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URBAN AND SUBURBAN LAND FRAGMENTATION IN NORTHEASTERN POLAND

FRAGMENTACJA TERENÓW MIEJSKICH I PODMIEJSKICH W PÓŁNOCNO-WSCHODNIEJ POLSCE

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ABSTRACT: The authors prove that relic land fragmentation can be a valuable component of urban and suburban landscape as a remnant of its history and a testimony to the past economic and social phenomena, as shown in the case study of the City of Białystok and the Town of Łapy, located in northeastern Poland. Such relics deserve to be considered in spatial planning, inducing both problems and new opportunities. Accordingly, the relevant discussion focuses on two examples of places where land fragmentation reached unprecedented proportions, especially in the 1920s. The most extreme historic examples are described, such as a farm divided into 1,221 plots in Łapy (52°59'28"N, 22°53'07"E), mentioned in 1926. Based on the most recent cadastral maps (2020), the contemporary remnants of extreme land fragmentation in Białystok and its land district (approx. 52°51'00.8"-53°23'02.4"N; 22°28'09.1"-23°56'45.4"E) are assessed. Distribution of landscapes with prevailing plots narrower than 30 m and with plots narrower than 15 m is mapped.

The results of the study are discussed against the background of broader historical and geographic context, in order to evaluate such "fossil landscapes" as a valuable cultural component. Recommendations are also formulated on the protection of relics of land fragmentation. In particular, the structure of their baulks should be locally restored to make highly fragmented arable lands discernible. The results of the study can contribute to discussions on the protection of fragmented land in other countries, especially in Eastern Europe, where the land fragmentation ('checkerboard') came into existence and perpetuated as a result of both settlement patterns and subsequent economic and social processes. However, compared to other urban areas, including those in neighboring countries, land fragmentation in Białystok is of a scale unknown elsewhere and deserves special attention from a conservation and heritage perspective.

KEY WORDS: northeastern Poland, Białystok, Białystok land district, urban landscapes, „fossil landscapes”, land fragmentation, field patchwork

ABSTRAKT: Autorka dowodzi, że reliktywne rozdrobnienie gruntów może być cennym składnikiem krajobrazu miejskiego i podmiejskiego jako pozostałość po jego historii, a także świadectwo minionych zjawisk gospodarczych i społecznych, co pokazano na przykładach z północno-wschodniej Polski, koncentrując się na Białymstoku i Łapach. Takie relikty zasługują na uwzględnienie w planowaniu przestrzennym, stwa-

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rzając zarówno problemy, jak i nowe możliwości. Omówiono to na przykładach, w których rozdrobnienie gruntów osiągnęło bezprecedensowe rozmiary, zwłaszcza w latach dwudziestych XX wieku. Opisano najbardziej ekstremalne przykłady historyczne, takie jak gospodarstwo podzielone na 1221 działek w Łapach (52°59'28"N, 22°53'07"E), wspomniane w 1926 roku. Na podstawie najnowszych map katastralnych (2020 r.) oceniono współczesne pozostałości skrajnego rozdrobnienia gruntów w Białymstoku i jego powiecie ziemskim (ok. 52°51'00,8"-53°23'02,4"N; 22°28'09,1"-23°56'45,4"E). Zmapowano rozmieszczenie krajobrazów z przeważającymi działkami węższymi niż 30 m oraz z działkami węższymi niż 15 m.

Wyniki badań zostały omówione na tle szerszego kontekstu historycznego i geograficznego w celu oceny takich „krajobrazów kopalnych” jako cennego elementu kulturowego. Sformułowano również zalecenia dotyczące ochrony relikwów fragmentacji terenu. W szczególności struktura ich międz powinna być lokalnie odtworzona, aby wysoce rozdrobnione grunty orne były rozpoznawalne. Wyniki badania mogą również przyczynić się do dyskusji na temat ochrony rozdrobnionych gruntów w innych krajach, zwłaszcza w Europie Wschodniej, gdzie fragmentacja gruntów („szachownica”) powstała i utrwaliła się w wyniku zarówno wzorców osadniczych, jak i późniejszych procesów gospodarczych i społecznych. Jednak w porównaniu z innymi obszarami miejskimi, w tym w krajach sąsiednich, fragmentacja gruntów w Białymstoku ma skalę nieznaną gdzie indziej i zasługuje na szczególną uwagę z punktu widzenia ochrony dziedzictwa.

SŁOWA KLUCZOWE: północno-wschodnia Polska, Białystok, powiat białostocki, krajobrazy miejskie, „krajobrazy kopalne”, fragmentacja terenu, mozaika terenowa

Introduction

The problem

For at least two centuries extremely fragmented landscapes have been a subject of discussion among economists, geographers and agronomists, and more recently among landscape ecology scientists. Land fragmentation reached the highest degree in Central-Eastern Europe, especially at the dawn of the 19th and at the turn of the 20th century. Extremely fragmented landscapes, although covered by multidisciplinary research in Eastern European countries, were still neglected from a cultural heritage perspective in these countries, with only a few exceptions [1, 2]. Such underestimation was due to the once decades-long campaign for land consolidation as a basis for agrarian reforms.

