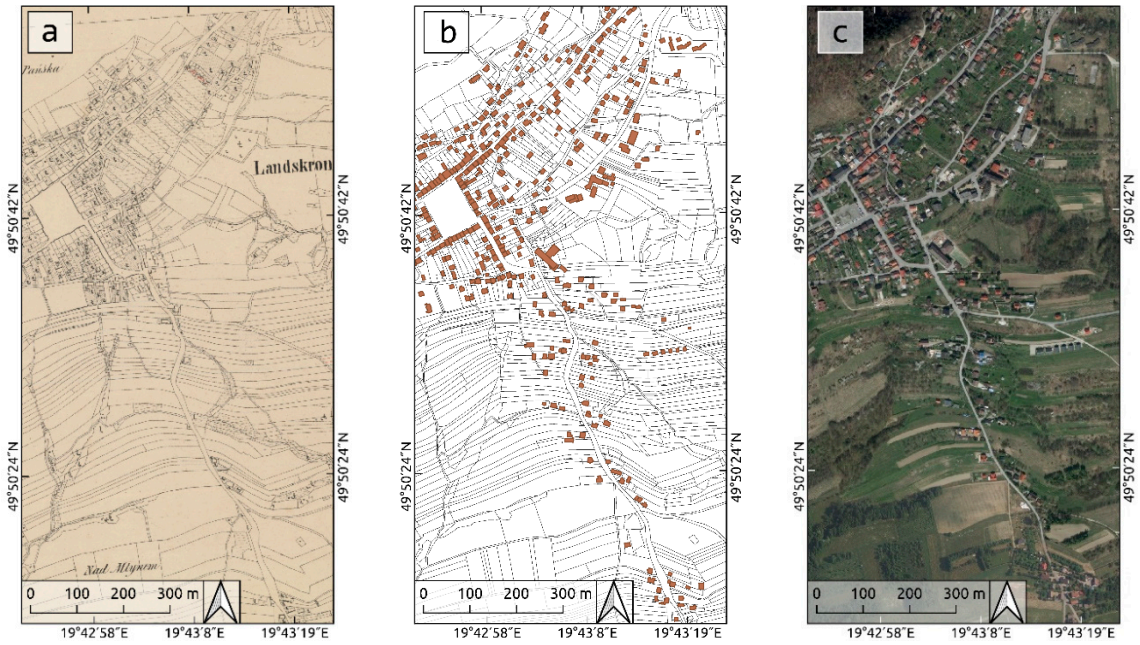


Figure 2. The historical spatial arrangement composed of fields, roads and buildings as a component of the rural cultural heritage. (**a**) A section of the Austrian cadastral map from 1846 presenting a landmark, i.e., a monastery in Lanckorona (Wadowitzer Kreis), and the characteristic small-town arrangement of buildings. Source: The National Archives in Kraków. (**b**) The current layout of buildings together with the current layout of cadastral plots. Source: own work based on DTO10k data. (**c**) An aerial photograph showing land cover forms. Source: Centre for Land Surveying and Cartographic Documentation in Warsaw (licensed).

The data were selected from the DTO10k, mentioned earlier. The data in the selected category did not need to be cleaned. They were saved in the geodatabase PostgreSQL + PostGIS format or other formats during computation. For the analysis, a digital terrain model (LiDAR DTM) with a resolution of 10×10 m, generalised from a detailed 1×1 m model, was applied (the 'elevation' parameter). The result processing technology is of high accuracy and considerably exceeds the needs [20]. The designated viewsheds were determined with an accuracy of up to 10 m in the field for the study area with a

diameter of approx. 15 km. The DTM used for the analyses has a vertical accuracy of the order of 0.15 m, and, it does not exceed 1 m following the generalisation of the basic assessment field (Figure 3). Geographic coordinates of the main landmarks in the study area were determined and projected onto the map (the parameter 'coordinate identifying the viewing position (x,y)'). Subsequent layers presented information on the compositions of view sheds, the topography, and the distribution of residential buildings. The information about buildings (including the functions of buildings) which are located within the visibility range of particular landmarks and secondary landmarks come from the Database of Topographic Objects (DTO10k). This database was built in Poland from 2012 to 2013, and includes units of administrative subdivision, transport network, water supply network, utility network, buildings, structures and facilities, complexes of land use, protected areas, and other objects. These data are provided in the GML format by the Centre for Land Surveying and Cartographic Documentation in Warsaw. The locations of the vertices of the buildings have been determined with the accuracy of 0.30 m. These parameters facilitated the development of a precise spatial model of the investigated features.

In the second stage, a statistical analysis of the current buildings was conducted to determine such parameters as the density and functions of buildings. Topography was analysed using advanced geoprocessing tools. The basic topographic landforms in the study area were classified. The literature specifies numerous landforms that can be identified based on the Terrain Position Index (TPI index), including streams, midslope drainages, upland drainages and valleys—grouped as 'Valleys'; 'Plains'; open slopes and upper slopes grouped as 'Slopes', and local ridges, midslope ridges and high ridges, grouped as 'Ridges' [21–23]. After preliminary analyses, the resolution of the model was decreased in order to limit the occurrence of sliver areas. This concerned the varied topography, and the occurrence of micro-landforms.

An analysis of the location of buildings in relation to landforms was conducted by generating centroids of the objects (the third stage). This ensured a clear allocation of objects in the case where a building overlaps borders of two zones. Buildings situated in multiple zones were indexed in each of them. Next, visual connections between buildings and landmarks and secondary landmarks were analysed based on a LiDAR DTM using spatial analysis. Geospatial analysis, together with elements of mathematics and statistics, highlights the vital role of GIS tools in the analysis of settlement phenomena in connection with landscape aspects [24].

The visual significance is influenced by the vertical dimension as well as the distance from the observer [25]. The height of each landmark was determined (the parameter 'viewing elevation above the ground'), with 3/4 of the height of the object adopted for calculations. The reason for such an assumption was the requirement of the clear field of view of the landmark, not just of its highest point (Figure 4). On the observer's side, an average human height reduced to the eye-level, i.e., 1.6 m was used (the parameter 'offset of target elevation above the ground'). The analysis was limited to 20 km around the landmark to ensure a hypothetical visibility of landmarks located on the edge of the study area in all places (the parameter 'maximum distance from the viewing point'). Due to the application of the above values, particularly the parameter 'offset of target elevation above the ground", the calculation of the landmark's viewshed is not affected by the occurrence of low vegetation, cropland, or bushes. The algorithm, however, does not eliminate high obstacles such as buildings or trees.

