APPLICATION OF DATABASES IN LANDSCAPE AUDIT FOR COMPREHENSIVE IDENTIFICATION AND ASSESSMENT OF POLISH LANDSCAPES

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Abstract

The purpose of the paper is to describe the principles of modern landscape policy as a subsystem of Polish and EU spatial policy. Landscape policy consists in the publication of spatial information, organized hierarchically (from the local level, to regional, national, and European). The legal instrument for landscape protection in Poland is landscape audit, provided for in the new Landscape Act (Journal of Laws: Dz. U. 774, 2015). The audit is a specialist report on the state of landscape, developed using GIS systems, based on the available cartographic and written material, with verification in the field. Space technicization is becoming a reality due to the widespread use of GIS tools. This includes guidelines for creating and modeling landscape data, based on the INSPIRE Directive, among other things. Encoding landscape characteristics and processes into a formal language of mathematics and informatics may raise questions about the completeness of such information. Therefore, in order to avoid formal errors, we have verified the resources and assessed the utility of cartographic resources used at all stages of the audit process.

Key words: *spatial policy, landscape audit, landscape identification, spatial assessment, data base, cartographic materials*

Background

The current legal provisions are a direct result of Poland's new landscape policy, initiated by the country's signing and ratification of the European Landscape Convention (2004). Spatial policy is an important area of focus for the EU, aiming at ensuring consistent and sustainable spatial development in the member states, while simultaneously protecting and strengthening their individual natural and cultural heritage. The Convention sets goals and directions of the EU spatial policy and requires all parties to adjust their policy (on the local, regional, and national levels) to the commonly accepted principles of landscape protection and management. (EUROPEAN LANDSCAPE CONVENTION, 2000). In accordance with the Convention, "Landscape" means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". "Landscape policy" means an expression by the competent public authorities of general principles, strategies and guidelines that permit the taking of

specific measures aimed at the protection, management and planning of landscapes (EUROPEAN LANDSCAPE CONVENTION, 2000, Chapter I, p. 2). This requires the development and implementation of instruments for the identification, assessment and protection of valuable, or "priority", landscapes.

In Poland, the primary legal instrument for landscape protection is landscape audit, provided for in the new Landscape Act (JOURNAL OF LAWS: Dz. U. 774, 2015). This is a particular kind of a report on the state of Poland's space, comprising a comprehensive description and assessments of all the landscapes of the country. The purpose of the audit is to identify the priority landscapes for protection. Each audit stage is based on an analysis of cartographic and written material, verified in the field. All applicable cartographic and written resources were listed in the landscape audit guidelines (SOLON et al., 2014). However, at the stage of methodology testing, the utility of all resources for particular stages of audit was verified (MYGA-PIĄTEK et al., 2015). This helped refine the scope of cartographic and written materials in the context of audit procedure requirements.

The purpose of the article is to analyze and assess the utility of cartographic data sets, written materials, and GIS tools at each stage of landscape audit.

Pro-landscape solutions and landscape protection instruments in selected European states

In many European states, legal instruments for landscape protection have been in place for years. This includes guidelines for creating and modeling landscape data based on the INSPIRE Directive (SALATA, MYGA-PIĄTEK, 2015).

In Germany, there are two legal acts concerning landscape quality: the federal Act of 1976 on nature protection and landscape management applicable and enforced nation-wide (RASZEJA, 2013), and the Act on nature protection, landscape care, and outdoor recreation opportunities applicable on the federated state level (BÖHM, 2008). The separation of competences in landscape policy into two levels of spatial management gave rise to a model for spatial planning (large-scale spatial development principles, federated state planning, local spatial planning) (KWARTNIK-PRUC, PRZEWIĘŹLIKOWSKA, 2007). On the federal (national) level, a non-binding Spatial Policy Plan has been developed. On the federated state level, there are State Development Plans and Regional Plans. The bottom level of spatial management concerns communes, with their Land Use Plans (equivalent in scale to topographic maps) and Development Plans (large-scale, equivalent in scale to master maps) (IZDEBSKI et al., 2007).