The relics of extremely fragmented arable lands still exist in northeastern Poland and deserve to be preserved as undervalued but important components of European landscape heritage. Remnants of fragmented landscapes have also survived in other countries, especially in areas long overpopulated with agricultural populations, as well as in foothill areas where the configuration of the terrain was an additional factor contributing to land fragmentation.

However, data from cadastral maps revealed that extremely fragmented lands with ‘checkerboard’ plot patterns survived even within towns and cities, not only in their fringe parts and suburbs, but also in their inner districts.

Aim and objectives

The present-day existence and distribution of relics of extremely fragmented landscapes (EFL) in Eastern Europe, deserve attention in order to prepare, implement

and hasten effective conservation programs, to preserve those remnants of the open-field system at selected isolated territories, especially in suburbs and urban areas. Therefore, the research-based support for a recently-observed reassessment of fragmented landscapes is a main aim of this article, resulting in the following objectives and tasks:

A. To gather and integrate multi-disciplinary knowledge about EFL:

A.1. To collect evidence to comprehend EFL as products of culture, with respect to their origin and evolution;

A.2. To collect evidence to comprehend both historic and contemporary impact of EFL on society and culture, on agrarian production and economy, and on natural environment.

B. To examine selected exemplary cases:

B.1. To assess historic dissemination of EFL in northeastern Poland, i.e. their geographic dispersion and fragmentation degree;

B.2. To survey present-day relics of EFL in northeastern Poland, especially in urban and suburban areas;

B.3. To assess and critically discuss matters of possible preservation of EFL in northeastern Poland, with focus on Białystok as the capital of the region and the city that has still maintained such landscapes.

Methods

Literature survey provided means to gather and integrate multi-disciplinary knowledge about EFL. Polish and Russian writings on ethnography, geography and rural science, from the period *ca.* 1840-2000, have been considered in this paper. To collect those writings, we used Polish, Russian and Lithuanian digital libraries. The inclusion of the 19th-century writings and those from the first decades of the 20th century was necessary to show the social relevance of land fragmentation at that time. To assess contemporary dissemination of relics of EFL in northeastern Poland, we used cadastral maps published in GEOPORTAL (www.geoportal.gov.pl, by the Head Office of Geodesy and Cartography in Poland). A GIS-assisted map survey revealed continuous abundance of extremely narrow and long strips of land scattered all over the region until the present days. Based on these maps we found:

- distribution of landscapes with prevailing plots narrower than 30 m in the Białystok land district in northeastern Poland,
- distribution of landscapes with prevailing plots narrower than 15 m in the Białystok land district.

The largest areas of EFL were found and then examined with the orthophotomaps, to find possible relationships between land fragmentation and types of landscape. Orthophotomaps were also used to find visual markers of land fragmentation. The last research stage included field surveys on selected territories to assess visual markers of land fragmentation from the horizontal perspective.

Geographic region of research

According to Polish old agricultural and geography literature, in the first decades of the 20th century it was northeastern Poland where fragmentation of arable lands reached the utmost degree in terms of individuals' holdings fragmentation, multiple holdings interspersion, as well as weird proportions and sizes of arable plots. This implies a need for re-examining the region, looking for direct and indirect relics of bygone extremely fragmented lands, possibly imprinted with baulks and other landmarks. The article contributes to the subject matter using the examples of Mazovia and Podlachia, two historic regions in northeastern Poland, that were the most unique for their 'balk landscapes' in the past.

However, unlike in other countries, where highly fragmented fields no longer exist or remain only on remote peripheral rural areas, in north-eastern Poland extremely fragmented fields still survive and exist even in the very capital of the region, Białystok, whose population already reaches 280,000. Białystok is, incidentally, the largest city in north-eastern Poland. 27% of the city's area is occupied by urban greenery; forests account for 18% of the aforementioned area, and areas of managed and 'unmanaged' greenery comprise 9% (CSO 2022). The last category include wastelands, which cover lands extremely fragmented in terms of ownership and cadastral structure. This state of affairs raises serious problems with the rational management of these areas. Therefore, the authors have analyzed the mentioned land, pointing its high historic value and the need for its rational protection.

Historic background and literature review

Since the end of the 18th century until the middle 20th century, academic and non-academic discussions about EFL in Central-Eastern Europe were conducted by Russians, Poles and Germans within their national circles; therefore, the relevant written works proved rather hermetic for an international reader, and such an obstacle still prevents those abundant studies from being absorbed by international academia.

There were also difficulties with quantitative estimation of land fragmentation in Eastern Europe in the past two centuries, because numerous agrarian reforms and frequent political cataclysms made census-based data out-of-date or incomparable to former or subsequent data. The relevant terminologies were also hermetic and mutually incompatible. Nevertheless, numerous old Eastern European research works, especially those written in Russian and Polish, clearly revealed an incredible range and degree of land fragmentation on such territories, so that their findings deserve to be evoked, reassessed, reinterpreted and included into contemporary discourse upon landscape heritage.