In the fourth stage, a statistical analysis was carried out for buildings (including the functions of buildings recorded in the Database of Topographic Objects (DTO10k) that are located within the range of visibility of particular landmarks and secondary landmarks. Based on the results of the viewsheds superimposition, the number of viewsheds covering the building was determined for each building. The method facilitated the quantitative aggregation of results and their statistical analysis.

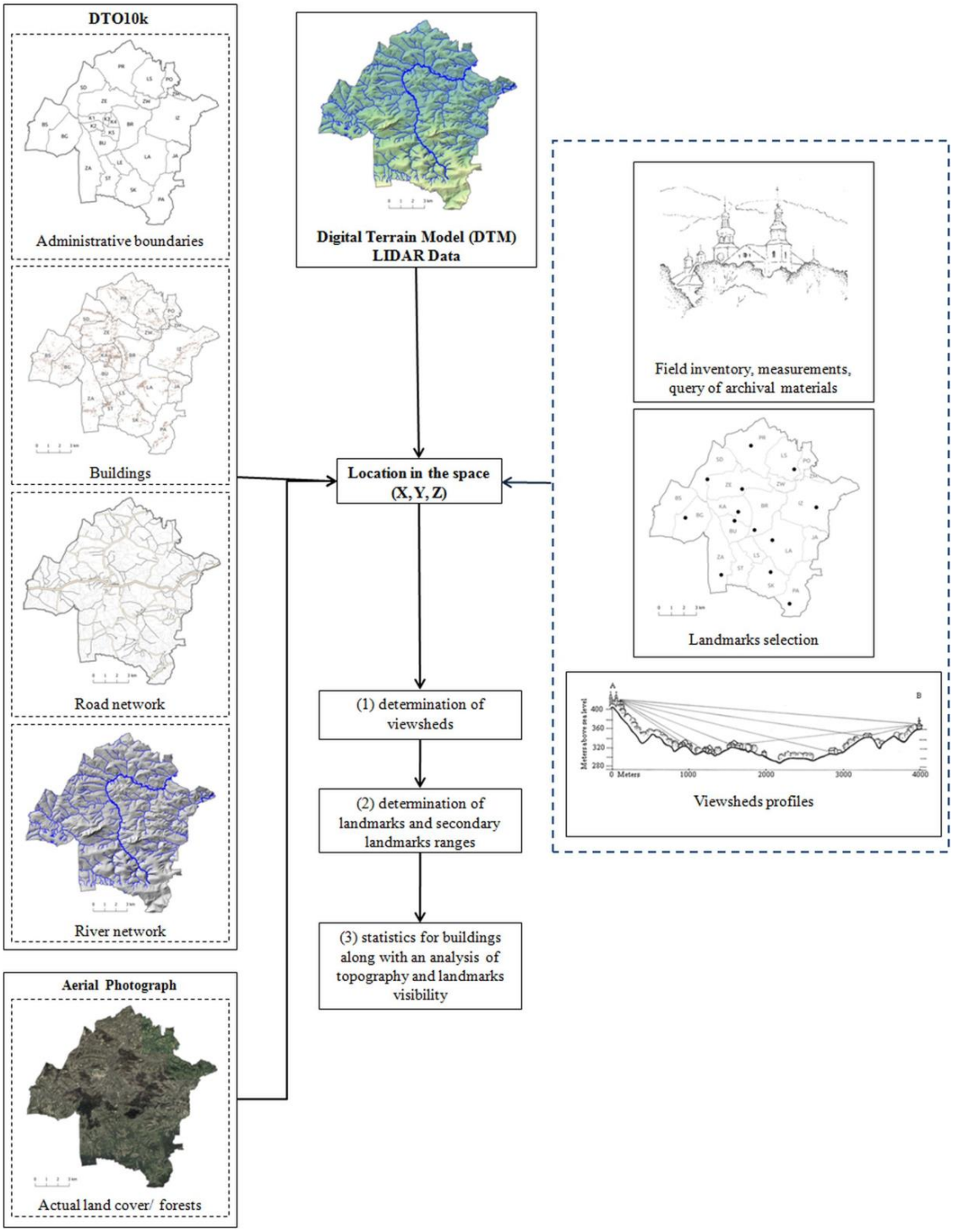


Figure 3. The general diagram of the research methodology and data used in the analysis, where DTO10k is the Database of Topographic Objects.

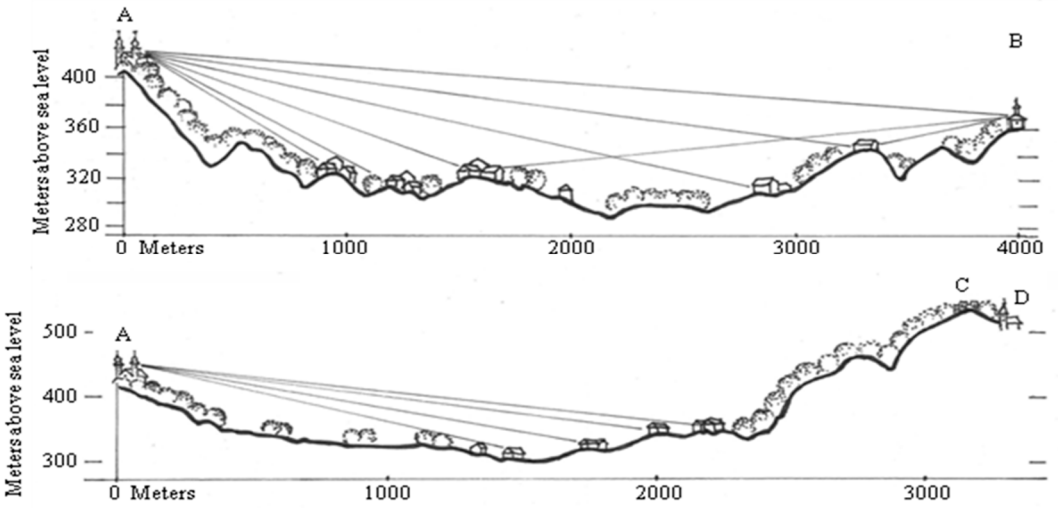


Figure 4. Viewsheds on the profile, from the main landmark to secondary landmarks, where A—a parish church in Kalwaria Zebrzydowska; B—a parish church in Stanisław Dolny; C—the Old Castle in Lanckorona; D—a parish church in Lanckorona. Source: own work based on DTM profiles.