Landscape law is well-developed in Spain. The administrative units in charge of landscape management are regions, for which landscape catalogs and landscape guidelines are drawn up (NOGUE, SALA, 2006). Exemplary regions in terms of landscape guideline application include Valencia and Catalonia, of which the latter has established a dedicated body called the Landscape Observatory. Landscape protection laws are also in force in Galicia, Castile, and the La Mancha region (CASADO-ARZUAGA et al., 2014).

France is another example of well-functioning landscape law. The basic legal act there is the Act of 1993 on landscape protection and management, but the most important pro-landscape document is the Urban Planning Code. It comprises a set of rules and principles for practices of landscape protection, management, and planning (WOJCIECHOWSKI, 2008). Under urban planning laws, the so-called Territorial Coherence Schemes (French: SCOT) regulate planning considerations on the regional level. On the local level, the same role is played by Local Urban Plans (French: PLU) (TOKARCZYK-DOROCIAK, JANKOWSKA, 2014). Another interesting solution in terms of architectural and urban planning is the introduction of an annex called volet paysager, comprising a graphical representation of the way an investment fits into the surrounding landscape (WIŚNIEWSKA, 1997). Beside their graphical function as investment visualizations in documentation, the annexes are also a landscape planning instrument, enabling verification of an investment's impact on landscape quality and ensuring that investments with a negative impact are not implemented.

In this context, Poland is just initiating its active and legally regulated processes for assessing landscape potential, monitoring threats, and introducing guidelines and recommendations for the protection of identified valuable landscapes.

Methods for evaluating cartographic and written materials and GIS tool utility for spatial studies in literature

Multiple researchers have undertaken evaluations of both analog and digital cartographic resources. Most papers report quality assessment and verification of Internet portals comprising spatial data resources. D. DUKACZEWSKI (2007) evaluated the spatial data portals of Poland's provinces in terms of function and subject scope. On the county and commune levels, geoportal resources were analyzed by E. B. KOZUBEK and P. WERNER (2009), and M. SIEJKA and M. ŚLUSARSKI (2014), based on the authors' own

criteria. The utility of land surveying and cartographic documentation for creating a spatial data infrastructure was evaluated by W. IZDEBSKI (2007). J. BAC-BRONOWICZ et al. (2008) described a concept for an online geoinformation portal comprising reference and thematic data. M. L. HUGHES et al. (2005) evaluated the accuracy of orthophotomaps, and J-F. MAS et al. (2004) evaluated a geoportal presenting surface changes in Mexico. Despite the increasingly common use of digital cartographic materials, E. KRZYWICKA-BLUM (2003) evaluated the current utility of maps (developed in accordance with the latest standards and using the latest technologies). Ł. WITCZAK (2016) evaluated the utility of spatial data for Environmental Impact Assessments prepared for agricultural projects.

A theoretical study on assessment criteria for spatial data was published by H. VEREGIN (1999), while B. P. BUTTENFIELD (1993) devoted her paper to the quality and representativeness of spatial data. Aspects of source data quality, both for traditional paper maps and digital maps, were defined by J. WOLSKI, including accuracy, cartometricity, fidelity, completeness, readability, and currency. J. NITA and U. MYGA-PIĄTEK (2012) proposed their criteria for quality assessment of historical maps, including as the most important: cartometricity, content scope, map key, technical quality, graphics and colors, labeling, and composition. Based on the proposed criteria, the authors analyzed historical cartographic resources from the Częstochowa Uplands.

Landscape audit is performed based on GIS standards. GIS software is commonly used for landscape analysis studies in the West. O. BENDER et al. (2005) used GIS tools to analyze landscape changes in Germany. Quality of digital databases was discussed by N. R. CHRISMAN (1999), and C.C. Petit and E. F. LAMBIN (2002). Historical map analysis using GIS software was performed by D. RUMSEY and M. WILLIAMS (2002), F. KIENAST (1993), and I. N. GREGORY (2005). In Poland, GIS tools were used for landscape analysis by a number of authors, including: J. WOLSKI (2007), K. OSTAFIN (2009), M. SOBALA (2012, 2016), J. NITA and U. MYGA-PIĄTEK (2012), K. PUKOWIEC-KURDA and M. SOBALA (2016) and A. AFFEK (2016).