The origin

The origin of extreme land fragmentation in Poland can be associated with the beginnings of rural settlement in the 13th-16th centuries mostly, bearing in mind the

genetic dichotomy of village categories which could be either 'autogenous' (originated by a spontaneous settlement process) or 'established' (enacted in a settlement campaign or as an occasional but controlled single settlement undertaking).

From their very beginning, *enacted (established) villages* in Poland had manorial juridical measures against fragmentation of their fields. On the opposite, *autogenous villages* became fragmented because of their nature, as they originated and grew in an uncontrolled manner; nevertheless, in the course of time they also became subjected to manorial mechanisms aimed at protection of their field system integrity.

On two territories, manorial juridical measures against fragmentation failed, though. The first region was Małopolska, where overpopulation was the main factor that caused the utmost *internal field fragmentation* (see §.1.7. *Research vocabulary*) with time. The other territory consisted of western Podlasie and eastern Mazovia. The rural population of those two adjoining territories consisted mostly of impoverished petty gentry who did not underlie manorial mechanisms, because they, in most cases, possessed neither manors nor serfs, but were just impoverished noble-farmers who owned their small freehold properties. For centuries petty gentry had unrestricted rights to manage, divide, resell, etc. their properties. As a consequence, land inheritance principles, marriage dowry, endowments, etc. led to rapid *external fragmentation* of petty gentry lands, eventually resulting with a checker-pattern of between-village fragmented fields of mixed ownership which occurred nearly impossible to be consolidated.

Eventually, field fragmentation became a common burden in Poland by the 18th century at the latest, as the problem was already mentioned in the 18th-century Polish enactments (see the anthology of old Polish law, *Volumina legum* [3] (p. 425)). However western Podlasie and eastern Mazovia were known for their extreme field fragmentation as early as in the 16th century [4] (pp. 92-97).

Polish inquiry into land fragmentation after the partitions of Poland

On the territories of present-day Poland, EFL became the subject of academic and political debate as early as at the beginning of the 19th century, after the Polish-Lithuanian Commonwealth had been progressively partitioned between the Habsburg Monarchy, the Kingdom of Prussia and the Russian Empire, thus deprived of its sovereignty for 123 years.

The debate focused on economic and ethical aspects of the then advised agrarian and social reforms. The two key concerns of that time were serfs enfranchisement and land tenure reform. Both those issues induced discussion about mixed property land management, i.e. where manor demesne plots were structurally interspersed with petty gentry hereditaments, enfranchised serfs acquests and allotments, and common properties. Therefore, since the 1840s, interspersed structure of fragmented arables started to be regularly discussed at many public fora.

Two decades later, in 1861, Józef Zawadzki wrote and published a short article *Drobna szlachta wobec oczynszowania* [Petty gentry's attitude towards rents imposed [on pe-

asants]], implementing the term ‘szachy’ (‘chess’ or ‘chequerboard’) to denote extremely fragmented land of interspersed types of property. Actually, its variant ‘szachownica’ (‘chequerboard’) was in use even earlier, constituting part of the formal nomenclature in the 18th-century maps of arables consolidation. Nevertheless, Józef Zawadzki was probably the first who, while using chess-related nomenclature, described precisely some examples of utmost ‘land pulverization’ such as a manor in Radomyśl near Siedlce with its demesne consisting of more than one hundred and several dozen small plots or selions. Zawadzki wrote in astonishment: “There was merely one old manor surf who was capable of identifying all those numerous land strips and who could remember their various locations” [5].

Zawadzki demanded state-enforced consolidation of Polish petty gentry hereditary fields. His proposal proved unacceptable to his contemporaries; nevertheless, his attempts to grasp, define and solve the essential agrarian problems of the epoch, sounded apt and resonated with other numerous efforts of his contemporaries. In any case, he contributed to common apprehension of utmost scale of checker-patterned land fragmentation in Poland, which problem started to be associated with a wide palette of agrarian and social concerns. Zawadzki was then followed by many 19th-century social activists, reformers and agriculture researchers, as well as by the 20th-century geographers who continued to use the term ‘szachownica’ (‘chequerboard’) to denote various degrees of fragmentation and interspersion of arables and other land holdings, still associating such structural landscape features with social and economic consequences. In *Kalendarz Centralnego Wydziału Kółek Rolniczych 1910* [The ‘1910 Calendar’ published by the Polish Central Department of Agricultural Associations], Konstanty Długoborski stated: “There was no [Polish] newspaper without a dispute about land consolidation; the subject was also present at every agricultural course and discussed at various meetings (...), resulting in a variety of proposed methods of land consolidation” [6: p. 88].