3. Results

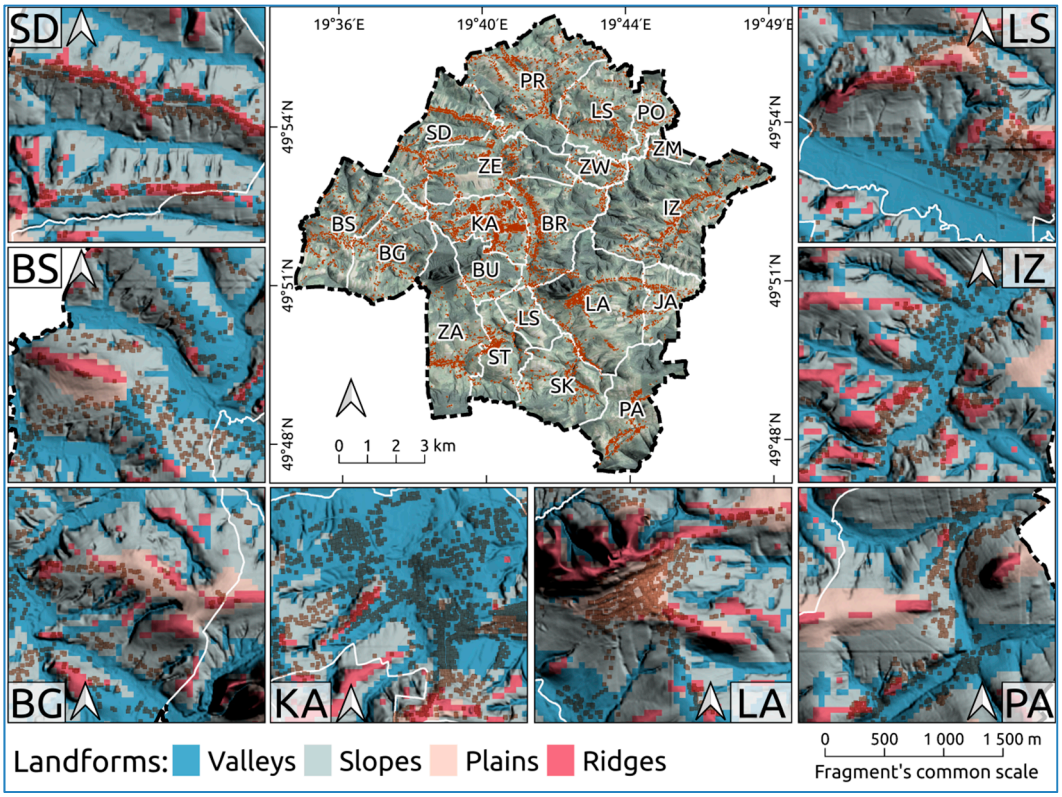
The field survey shows that the topography of the area is formed by rugged mountain ranges, hills, and valley bottoms, with cropland and residential buildings among them. Therefore, it was proven that religious buildings (churches) perform the function of landmarks in the investigated area best as they tower over residential buildings. They are typical objects of the Carpathian Foothills, which determine the identity and history of the region. They are located in the centres of localities, recognised by the local community, and characterised by a unique style, form, and appearance. They are often a local tourist attraction. Thanks to their excellent visibility, they facilitate orientation in the field. They determine the unique nature of the traditional sub-mountain landscape and are, therefore, perceived by the local community as the 'spirit of place' (genius loci), and build the landscape identity [10,26,27]. The religious landmarks selected for the analysis, i.e., churches (13) are objects built from the 17th to the 20th century. In the analysed area, the viewsheds for these landmarks vary from less than 46 km^2 for the locality of Kalwaria to less than 3 km^2 in the locality of Skawinki (see Table A1 in Appendix A). The most extended viewshed is noted for the oldest of the landmarks, i.e., the Bernardine Shrine of Passion and Holy Mary in Kalwaria Zebrzydowska.

The study area (140 km^2) has almost 15 thousand buildings. Most of them (60%) are single-family housing. Agricultural production buildings of microholdings make up 32.7% of the total number of buildings. The other building classes, i.e., commercial, industrial and technical, multi-family residential buildings, as well as tourism and hotel facilities, science, culture and healthcare, and religious buildings are 7.3% of the total number of all buildings (see Table A2 Appendix A).

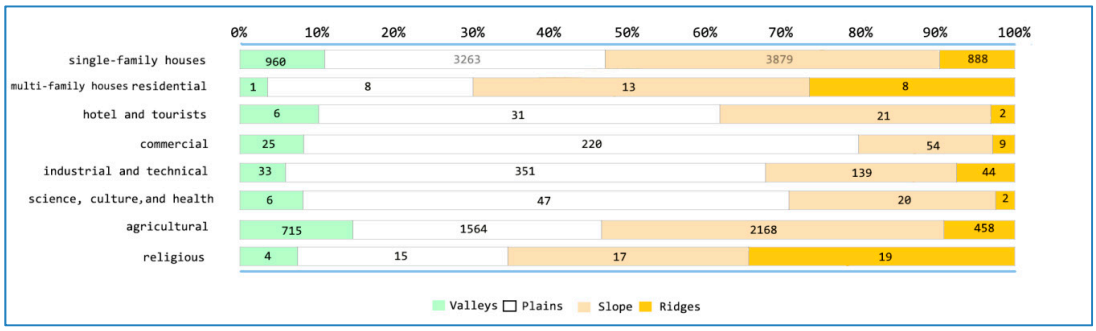
The most significant number of buildings of all functions was found on evenly sloped areas—42.1%, 36.7% in flat areas, 11.7% in valleys, 9.5% on hills. Single-family residential buildings were located mainly on slopes and in flat areas 79.4% and only 20.6% in valleys and on hills (Figure 5).

As regards single-family residential buildings, 7142 objects were located on slopes and in flat areas, which accounts for 79.4% of the total number of such buildings (Table A3 in Appendix A). Other types of buildings were characterised by a similar spatial distribution: multi-family residential, commercial, industrial and technical, agricultural, and science, culture and healthcare. For this type of development, economic aspects are much more important than landscape ones. It would appear that the location has a significant importance for the allure of tourism and hotel buildings. The study does not reflect this as buildings of this type were similar to single-family residential buildings. Tourism and hotel buildings were mainly located in flat areas and on slopes (a total of 86.7% of buildings with this function). Only 10.0% of tourism and hotel buildings were located in valleys, and as few as 3.3%, on

hills. The 19 objects marked as religious buildings were located mainly on hills and slopes (65.5%). Fifteen buildings (27.3%) were located in flat areas, and only 4 (7.3%) were located in valleys.