Landscape audit methodology testing

Landscape audit comprises a descriptive part and a graphic part. The descriptive part is performed using GIS standards, and comprises a series of consecutive stages:

- landscape identification;
- identified landscape characterization;
- landscape value assessment;
- priority landscape identification;
- description of threats to priority and protected landscapes;
- recommendations and conclusions regarding priority landscape management and protection;
- prescribing local architectural forms for priority landscapes.

The graphic part involves developing a map of identified landscapes, and a location map of priority landscapes and previously protected areas. The maps are developed in the regional scale — 1:50,000. Each stage listed above uses databases and cartographic resources detailed in the audit guidelines (SOLON et al., 2014), tested for utility in the audit process by the methodology testing team (MYGA-PIĄTEK et al., 2015).

The methodology of landscape auditing using GIS methods was tested between July and November 2015, and the resulting report has been published on the General Directorate for Environment Protection (Polish: GDOŚ) website. The test goals included verifying the availability and quality of cartographic and written material. Due to the nature of the audit (that concerns the current state of landscape), the currency of cartographic materials was one of the primary selection criteria. The process of acquiring the cartographic materials was complicated, and the materials themselves varied in terms of currency, completeness and utility for landscape audit; therefore, the need was identified to evaluate and describe the cartographic and written materials used in the audit process. The present paper evaluates the resources useful for the GIS audit, omitting resources not used at any auditing stage. According to the Polish Surveying and Cartography Law, the national surveying and cartographic resources are "data sets maintained in accordance with the applicable Act by the Surveying and Cartography Service; cartographic materials, registers, records, and lists based on these data sets; documentation of surveying or cartographic work results or documents produced through these works; and aerial and satellite images".

Use of GIS software in the Polish landscape audit procedure

GIS methods are essential at all stages of landscape audit. Most materials necessary for the audit are available in GIS systems as raster graphics (mainly maps) or vector layers (digital elevation databases and maps produced in accordance with modern standards). At the province landscape identification stage,

landscapes are delimited in a newly created layer in the GIS software (landscape units are determined based on uniform background, which in practice means uniform surface and land use). The attribute table is populated with information on landscape type and subtype, and location relative to physico-geographic regions defined by J. KONDRACKI (2011), natural landscapes defined by A. RICHLING and A. DĄBROWSKI (1995), geobotanical regions defined by J. MATUSZKIEWICZ (1993), and cultural and historical regions defined by J. PLIT (2016). Additionally, the surface area and circumference of all landscapes is calculated automatically.

At the landscape characterization stage, focusing on natural and cultural assets, all the available vector data are processed using dedicated tools (cropping and adjusting to borders of administrative units and identified landscapes, attribute- or location-based selection), and the recorded resources not available in digital databases undergo on-screen digitization and are saved as new layers. All the natural and cultural assets of the landscapes are saved as layers in the .shp format, making up the digital data resource for the landscape audit.

Subsequently, the basic landscape metrics are calculated — the operation is required for priority landscapes, and optional for the remaining landscapes. These include the surface diversity and the spatial integrity. Surface diversity is measured using the Shannon Diversity Index (SHDI). The value of SHDI depends on the number of classes and degree of its coverage (URBANSKI, 2012). In turn, the spatial integrity of landscapes can be determined by the Eurel number. The Eurel number based upon the difference between the number of fragments and the number of perforations (BOGAERT et al., 2002). One example of freeware software for landscape metrics calculation is FRAGSTAT. Its use has been described by: K. MCGARIGAL with B. MARKS (1994), J. WU, W. SHEN, W. SUN, P. T. TUELLER (2002), M. C. NEEL, K. MCGARIGAL, S. A. CUSHMAN (2004), C. HUANG, E. L. GEIGER i J. A. KUPFER (2006) and J. URBAŃSKI (2012). ArcGIS license holders can also install a dedicated V-late add-on for the software.

Methods for evaluating source materials used in landscape audit

Based on the vast body of research on evaluation methods for cartographic and written resources and GIS tools, cited above, and considering the purpose and procedure of landscape auditing, which is the primary landscape protection instrument in Poland, we propose a two-stage evaluation of the materials. The first stage involves a descriptive characterization and qualitative assessment of the cartographic and written materials used in landscape audit testing, while the seconds stage involves their quantitative evaluation based on selected criteria.