Land fragmentation in Russian research until the October Revolution

Apart from Polish-writing authors, there were also a number of Russian scholars and government officials who debated about the necessity of agrarian reforms that would include government-executed land consolidation. As soon as in the early 18th-century, in the Russian Empire, the term *cherespolositsa* (чересполосица, literally: ‘over the field strips or selions’ or ‘[territory consisting of] alternating field strips’) was coined to mean highly fragmented arable land. Later, in the 19th century, other synonyms originated, including: *uzskopolositsa* (узкополосица, literally: ‘[territory consisting of] very narrow field strips’), *mnoghopolositsa* (многополосица, lit.: ‘[consisting of] multiple field strips’) and *dlinnopolositsa* (длиннополосица, lit.: ‘[consisting of] elongated field strips’). Highly fragmented arable landscape was regularly mentioned in Russian agrarian journals such as ‘Zhurnal Zemlevladel’tsev’ (‘Журнал Землевладельцев’), ‘Sankt-Peterburgskiya Vedomosti’ (‘Санкт-Петербургскія Ведомости’), ‘Sel’skoe

Khozyaystvo i Lesovodstvo' ('Сельское Хозяйство и Лесоводство'), 'Yuridicheskiy Vestnik' ('Юридический Вестникъ') and 'Vestnik Evropy' ('Вестникъ Европы'), apart from being discussed in other writings as one of the essential agrarian problems of that time.

As a matter of fact, land fragmentation in the Russian Empire was determined by a number of factors, with the key role of *obshchina* agriculture. The *obshchina* (*община*), or local village community in Russia, was the de facto owner of land and was therefore responsible for periodic reallocation (*peredel, передел*) of all peasant arable land. The number of households and their members, as well as the existing distribution of arable land, the quality of the soil, the distance from the village, etc., were taken into account when determining the allocation scheme. Such a divergence of factors tended to create puzzling complexity in the temporal allocations of agricultural land and, as a result, a constant fragmentation of land.

In the course of time, the role of *obshchina* in land disposition in Russia evolved, with the following stages:

1) primaeval (natural) form of agriculture administered by the community, with occasional or partial reallocation of arables: up to the end of the 17th century,

2) legal (formal) agriculture with periodical reallocation of arables: especially since 1725, i.e. after the introduction of *the common soul tax* in Russia,

3) either spontaneous and state-enhanced development of independent individual farms, *khutors*, as an alternative to *obshchina*-administered agriculture: especially after the abolition of serfdom in 1861,

4) in 1906, the Stolypin agrarian reforms included administrative measures to overcome economic and social defects of *obshchina* form of agriculture and to overcome its extreme land fragmentation.

The Stolypin agrarian reform, perhaps one of the most complex reforms of its kind in the whole history, deserves attention for its multiple references to the issue of land fragmentation. This aspect of the Stolypin reform had its passionate advocates such as Carl Andreas Koefoed (known in Russia as Андрей Андреевич Кофод, Andrey Andreevich Kofod), an agronomist of Dutch ancestry and a collaborator of Pyotr Stolypin. Koefoed wrote a number of works related to agrarian reforms in Russia. A few of his works were devoted to the subject of land fragmentation, and one of them, a 150-page book *Борьба съ чресполосицею въ Россіи и за границею* (*Means against land fragmentation in Russia and abroad*) included a comprehensive review of the problem of land fragmentation all over Europe, as well as in the Russian Empire [7].

Koefoed's interest in this aspect of agrarian change, enhanced other researchers of that time to examine fragmentation of arable land in the western regions of the Russian Empire, including the eastern parts of present-day Poland, which were under Russian dominion at that time. These territories were analyzed concurrently by both Russian and Polish researchers, as in the case of Łomża District (*Gubernia Łomżyńska*). Łomża District, now in the western part of Podlasie region in northeastern Poland, was a model example of the most extreme 'land pulverization' at that time [8].

Struggle against land fragmentation

In order to counteract further uncontrolled ‘pulverization’ of arable fields, Polish petty gentry initiated attempts to consolidate their fragmented and dispersed estates. Such grassroots initiatives emerged in parallel with governmental programs of peasant enfranchisement and official land reforms. In the decades following The Peasant Enfranchisement Act of 1864, overall land fragmentation was steadily reduced, as a result of both spontaneous (rank-and-file initiatives) and systemic land commassification; nevertheless, opposing fragmentation processes still worked, leading to the paradox that secondary peaks of land fragmentation occurred in some territories relatively recently, especially along the Polish-Belarusian frontier, on land owned by former serfs or peasants, not by petty gentry.

Beginning in 1911, the western parts of the Russian Empire became subject to more orderly land consolidation efforts administered by the government. Land consolidation programs were temporarily interrupted by World War I, and then resumed in communist Russia since 1922, and in Poland since 1923. In Poland, 11,000 villages and 5.42 M hectares were subjected to land consolidation programs between 1923 and 1939. On average, it took about 2 years to consolidate all the villages of one village ([9]: 17).

In northeastern Poland, large-scale land consolidation projects were carried out from the mid-19th century until the end of the 1970s [9], spanning one century. Such a long period of struggle against the checker-patterned field system reflected the unusual degree of fragmentation of arable land and the complexity of the problem in that area. The struggle was observed and assessed by ethnographers, geographers, agricultural science scholars, etc., who, despite focusing on the transformation process, precisely circumscribed an essential source of the problem, namely arable fragmentation [10-13], and also proposed new measures for land fragmentation assessment, such as ‘Januszewski index’ (J-index) [14].