(**a**)



(**b**)

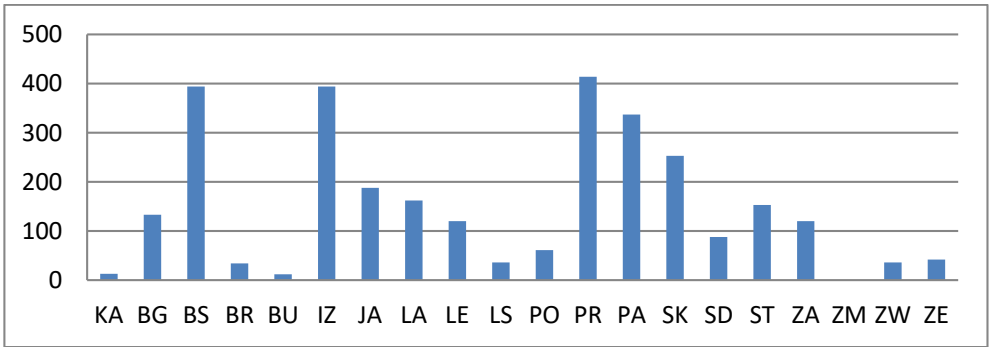
Figure 5. (**a**) A general map of landforms—classification of objects according to the TPI (Terrain Position Index) index-based landforms (example localities). (**b**) Distribution of buildings over landforms with consideration of building functions. The localities: KA—Kalwaria Zebrzydowska; BG—Barwałd Górny; BS—Barwałd Średni; BR—Brody; BU—Bugaj; IZ—Izdebnik; JA—Jastrzębia; LA—Lanckorona; LE—Leńcze; LS—Leśnica; PO—Podolany; PR—Przytkowice; PA—Palcza; SK—Skawinki; SD—Stanisław Dolny; ST—Stronie; ZA—Zakrzów; ZM—Zarzyce Małe; ZW—Zarzyce Wielkie; ZE—Zebrzydowice.

As demonstrated by detailed studies (Table 1, Figure 6), more than 80% of the 8893 single-family residential buildings located in the area had visual contact with at least one landmark. Visual contact with a landmark was not noted for only 19.95% of the buildings located in the area. As many as 35.29% of the buildings had visual contact with two landmarks, 19.84% with three, 11.22% with four, and as many as 4.22% with five landmarks.

Table 1. The percentage of visibility of a specified number of landmarks in the total number of single-family residential buildings.

Landmark Visibility	0		1		2		3		4		5		6	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
KA	13	0.7	121	6.3	406	21.1	684	35.6	671	34.9	27	1.4	0	0.0
BG	133	18.3	386	53.2	188	25.9	19	2.6	0	0.0	0	0.0	0	0.0
BS	394	49.7	253	31.9	127	16.0	16	2.0	2	0.3	0	0.0	0	0.0
BR	34	2.7	318	25.3	218	17.3	192	15.3	309	24.5	164	13.0	24	1.9
BU	12	4.0	114	38.3	160	53.7	0	0.0	9	3.0	3	1.0	0	0.0
IZ	394	31.7	393	31.6	421	33.9	35	2.8	0	0.0	0	0.0	0	0.0
JA	188	47.4	204	51.4	5	1.3	0	0.0	0	0.0	0	0.0	0	0.0
LA	162	12.8	682	54.0	285	22.6	68	5.4	15	1.2	11	0.9	28	2.2
LE	120	16.2	237	32.0	205	27.7	168	22.7	9	1.2	1	0.1	0	0.0
LS	36	21.1	100	58.5	25	14.6	1	0.6	4	2.3	5	2.9	0	0.0
PO	61	25.5	152	63.6	26	10.9	0	0.0	0	0.0	0	0.0	0	0.0
PR	414	32.1	497	38.6	232	18.0	121	9.4	16	1.2	2	0.2	7	0.5
PA	337	50.4	331	49.5	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
SK	253	45.5	189	34.0	99	17.8	12	2.2	3	0.5	0	0.0	0	0.0
SD	88	9.5	175	19.0	196	21.2	68	7.4	101	10.9	246	26.7	49	5.3
ST	153	28.9	345	65.1	28	5.3	4	0.8	0	0.0	0	0.0	0	0.0
ZA	120	16.9	528	74.5	57	8.0	1	0.1	3	0.4	0	0.0	0	0.0
ZM	0	0.0	25	30.9	46	56.8	10	12.3	0	0.0	0	0.0	0	0.0
ZW	36	12.8	113	40.2	67	23.8	44	15.7	21	7.5	0	0.0	0	0.0
ZE	42	4.7	127	14.1	181	20.1	238	26.4	115	12.8	174	19.3	23	2.6
Total	2990	19.9	5290	35.3	2973	19.8	1681	11.2	1278	8.5	633	4.2	131	0.9

The localities: KA—Kalwaria Zebrzydowska; BG—Barwałd Górny; BS—Barwałd Średni; BR—Brody; BU—Bugaj; IZ—Izdebnik; JA—Jastrzębia; LA—Lanckorona; LE—Leńcze; LS—Leśnica; PO—Podolany; PR—Przytkowice; PA—Palcza; SK—Skawinki; SD—Stanisław Dolny; ST—Stronie; ZA—Zakrzów; ZM—Zarzyce Małe; ZW—Zarzyce Wielkie; ZE—Zebrzydowice.