Based on experience from landscape audit methodology testing, the resource evaluation criteria mainly focused on the utility of the resources for each stage of the process. The currency of the cartographic and written materials was also a priority, as up-to-date information allows for identifying the current landscapes of Poland (Chmielewski, et al., 2015). We analyzed all materials used in landscape audit methodology testing, i.e. both cartographic materials and written resources (including: historic monument registers and files, remembrance site lists, nature protection form documentation, local zoning plans).

In the qualitative assessment of cartographic and written materials, the following criteria were used (table 1):

- origin of the resource — the institution that owns and maintains the resource and holds use rights to the resource;
- availability of the resource — information on charges for use of the materials and possibility of obtaining the materials free of charge for landscape audit purposes;
- currency — time of origin of the data, which may differ from the publication date of the resource;
- additional information — information found in digital databases as text in object attribute tables, typically concerning the time of construction of an object, its size, architectural style, or less commonly, state of repair;
- audit stage — the stage of landscape audit where the resource is used;
- accuracy and completeness of the resource — information verified based on field work and current orthophotomap analysis, concerning the number of items missing from the resource, which reflects the accuracy and currency of the resource;
- utility — information about whether the resource is considered obligatory (primary material), complementary, or unnecessary;
- data model type — vector or raster.

At the second stage (table 2), the source materials used in landscape auditing were rated on a 1 to 5 scale, based on the degree to which they fulfill the set criteria. The criteria included: utility for audit

purposes, data currency, data accuracy, level of detail, and availability. The scales are described in detail in table 2. The evaluation was performed from the point of view of the landscape auditing entity, having free access to the cartographic materials, as opposed to natural persons using the materials for other purposes, in which case the same materials are available for a charge.

Evaluation results for the cartographic and written materials used in audit

For the landscape auditing entities, the primary resource for identifying current landscapes in the provinces, determining the natural and cultural assets present, and identifying priority landscapes, are cartographic materials that are as up-to-date as possible. However, most information regarding the assets of the landscapes, especially cultural ones, is contained in lists, registries, and records maintained by local government units, and in commune administration documents (e.g. local zoning plans). Though these do not contain direct spatial references, they are typically complemented with location information (address). This requires the creation of a new spatial database in the GIS software and the transfer of these items to this database — but the information is essential in the audit procedure. Table 1 lists the cartographic and written materials used in landscape audit methodology testing with their descriptive characteristics.

Table 1. Stage 1 — qualitative assessment of the cartographic and written materials used in landscape audit

CARTOGRAPHIC MATERIALS (MAPS, ORTHOPHOTOMAPS, DEM, GEOPORTALS, SPATIAL DATA)								
Source	Origin (publishing and managing institution)	Availability (general or restricted, free or paid)*	Currency (time of origin of data)	Additional information	Use in audit	Accuracy and completeness	Utility	Data model
BDOT10k	CODGIK	free of charge for audit purposes — for other purposes for a charge of 2 PLN/km²	2012-2013	age, type, size for some layers	identified landscape characterization	requires amendment and updating	obligatory	vector
BDOO	CODGIK	free of charge	2012-2013	age, type, size for some layers	identified landscape characterization	generalization of the BDOT10k (does not match the audit scale)	unnecessary	vector
1:50,000 geoenvironmental map of Poland	PIG-PIB	free of charge	2002-2003	geological information	identified landscape characterization	requires updating	complementary	vector and raster
Orthophoto map	CODGIK	free of charge for audit purposes — for other purposes for a charge of 2 PLN/km²	2009-2016	none	landscape delimitation, type identification, identified landscape characterization	satisfactory	obligatory	raster
1:50,000 topographic map	WODGIK	free of charge for audit purposes — for other purposes for a charge of 10 PLN/sheet	1991-1996	none	identified landscape characterization	requires updating	complementary	raster
Digital Elevation Model	CODGIK	free of charge for audit purposes — for other purposes for a charge of 2 PLN/km²	2000-2010	none	landscape delimitation	varies accuracy according to area	complementary	vector
Digital Surface Model	CODGIK	free of charge for audit purposes — for other purposes for a charge of 2 PLN/km²	2010-2017	none	landscape delimitation	varies accuracy according to area	obligatory	vector