Recent research interest in land fragmentation and consolidation in Poland

During the next two decades (ca. 1980-2000), this topic was temporarily abandoned by Polish geographers and agricultural science scholars, with few exceptions [15], because at that time transformation of large collective or state-owned farms was recognized as the most important issue.

More recently, however, the issue of agricultural land fragmentation has been resumed again by geographers [16, 17] and the relevant subject of midfield baulks system has been assimilated by new academic disciplines such as landscape ecology [18] and landscape history.

Considering the multidisciplinary nature of the subject matter, this work is the first to include the subject matter into heritage studies and to suggest possible directions for protection of relics of extremely fragmented landscapes in Poland.

Recent international research on land fragmentation in terms of cultural heritage

We searched for other scientific works that consider the checkerboard landscape in terms of a historical or cultural value instead of focusing on its impact on agricultural productivity. Jana Špulerová et al. consider the significance of historic landscape fragmentation as a remedy against a decline of biological diversity, relying on examples from Slovakia [1]. Cosmin Ivaşcu and Laszlo Rákósy analyze the significance of fragmented landscapes and their baulks as ecological corridors in Romanian landscape [19].

Barbara Prus et al. [2] examined the use of computational methods and tools to define and determine the intangible components of cultural heritage related to the spatial structure of land, to identify places with greater cultural potential. These scholars also agreed that the historical value of the traditional agricultural landscape was related to the small-scale structure of the plot division and the presence of original baulks.

However, paradoxically, even scholars who believe that “agricultural land is the country’s natural heritage” tend to assume that “land fragmentation is a problem” rather than a value [20].

Research vocabulary

While struggling against land fragmentation, the early 20th-century Russian- and Polish-writing scholars started to publish land consolidations manuals [21] and research treatises, in which they categorized EFL. The parameters of such categorization included:

- plots ownership:
 - mean number of plots per farmer,
 - interspersed properties owned by members of various social classes were considered much more difficult to conflate,
 - if a plot was co-owned by more than one owner, such a plot structure was usually extremely difficult to consolidate,
- dispersion of plots (whether fragmentation was ‘internal’, i.e. confined to a single village surroundings, or of between-village ‘external type’),
 - plots shape: e.g., according to Zdzisław Ludkiewicz ([22]: 33), highly fragmented land patchworks should be classified as ‘scattered’ or ‘elongated’, depending on plots proportions,
 - plots mean area: this parameter was also assessed as “plots atomization”.

Mean number of plots per farmer was the most important factor in past census-based research. However, we focus on the other two parameters in our assessment of contemporary relics of EFL in northeastern Poland.

Due to the variety of factors influencing land fragmentation, the different scientific disciplines involved in assessing land fragmentation have resulted in discrepancies in Polish terminology on this issue. In this article, the research vocabulary has been par-

tially derived from Polish geography literature and translated by the authors, resulting with the following English terms and their abbreviations:

- ‘Extremely Fragmented Landscape’ (EFL; in Polish *szachownica gruntowa*, i.e. literally ‘checker pattern of fields’ or ‘agrarian chequerboard’) = a checker-patterned or ribbon-patterned system of tiny narrow land plots.

EPL can be considered as the most general term that includes the following sub-categories:

- ‘Internally Fragmented Arable’ (IFA; in Polish *szachownica wewnętrzna*) = a checker-pattern of fragmented fields, confined to a single village and its surroundings.

- ‘Externally Fragmented Arable’ (EFA; in Polish *szachownica zewnętrzna*; synonyms: *szachownica uciążliwa*, i.e. literally ‘burdensome checker pattern’, or *szachownica międzywioskowa*, i.e. literally ‘inter-village checker pattern’) = a checker-pattern of between-village fragmented fields.

- ‘Tangled Fragmented Arable’ (TFA; in Polish *szachownica złośliwa*, i.e. literally ‘malicious checker pattern’; also *szachownica zawikłana*, i.e. literally ‘tangled checker pattern’) = a checker-pattern of between-village fragmented fields of mixed ownership, especially when each single field strip belongs to two or more co-owners.

IFA (*szachownica wewnętrzna*), EFA (*szachownica zewnętrzna*) and TFA (*szachownica złośliwa*) tend to be old Polish terms that are related to arable fields in the Open Field System. Conversely, the term EFL (*szachownica gruntowa*) is still in use. EFL relates to fragmented lands of any type: not only arable lands, but also meadows, wastelands or forest. Therefore, we have translated it not as Extremely Fragmented Arable, but Extremely Fragmented Landscape (EFL).

Extreme land fragmentation in northeastern Poland

Accessible data for quantitative assessment of the origin and geographic dispersion of EFL in Poland in the past, are inconsistent; therefore, former land fragmentation can be traced for limited territories only. Nevertheless, some data reveal unbelievable extent of land fragmentation in some areas and its multiple social and cultural consequences.