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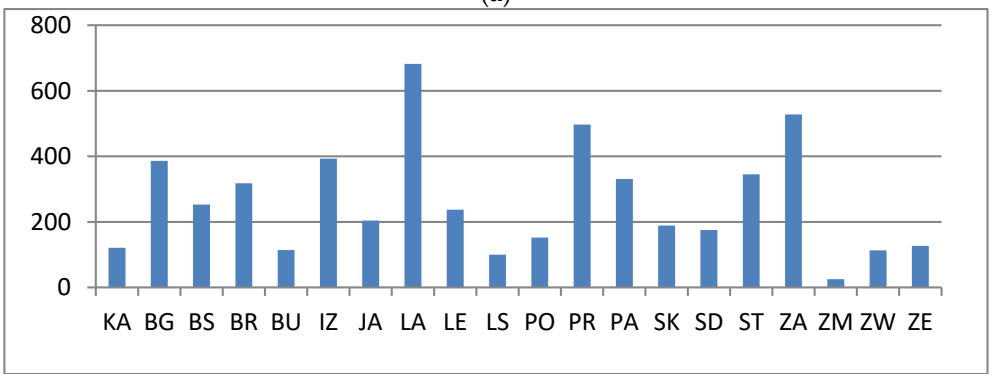
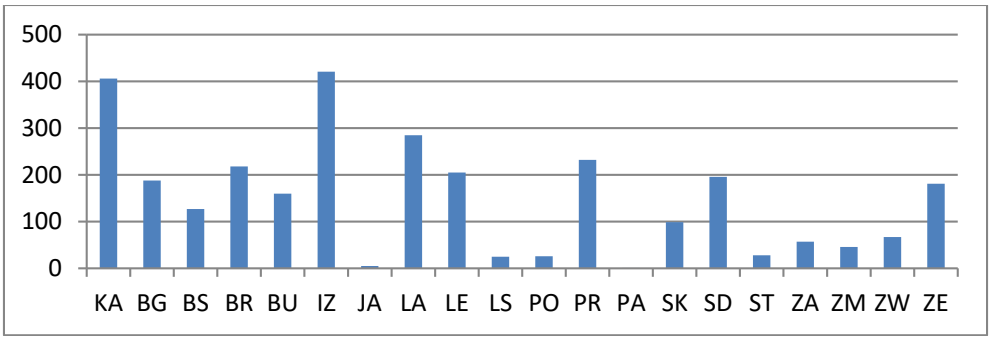


(b)

Figure 6. *Cont.*



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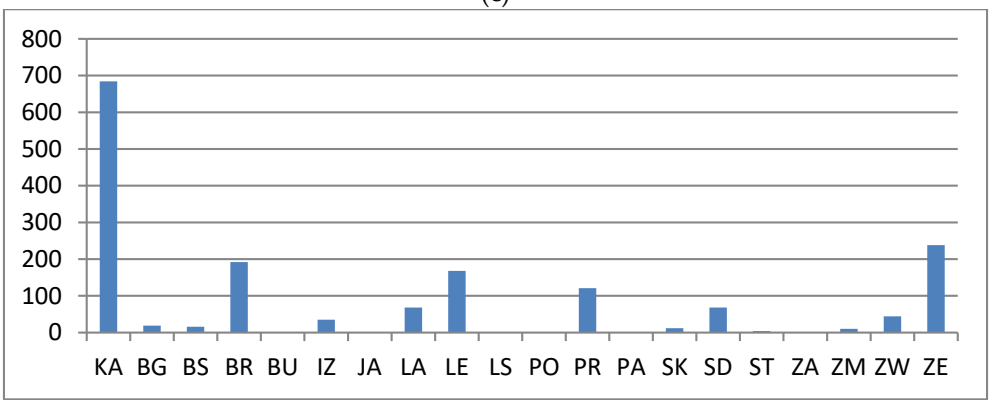

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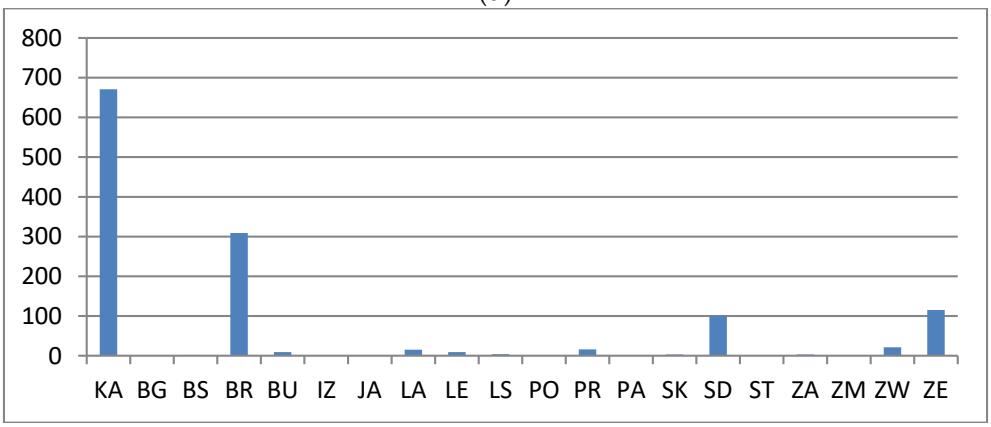

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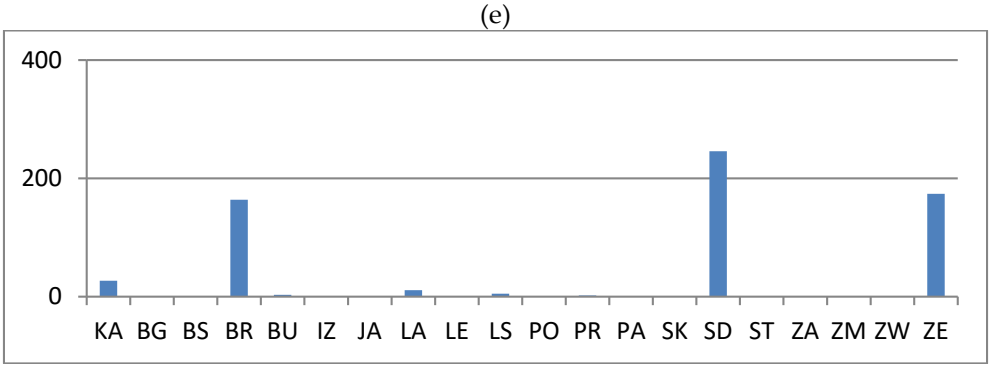

(f)

Figure 6. Comparison of visibility of landmarks from single-family houses in the analysed localities. The vertical axis shows the number of buildings, where (**a**) zero visibility of landmarks from single family houses; (**b**) one landmark visibility; (**c**) two landmarks visibility; (**d**) three landmarks visibility; (**e**) four landmarks visibility; (**f**) five landmarks visibility.

Figure 7 presents the shaded relief topographic map. The red stars indicate landmarks, including the landmark located in the area of one of the analysed objects in the village of Izdebnik. The viewshed for the height parameters of the Izdebnik (IZ) landmark is in light purple. Buildings, dark grey points, in this area are in the zone of the direct influence of the landmark.