Map of Nature Protection Forms	GDOŚ/RDOŚ	free of charge	updated contin-uously	names, surface areas, habitat types	identified landscape characterization	satisfactory	obligatory	vector and raster
Digital Forest Map	State Forests	free of charge	2010-2015	age, type of forest community economic information, health condition	identified landscape characterization	satisfactory	obligatory	vector
VMap Level 2	WODGIK	free of charge for audit purposes — for other purposes for a charge of 87,50 PLN/double sheet	date of map execution, but date of origin is earlier	age, type of object, object size, name	identified landscape characterization	requires amend-ment	comple-mentary	vector
INSPIRE Geoportal 2	GUGIK	free of charge	updated continuously	name of object, number ID form NID base, date of discovery	identified landscape characterization	requires amend-ment	comple-mentary	raster
OTHER ONLINE RESOURCES (REGISTERS, LISTS, WRITTEN MATERIALS)								
Historic Monument Register	Provincial Monument Preservation Officer	free of charge	updated continuously	age, architectural style, address	identified landscape characterization	Source satisfactory, obligatory		list
Commune Monument Records	communes	free of charge	updated continuously	address, age	identified landscape characterization	Source satisfactory, obligatory		list
Remembrance Site Records	province administration	free of charge	updated continuously	address, picture, characteristics	identified landscape characterization	Source satisfactory, obligatory		list
Historic Monument Preservation Program	communes	free of charge	updated continuously	age, architectural style, state of repair	identified landscape characterization	Source satisfactory, complementary		text resource
Local Zoning Plan	communes	free of charge	depends on date of establishment	information about protection of objects	identified landscape characterization	Source satisfactory, complementary		text resource

*information for the audit methodology testing period (July–November 2015)

In the qualitative evaluation, the highest scores were awarded to the most current resources that were also found obligatory or complementary in landscape audit methodology testing. We found the orthophotomap to be the most significant cartographic resource for landscape audit purposes (19 points). This is evidenced by its frequent use and utility for virtually all audit stages (table 1). As it is continuously updated, and thus reflects the current state of landscape (both in terms of surface and of spot characteristics), it is the primary source of spatial information. High scores were also awarded to sources of information on the natural and cultural assets of the landscapes (stage 3 of audit). These were scored between 18 and 20 points, and include both cartographic materials (Map of Nature Protection Forms) and written resources (historic monument register, commune monument records, remembrance site list; as well as the historic monument preservation program and local zoning plan, if current). The high scores are due to the utility of these resources for landscape characterization, as well as their availability, currency, and level of detail. Most managing institutions update the resources continuously and make them available free of charge on their Internet portals. Moreover, they are highly accurate, due to the expert knowledge on the specific area of interest of each institution and to the legal requirements for these documents. Moderate scores were awarded to the following cartographic materials: BDOT 10k (14 points), DEM (15), DSM (14), and Digital Forest Map (16). In the case of BDOT 10k, which is used along with the orthophotomap as the primary resource for landscape audit, the lower score is due to the outdated information and limited availability — access required an application to the National Center for

Surveying and Cartographic Documentation (Polish: CODGIK). The lower degree of currency, and thus lower accuracy, of the database is shown on the example of the field wood and shrub layer, updated based on the orthophotomap, in the next section. As to the remaining resources, the scores are mainly due to their low utility in the landscape audit process and data age (between 2 and 5 years). The remaining resources: BDOO, the Geoenvironmental Map of Poland, the Topographic Map, VMap Level 2, and the architectural information from the INSPIRE Geoportal 2, obtained the lowest scores (10 and 11 points), due to their low utility, outdated information (especially in the case of the Topographic Map), or incomplete content (VMap Level 2).