Geographic dispersion and extent of land fragmentation

In general, the northeastern and southern parts of the country achieved the highest degree of land fragmentation in the past, and as stated above, the following two regions used to be famous for having the greatest field dispersion: Lesser Poland (Małopolska) (around and eastwards of Kraków in the southern part of the country) and northeastern Poland between Warsaw and Białystok, comprising eastern Mazovia (Mazowsze) and western Podlasie. In Lesser Poland, field fragmentation was of intra-village type and the fragmentation degree ranged from 1 to 20 field strips per farm. Farms and their fields were extremely small because of overpopulation and peasant impoverishment.

On the contrary, western Podlasie, adjacent eastern Mazovia region and Suwałki-Augustów Lake District were inhabited not by peasants, but by impoverished petty gentry. Their farms were larger but much more “pulverized”, consisting of 40-, 60- or even over hundred field strips per farm ([23]: 75); ([4]: 109). A checker-pattern of between-village fragmented fields of mixed ownership was a general rule at petty gentry territories; therefore, utmost examples of incredible ‘field pulverization’ were regularly mentioned by Polish authors in the first decades of the 20th century ([22]: 128); ([24]: 103-104).

For example, Stanisław Rosłonec [4], who examined archival registers of taxes, found out that, at the end of the 18th century, eighteen families of petty gentry had possessed 1,108 arable plots in a small hamlet Żebry Wielkie. After a century, in 1872, 55 owners possessed 2,451 arable plots in Sawice-Bronisze (consolidated in 1908). Half a century later, in 1923, there were interesting cases of seven small adjacent hamlets: Nienały-Doniczki, Nienały-Szymany, Nienały-Michny, Nienały-Niestępowo, Rawy-Gaczkowo, Skłody-Stachy and Nienały-Brewki. Their 81 residents possessed 4,902 arable plots.

The other territories of Podlasie, i.e. its central, eastern, northern and southern parts, were inhabited by peasants who were not allowed to administer their selions until the abolition of serfdom (1861) and peasant enfranchisement (1864). On those territories, both the process of land fragmentation and struggle against it, were initiated later. As recently as in 1970, concerning those territories, Władysław Biegajło wrote: “In those villages where arable lands have still remained fragmented, fragmentation has reached the utmost degree, anew. On the average, each farm, either small or large, consists of about 20 land plots. (...) In Nowy Dwór, Dąbrowski district, the average is 54 land plots per farm. Some of those plots are 1.5 meter wide and nearly 4 kilometers long. There are also numerous villages with the average land fragmentation degree as more than 40 land plots per farm, where width to length ratio is 1:1,000; the examples are as follows: Pieszczaniki, Ryboły, Hołody, Ostrów Południowy, Saczkowce. (...) In Sanniki, Sokólski district, and Podlewkowie, Hajnowski district, there are farms consisting of 100 to 130 farm plots. (...) In the whole region, furrows and baulks occupy about 10,000 hectares of arable” ([25]: 56). Similar estimations were also published by non-Polish authors. For example, G.A. de Réparaz ([26]: 54) mentioned a 6-hectare farm that consisted of 70 field strips. The farm was located near Hajnówka.

For the following three decades (1970-2000), field fragmentation was diminishing because of both economic factors and state-controlled consolidation projects. Nevertheless, on some territories the opposite processes were still prevailing, instead.

The utmost case: A farm of 1,221 field strips

An average degree of fragmentation of peasant farmlands in the past was estimated and included in the National Census reports, but there were no case study reports that revealed the most unique or extreme instances of land fragmentation. However, a few

extreme cases were acknowledged by geographers and social activists who promoted agrarian reforms.

Northeastern Podlasie. Władysław Biegajło mentioned (as quoted by W. Bujnowski) field strips being 7 km long while 2 to 4 meters wide, in Dąbrowa Białostocka ([10]: 540). Those data referred to the period before World War II.

Mazovia. More than a century ago, Jan Zakrzewski ([27]: 3) mentioned an extreme elongation of petty gentry arable plots: “This year I saw in Rostki Daćbogy, Ostrowski District, one arable plot of one kilometer in length while its width was only 12 to 18 inches [30-45 cm].”

Łomżyńskie. This sub-region between historic Mazovia and Podlasie, now included into the administrative region of Podlasie, has often been mentioned by historians and geographers because of its amazing fragmentation of arable lands. There were records about farms dispersed and consisting of 115, 120 and 200 field strips ([24]: 104), ([28]: 298). Some researchers called the capital of the region, Łomża, “the [world] ‘capital city’ of checkered fields” ([28]: 297), and the region was regarded as “the most extremely pulverized in the world” ([22]: 128), others termed its checkered fields as “absurd and ridiculous” ([4]: 141), ([29]: 21).

Western Podlasie. The most impressive example of an extreme fragmentation or ‘pulverization’ of a nobleman-owned farm, was described by Bohdan Zaborski, who wrote: “A farmer in Łapy-Kołpaki had his farm of several dozen hectares scattered in 1,221 narrow strips. (...) In Łapy there were many farms consisting of 600 to 800 field strips” ([23]: 75).