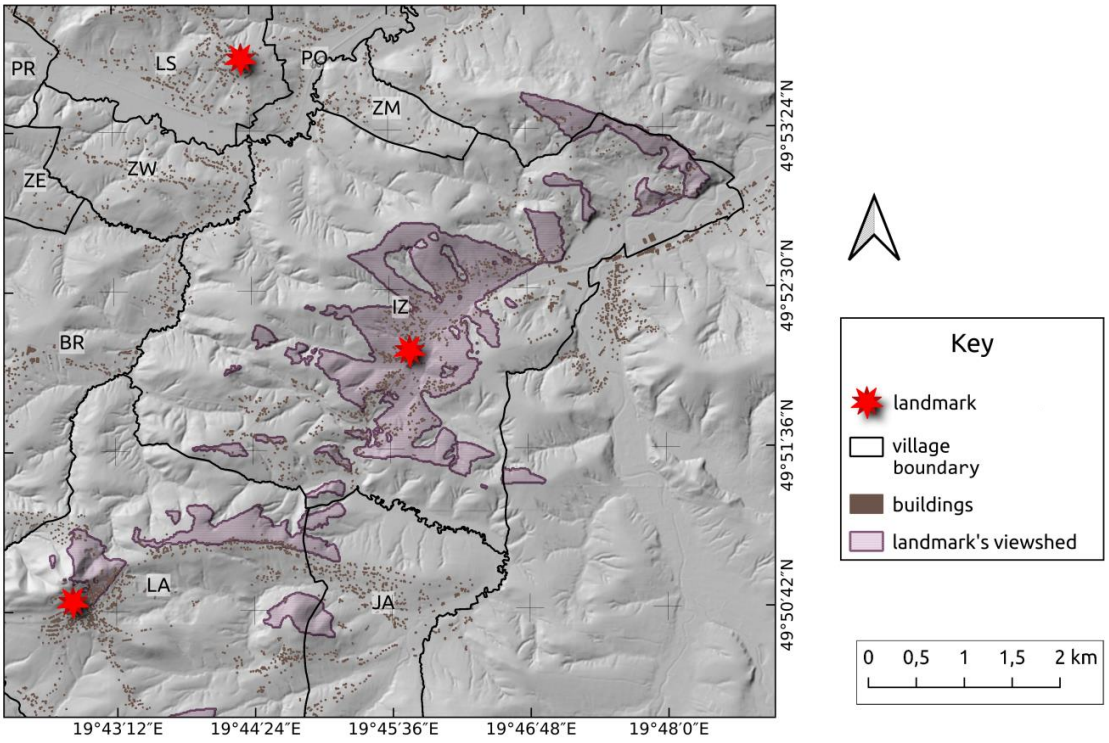

Figure 7. An example of a single viewshed of the Izdebnik (IZ) landmark.

Figure 8 presents the effect of the superimposition of several viewsheds on the study area. The localities with the most considerable number of visible landmarks include Kalwaria Zebrzydowska (KA), Zebrzydowice (ZE), Stanisław Dolny (SD) and Brody (BR). The highest proportion of buildings for which no landmark visibility was noted were found in the localities of Przytkowice (PR), Izdebnik (IZ), and Barwałd Średni (BS), which may result from the topography and the large proportion of high forest vegetation in the cover of the area. One hundred and one buildings in all the analysed places had an unobstructed view of six landmarks. Kalwaria Zebrzydowska (KA) is among the towns that stand out in terms of the landmark visibility. A detailed analysis with the use of LiDAR DTM and DTO10k data demonstrated that in Kalwaria Zebrzydowska (KA), only 13 (i.e., 0.7%) of the total number of buildings, i.e., 1922 did not have visual contact with any of the analysed landmarks or secondary landmarks, 6.3% of the buildings (121) had visual contact with one landmark, 21.1% (406) with two landmarks, 35.6% (684) with three landmarks, and slightly fewer, i.e., 34.9% of the buildings (671) had a contact with four landmarks. As many as 1.4% of the buildings (27) had visual contact with five landmarks (Figure 8).

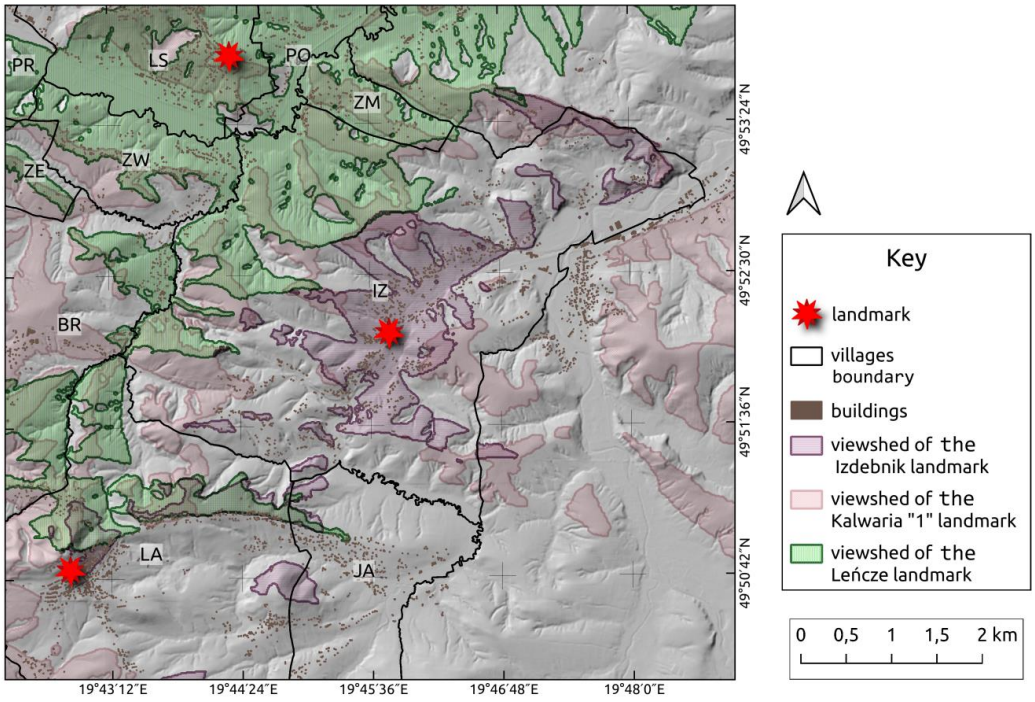

Figure 8. An example of multiple landmarks' viewsheds (landmarks in Izdebnik, Kalwaria and Leńcze).