Table 2. Stage 2 — quantitative assessment of the cartographic and written materials used in landscape audit

SOURCE	UTILITY FOR AUDIT	DATA CURRENCY	DATA ACCURACY/DETAIL	AVAILABILITY	TOTAL SCORE
BDOT10k	5	3	4	2	14
BDOO	0	3	2	5	10
Geoenvironmental map of Poland	2	2	3	4	11
Orthophotomap	5	5	5	4	19
Topographic map	5	1	1	4	11
Digital Elevation Model	4	3	4	4	15
Digital Surface Model	3	3	4	4	14
Map of Nature Protection Forms	5	5	5	5	20
Digital Forest Map	5	4	3	4	16
VMap Level 2	3	1	2	4	10
INSPIRE Geoportal 2	3	2	1	5	11
e-archeo					
Historic Monument Register	5	5	5	5	20
Commune Monument Records	5	5	5	5	20
Remembrance Site Records	5	5	5	5	20
Historic Monument Preservation Program*	3	0-5	5	5	13-18
Local Zoning Plan*	3	0-5	5	5	13-18

*****score depends on the date of establishment for a given area (note — these documents are not obligatory for communes, therefore not all communes have established them)

Categories used for cartographic material evaluation:

- Utility: 5 – essential ; 4 – important; 3 – auxiliary, 2 – complementary; 1 – not important; 0 – unnecessary
- Data currency: 5 – past six months; 4 – 1 year; 3 – 2 to 5 years; 2 – 5 to 10 years; 1 – older than 10 years; 0 – older, disqualified
- Data accuracy/detail: 5 – complete; 4 – requires small amendment (up to 5 items/km2); 3 – requires amendment (up to 10 items/km2); 2 – requires significant amendment (up to 30 items/km2); 1 – incomplete (up to 40 items/km2); 0 – disqualified (more than 40 items /km2)
- Availability (for auditing entities): 5 – free of charge, no application required; 4 – free of charge, application required ; 3 – paid, no application required; 2 – paid, application required; 1 – expensive, application required, publication not allowed; 0 – not available

Discussion of results

The primary resources for landscape audit are the orthophotomap and the BDOT 10k topographic database. However, the outdated information contained in the topographic database, as demonstrated in the test report (MYGA-PIĄTEK et al., 2015), is a significant obstacle in the audit process. The testing showed significant discrepancies between the actual state of the spaces (according to the latest orthophotomap for the day of the testing) and information in the BDOT 10k. Verification concerned e.g. the field woods and shrubs layer. In the GIS software, layers from the BDOT 10k were displayed (field woods marked in green, field shrubs in yellow — figure 1). The orthophotomap was then displayed and the missing items were digitized on-screen (red — figure 1). This demonstrated the differences between the actual state of the landscape and the information in the BDOT 10k database.