Belarus. In addition to these extreme cases in northeastern Poland, there was also an example related to Nowogrudak (Наварудак) in what is now Belarus. In 1926, according to a correspondent of Polish agricultural journal *Tygodnik Rolniczy* (The Agricultural Weekly), a 15-hectare farm was scattered over 700 cord-shaped field strips. The neighboring farms consisted of 300 to 400 arable plots ([30]: 507).

Baulks as markers of land fragmentation

In 1908, Józef Jeziorański analyzed the relationship between land fragmentation and baulks. Assuming a 10-hectare farm divided into twenty plots of $1500 \times 3\frac{1}{2}$ m., each one bounded with 15 cm wide baulks, he assessed that baulks covered nearly one hectare, namely, 9,020 m² ([31]: 83); similar results were also achieved by Kocent-Zieliński ([21]: 5).

Baulks were 5 to 40 cm wide, but usually had a rather moderate width of about 15 cm. Baulk hedges were avoided because of their negative impact on the yield, especially when field strips were narrow. Sometimes wild pear trees were adopted as baulk markers. Such markers used to be necessary in the ‘three-field system’ and ‘open-field system’ arrangements, whose relics survived locally until as late as the 1960s. In such arrangements, arable lands were cultivated individually, but stubble fields were grazed commonly, therefore multiple alternate cycles of individual and

communal land use could blur baulks, thus inducing problems with field allocation at the beginning of the next season. Baulk markers, though few in number, prevented such a problem.

Contemporary relics of highly fragmented agricultural lands in northeastern Poland

Surprisingly, in contrast to written information and census data, which showed systematic post-war decline in land fragmentation except the last decade, a GIS-assisted map survey has recently revealed continuous abundance of extremely narrow and long field strips, as well as extensive areas of extremely fragmented fields, scattered all over the region until the present days.

To look for contemporary relics of the utmost land fragmentation, we have not found necessary to define quantitative border parameters to assess landscape as 'non-fragmented', 'fragmented' and 'extremely fragmented'. Instead, we took advantage of the fact that relics of EFL and its derivatives (IFA, EFA, TFA) usually differ clearly from their surrounding territories. In most cases, EFL areas covered by extremely narrow land plots, with some plots as narrow as 2 or 3 meters wide, bordered on consolidated lands with no intermediate zones.

Examples of the most extreme landscape fragmentation remained alongside the valleys of the rivers Biebrza, Narew and Bug, and their tributaries. Highly fragmented 'checker-like' lands, while easily revealed by cadastral data, are not recognizable visually in most cases, being masked in landscape. Such a 'landscape camouflage' is caused by vanishing baulks, visual determinants of land fragmentation, as well as by fallowing and reforestation of such lands.

We found the most unique occurrence of EFL (TFA relics) scattered all over the Białystok land district (Figure 1 and 2), including Białystok, the capital of the region. Two occurrences have been found in the eastern districts of the city (Figure 3). One of them is in *Wygoda* and *Pieczurki* districts and covers an area of 1.5×1.5 km², including hundreds of narrow land plots (former selions) 410 m long while only a few meters wide. There are also land plots as narrow as 2 m while about 540 meters long; a few ones are 1.3 m wide and 390 m long.

Another trapezium-like 16-hectare area of EFL has been found in *Piasta* district. The area of ca. 450×450 m includes a few hundred land plots approximately 3 meters wide, but numerous plots are much narrower, and a few of them are only 127 cm wide and 400 m long.

In northern part of Białystok, the *Białostoczek* district includes 6 EFL areas of various sizes (5 to 16 hectares). One of those areas still includes the most extreme land plots, 1.25 m wide while 700 m long.

Two TFA areas have survived in northern parts of Białystok, i.e., one in *Starosielce* district and another in the most northward area adjoining to the Supraśl River which partly defines the city borders.

After examining other Polish cities, we found Białystok to be unique in terms of its TFA legacy. No other city of such range (about 280,000 inhabitants) includes EFL areas even in the vicinity of its historic center, while in Białystok two EFL areas are 1.5 km distant from its downtown. No other city has such numerous and such narrow land plots. But in northeastern Poland, a few towns are surrounded by EFL on their outskirts. Examples include Łomża, Łapy, Ostrów Mazowiecka, Małkinia, Ciechanowiec and Kosów Lacki. Less impressive cases of land fragmentation can be discovered in almost the whole eastern part of Mazovia, including the eastern vicinity of Warsaw (Sulejówek, for example).

On the rural territories of Podlasie and Mazovia, there are numerous examples of EFL. Some of them seem similar to the most extreme ones, described by Polish geographers in the past. For example, in Żochy-Dębe-Guty there are land plots No. 142905_5.0007.43/1 – 142905_5.0007.43/5, ca. 630 meters long while only 80 cm wide; a nearby land plot No. 142905_5.0007.59/2 is 610 m long and 0.5 m wide; a plot 143306_2.0002.2328 near Miedzna, Węgrów district, is one meter wide while 1,600 meters long; alongside the Biebrza River there are field strips up to 2 m wide while 2 km long, etc. In many cases, such relics of EFL have been afforested and the fragmentation cannot be assessed visually in the landscape.