4. Discussion

The analyses have demonstrated that in the area with long settlement history, improvements on land comprise several interconnected elements: land, buildings, and facilities made by inhabitants, which was confirmed by Heathcott [28] as well. The shape of a settlement unit, emerging from the composition of buildings and transport system together with the natural environment (relief), creates a functional whole developed over a specific time, specific space, and under specific physicogeographical and socioeconomic conditions [29,30]. As the case study demonstrates, view connections between buildings and landmarks are also an important part of the awareness of residents who shape their space There are well-known examples that show local interactions between human settlements and the natural environment [31,32], between ecosystem components and human societies [33], or urban settlements processes [26,34]. As early as the 19th century, humans were found not always to act reasonably when organising the space in which they live and work. The example in southern Poland shows that humans perceive the environment they live in at various levels, e.g., from the angle of cultural, religious, social, and other traditions, which was confirmed in a Norway study, for example [35]. The rural landscape, being a particularly valuable space in terms of cultural heritage, reflects the character of the environment, space, culture, and tradition—and as we can observe—of uniqueness and diversity [36].

Analysis of the locations of buildings suggests that they should be considered in terms of internal and external conditions (general location properties). As a place chosen based not only by physical and geographical factors but also by behavioural ones, i.e., the perception of a particular place and features of places particularly preferred by various social and cultural groups [12,37]. It has also been proven that with an increase in the number of buildings within a specific area, the attractiveness of the place increases, that is the aggregating element can be historical, religious, and other centres [38], as was demonstrated here with selected localities. A study into the dependence of the type of buildings in a location on a particular landform confirms theses which may appear obvious and be generally considered to be robust. The residential buildings are located in general in flat areas and on slopes, and, to a lesser extent, on hills and in valleys. Hotel and tourism buildings prefer flat areas followed by slopes. At the same time, commercial buildings and sports facilities were identified almost only in flat areas. There are surprisingly few buildings on hills where the potentially best landscape and viewing

conditions occur. The study suggests that cultural (religious) buildings are located mostly on hills. One can assume the fundamental prerequisite for their construction was excellent visibility from as far as possible. It made them inherently landmarks that determined the development in the investigated area. This supports the thesis suggested throughout the paper that landmarks played an essential role in building social bonds and relations, also in spatial terms. Hence the reference landform category that was not used for other classes, ridges.

Profiles and the viewsheds confirm the existence of visual connections between the landmarks selected for analyses. Besides, the cross-sections along the lines of viewsheds between landmarks confirm the previously presented studies according to which buildings are mainly found in flat areas and on small slopes [12,39]. The study has confirmed the crucial role of the tall landmark in the spatial and social structure of settlement units in relation to the concept of familiarity. According to this concept, a positive emotional connection can exist between a human and a place. A community living in the zone of influence of a tall landmark has a sense of being at home and provides the place with a host who cares for it [40]. This psycho-sociological perception of a place in a spatial-cultural space (considered as cultural heritage), can be considered a landscape identity [41].

The relationship with the visibility of landmarks may indicate an influence of the location of spatial landmarks on decisions concerning the location of homesteads taken by inhabitants [36]. The distribution of buildings in the area concerned is not random but, to a certain extent, ordered, and results from informed decisions of citizens and their perceptions and social valuation of landscape [42]. The analysis indicates an important relationship between human settlements and cultural landscape elements.

The area of ecumene has been continuously growing (which is indicated, among other things by the increasing number of buildings, in Poland particularly following the 1989 political transformation). Anthropogenic transformations occur within it. Each part of the settlement unit was subject not only to the influence of strictly determined factors but also random phenomena; however, as presented in the results, deliberate human influence also takes into account (more or less consciously) the cultural aspect in the development of buildings. The analysis of settlement localisations, conducted in the article, shows bonds between people and their surroundings (landmarks in this case) [43]. In addition, the studies presented in the article confirm that the high landmarks in southern Poland's landscape accentuate the space and make it more explicit by setting directions of viewsheds as the region's treasures [30,44]. Therefore, they can be considered an intangible component of the regional cultural heritage. It has been proven that in the analysed area, a landmark indicates the centre of a village's or a town's life and is a significant factor for spatial identification and orientation. Thus, it can be perceived as a determinant of the quality of both urban and rural space, a historical value, a spatial symbol, a specific identifier in the landscape space, and a means of conveying the identity [10,45]. It was noted that transport, visual, and cultural connections were being established between the distinctive objects (landmarks), which, while creating spatiotemporal relations, may influence the local identity of the areas [46,47], which is particularly evident in the Carpathian Foothills.

The role of landmarks may change over time, also due to significant changes and transformations of functional and spatial structures [47]. However, landmarks will always be a 'good continuation' in the development of landscape structures and the urban and architectural development of towns and villages. They are a factor that remains constant over time, which from a historical point of view, could have affected the shape and distribution of housing estates, as being the determinant of the location of individual buildings, not only in the past but also today.

5. Conclusions

The article confirms the fundamental statements of human geography according to which places interact with one another. A viewshed ensuring contact with a spatial landmark as an intangible aspect is a factor that plays an essential role in the location of residential buildings in the Polish sub-mountain area, which is confirmed by the geospatial analysis carried out for 20 settlement units.

According to the authors, this analysis can be used to carry out historical and compositional studies and landscape analysis for local zoning plans, which should be a future research. An analysis of a settlement and description of rural settlements from various perspectives are very important for the spatial planning and sustainable development of the settlement network as well as preservation of rural cultural heritage, particularly in highly developed countries where urban-to-rural migration trend is observed.

From the spatial point of view, this study facilitates the broadening of the scope of spatial analyses and settlement typology to include an abstract interaction between the settlement network and the cultural landscape, represented in this case by landmarks. At the policy level, the proposed approach requires the consideration of all significant natural and human components and their interaction at a specific place and time in the settlement network creation. It should be taken into account that a phenomenon observed and researched on a local and regional scale may manifest itself on a global scale as well. On the other hand, an analysis of the settlement structure perceived in the context of visual connections is a part of the morphogenesis of settlement units, explaining the concept of geographical space development.

Although it may be a priori assumed that many of the new buildings did not consider the landmark visibility factor, the present study representing the bulk approach to the calculation of the number of landmarks visible from each building in the investigated area clearly indicates that such a relationship exists. This conclusion is also confirmed by the analysis of the mutual distribution of residential buildings and their concentration around the landmark. As the distance from a landmark and village centre increases, the dispersion of residential buildings can be noticed as well as maintaining the visual contact with the landmark, which can confirm its emotional and aesthetic influence on residents.

The present study may indicate well-thought-out, planned, or designed activities or only an approach unconsciously applied by residents, related to the use of landmarks as a borrowed view, where a part of the landscape (view) or panorama located outside the boundaries of one's property (often a garden) is incorporated into the composition interplay. The study confirmed the particularly good visibility of landmarks from Kalwaria Zebrzydowska, which can be attributable to the monastery established there in the 17th century as well as the landscape pilgrimage park (Kalwaria was listed as a UNESCO heritage site in 1999). One of the ideological assumptions for Kalwaria was to form a harmonious combination of religious facilities (the monastery, shrines) while maintaining visual connections between them. This principle could be continued by inhabitants of the localities established in the vicinity of the monastery. Thus, it could strengthen and emphasise the significance of the religious zone and its influence on the nearby localities. The protection of the cultural landscape of historical rural systems requires that their most valuable features should remain clear, and the new elements should be coherent with them.