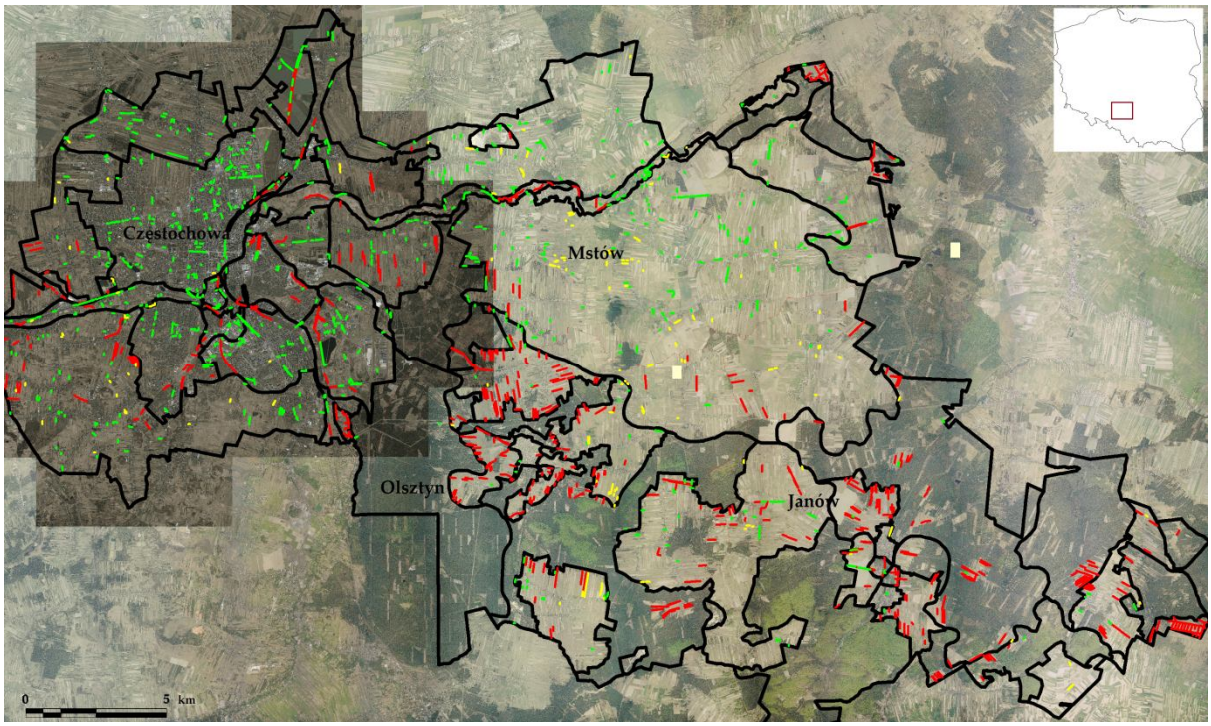

Fig. 1. The field wood and shrub layer from the BDOT 10k digital spatial database (items in green and yellow), updated based on the orthophotomap (red). *Source: Authors' own work based on the BDOT 10k and orthophotomap*.

Other resources useful in the audit procedure include all lists and registries of cultural assets (text resources) and digital maps of natural assets (the Map of Nature Protection Forms and the Digital Forest Map). In this case, the cultural assets need to be digitized manually, which is a work-intensive task.

One important general cartographic resource is the 1:10,000 or 1:50,000 topographic map. However, maps published in the early 1990s reflect data from the late 1980s. Despite the old data, they are the only resource reliably depicting some cultural assets in the landscape, such as roadside shrines and crosses (for which the relevant layer in the BDOT 10k contains incomplete information). The Digital Forest Map cannot be considered complete either, due to the fact that it only depicts state forests and not private forests — and in Poland, forests on land owned by the State Treasury account for most, but not all forest land.

Conclusions

The most useful cartographic materials include the orthophotomap and the BDOT 10k database. However, the data contain numerous inaccuracies and require additional processing for landscape audit purposes:

- the orthophotomap is a raster resource, and therefore cannot be immediately used for unit delimitation (requires on-screen digitization);
- the BDOT 10k is potentially very useful, but it contains outdated information;
- the topographic map is the only source of information regarding certain items, but also contains outdated information and requires verification in the field;
- the Digital Forest Map is incomplete, as it only applies to state forests (though these are dominant, private forests also exist, for which the required metrics cannot be determined);
- registries, records, and lists (table B) are not cartographic, so they require the creation of databases that should be made available by the competent local administration units as vector files.

Resources of this quality are not suited to the requirements of the audit, which means that cartography services need to amend the materials. These amendments should involve updates to the available materials, as well as technical processing for landscape audit purposes. Written resources require manual digitization (creation of new vector layers). Field verification is also required, as the data may be not only outdated, but also incomplete.

The main advantage of the available databases is the possibility to transfer the registry and record data onto vector layers. In the authors' opinion, the databases regarding the cultural assets of landscapes should be developed by the competent local authorities at the stage of preparation for the landscape audit,

and made available in a vector layer format. Some geoportals publish cultural data from the relevant area, but the areas are often limited to specific communes or counties, i.e. just a small portion of the scope required for landscape audit at the province level.

With the currently available cartographic and written resources and GIS tools, landscape audit is only possible with additional technical processing of the data and field verification of data. Additionally, cartographic services should cooperate with the local administration units responsible for planning tasks, in order to make the available maps ready for use in audit. Currently, intensive work is underway in order to adjust the cartographic resources of the Surveyor General of Poland to landscape audit requirements. Several layers (object classes) selected from the above-listed databases comprised in the national surveying and cartographic resources should be combined with thematic content related to landscape in order to create a landscape registry integrated with reference databases. In a registry defined this way, no unnecessary data redundancy would exist, and thematic data should be associated with the data from the national surveying and cartographic resources using unique object identifiers. Such a registry would have the following advantages (ANDRZEJEWSKI et al., in print):

a) ease of update,
b) possibility of creating any kind of visualization in the geoportals, and of generating variants of thematic landscape maps to a given scale.

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