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Appendix A

Table A1. Examples of analysed landmarks and secondary landmarks.

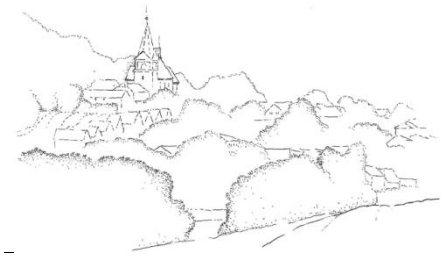
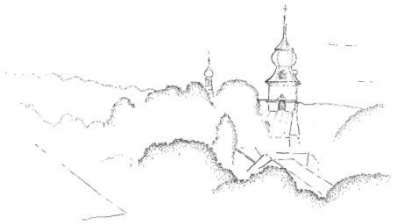
No.	Object/Landmark Visibility Sketch	Characteristics of Selected Landmarks	Determined Area of the Range of Visibility [km^2] within the Study Area
1		The Bernardine Shrine of Passion and Holy Mary in Kalwaria Zebrzydowska UNESCO list (1999); built between 1600 and 1617 Elevation incl. the tower: 405 + 35 = 440 m ASL	45.981
2		Lanckorona—a parish churchBuilt in 1649 Elevation incl. the tower: 488 + 30 = 518 m ASL	20.486
3		Izdebnik—a parish church Date of establishment: 1838–1841 Elevation incl. the tower: 270 + 22 = 292 m ASL	5.333
4		Brody—a parish church Date of establishment: 1615–1642 Elevation incl. the tower: 319 + 20 = 339 m ASL	9.085

Table A1. *Cont.*

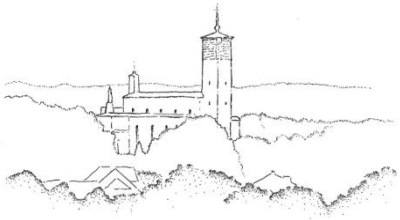
No.	Object/Landmark Visibility Sketch	Characteristics of Selected Landmarks	Determined Area of the Range of Visibility [km^2] within the Study Area
5		Przytkowice—a parish church Date of establishment: 1948–1953 Elevation incl. the tower: 293 + 27 = 320 m ASL	8.675
6		Leńcze—a parish church Date of establishment: 1931–1938, Date of tower establishment: 1958–1959 Elevation incl. the tower: 325 + 27 = 352 m ASL	14.739
7		Skawinki—a parish church Date of establishment: 1733 (1962–1964) Elevation incl. the tower: 379 + 20 = 399 m ASL	2.989
8		Zebrzydowice—a parish church Built in 1620 Elevation incl. the tower: 281 + 20 = 301 m ASL	12.615

Table A2. Characteristics of the functions of buildings in the investigated area.

Buildings' Functions	SFR	MFR	HTF	OF	CS	RST	GIW	SCH	AF	R	ONR	Total
KA	1090	98	19	18	93	4	245	17	328	9	1	1922
BG	447	0	0	2	9	1	22	2	241	2	0	726
BS	436	0	0	1	4	0	30	2	318	0	1	792
BR	827	6	17	7	32	0	64	2	296	7	1	1259
BU	175	0	0	2	0	0	5	1	96	19	0	298
IZ	693	3	3	5	29	0	37	5	464	3	1	1243
JA	237	0	0	1	3	0	1	3	152	0	0	397
LA	770	4	12	9	5	0	17	8	433	4	1	1263
LE	469	3	0	2	8	1	8	4	243	2	0	740
LS	92	0	0	0	1	0	3	0	75	0	0	171
PO	135	0	0	0	2	0	0	1	101	0	0	239
PR	762	1	0	3	30	1	36	10	444	2	0	1289
PA	335	1	0	0	4	0	4	2	322	1	0	669
SK	314	1	0	1	1	0	3	1	234	1	0	556
SD	583	1	0	1	5	0	41	2	287	2	1	923
ST	338	1	0	2	3	0	3	6	177	0	0	530
ZA	379	3	5	1	6	1	12	4	297	1	0	709
ZM	49	0	0	0	0	0	0	1	31	0	0	81
ZW	182	0	2	1	2	0	1	1	92	0	0	281
ZE	580	5	2	2	4	0	34	3	268	2	0	900
Total	8990	127	60	58	241	8	566	75	4905	55	6	14,990

Where buildings' functions: SFR—single-family residential housing, MFR—multi-family residential, HTF—hotels, tourism facilities, OF—offices, CS—commercial and service, RST—railway stations and terminals; GIW—garages, industrial and warehousing, SCH—science, culture and health; AF—agricultural farms; R—religious ONR—other non-residential purposes. The localities: KA—Kalwaria Zebrzydowska; BG—Barwałd Górny; BS—Barwałd Średni; BR—Brody; BU—Bugaj; IZ—Izdebnik; JA—Jastrzębia; LA—Lanckorona; LE—Leńcze; LS—Leśnica; PO—Podolany; PR—Przytkowice; PA—Palcza; SK—Skawinki; SD—Stanisław Dolny; ST—Stronie; ZA—Zakrzów; ZM—Zarzyce Małe; ZW—Zarzyce Wielkie; ZE—Zebrzydowice.

Table A3. Building types according to landform classes.

Buildings' Types	Valleys		Plains		Slopes		Ridges	
	No	%	No	%	No	%	No	%
SFR	960	10.68	3263	36.30	3879	43.15	888	9.88
MFR	1	0.01	8	0.09	13	0.14	8	0.09
HTF	6	0.07	31	0.34	21	0.23	2	0.02
CS	25	0.28	220	2.45	54	0.60	9	0.10
IT	33	0.37	351	3.90	139	1.55	44	0.49
SCH	6	0.07	47	0.52	20	0.22	2	0.02
AF	715	7.95	1564	17.40	2168	24.12	458	5.09
R	4	0.04	15	0.17	17	0.19	19	0.21

Where buildings' functions: SFR—single-family residential housing, MFR—multi-family residential, HTF—hotels, tourism facilities, CS—commercial and service, IT—industrial and technical, SCH—science, culture and health; AF—agricultural farms; R—religious.

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