An overlooked phenomenon

Although the excessive fragmentation of arable lands in Poland used to be systematically researched in the past and the fragmentation problem has seemed well-recognized, we perceive the general scientific assessment of this subject matter as somehow deformed, paradoxically enough, because the relevant post-WWII research in Poland was based on census data. Census data showed southeastern Poland rather than northeastern part of the country as of the most unfavorable agrarian structure afflicted by land fragmentation: e.g., some Polish authors estimated that average arable plot sizes in three southeastern voivodeships (regions) were 0.3 ha, 0.4 ha and 0.6 ha, respectively ([32]: 55), while arable plots in northeastern Poland are on average much larger, although statistical estimates give uncertain data for this region. Thus, in recent works, extreme land fragmentation in northeastern Poland, although acknowledged as a historical phenomenon, has been almost completely ignored as an existing relic and a contemporary research problem.

Therefore, we argue that numerous exceptions, rather than statistics, should be prioritized in the study of land fragmentation as a cultural phenomenon and in discussion of possible conservation needs.

Highly fragmented and balk-divided arable lands as constituent of culture

In the past, multifarious influence of land fragmentation on agriculture, economy and culture was repeatedly described by Polish ethnographers and geographers, but

on the basis of rather anecdotal evidence. Selected levels of such an influence are explained below.

Land fragmentation and the three-field system

According to W. Biegajło, it was land fragmentation that petrified traditional three-field system in northeastern Poland until the 1950s [10]; ([33]: 56 and 73). The three-field system was finally abandoned in the 1960s. Before the land consolidation epoch (1860-1960), the common regime of crop rotation was strictly determined by land structure: many cultivated plots were isolated from roads and surrounded by other farmlands, making it impossible to cultivate them independently. This system of crop rotation was referred to by Polish geographers and ethnographers as “field compulsion”, as it was enforced by both tradition and the layout of the fields.

Land fragmentation and the open-field system

For the same reason, i.e. due to ‘field compulsion’ determined by land fragmentation, all individual fallows in a village were temporarily consolidated each year to serve as common grazing. Common grazing was essential for local rural economy in the conditions of extreme land pulverization.

The three-field system with common regime of crop rotation and common grazing, were all relics of the medieval open-field system, which on some territories had survived until the World War II or even until later. For example, in Borysówka and Grodzisko in Hajnówka commune, relics of open-field system were still noted in the late 1950s ([29]: 104-115); [12]. There were also relics of extreme land fragmentation, including land plots 2.8 km long and 2.4 meters wide.

Land fragmentation, baulks and social ties

Common land cultivation and common grazing influenced social ties, in general. But common cultivation of extremely narrow and elongated plots, where every baulk divided one’s belongings, amplified both positive and negative social ties, including the most extreme animosities. Therefore, the territories inhabited by Polish petty gentry, which were unique with the most extreme land fragmentation, were also famous for the most severe neighbor conflicts.

While farming on hundreds of field strips with common crop rotation, a farmer challenged problems with identifying his plots properly. According to Stanisław Rosłonec, “a petty gentry farmer often fails with counting or identifying his selions and he sometimes ploughs or harvests his neighbor’s one,” thus fanning the flames of neighbor quarrels ([4]: 141); see also: ([29]: 21). Małgorzata Dajnowicz ([24]: 169) mentioned a long lasting land ownership lawsuit between Stanisław Chojnowski and Hipolit Chojnowski who had litigated a cause against each other for 16 years at the turn of the 20th century. The subject matter of the claim was merely ‘a tuft of grass’, i.e. the tiniest piece of pasture.

Małgorzata Dajnowicz describes how land fragmentation influenced family ties: “The farmlands of large Jamiołkowski family consisted of 60 tiny field strips that were scattered around five hamlets. (...) Therefore, in order to avoid partitioning those field strips for a dowry or bride-price, new marriages were arranged only ‘in exchange’, i.e. a bride was allowed to marry a man whose sister married the bride’s brother. In such a case a dowry or bride-price was not necessary” ([24]: 102).

Landmarks: Baulks and pear trees

To enable proper identification of selions just after their fallowing, i.e. every third year, easily discernible landmarks were needed. Baulks as landmarks were not sufficient. Therefore, sometimes, self-sown trees were allowed to grow on baulks to indicate original arrangement of selions, field strips and baulks, and to fix them. The number of such landmarks was limited, as they significantly reduced grain yield. The exceptions were self-sown wild pear trees which were accepted and appreciated for their fruits. Pear trees were also believed not to decrease crop yield around them. Consequently, baulks and pear trees appeared in local folklore.

Preservation

Until now, there have been no initiatives to restore or preserve extremely fragmented field patchwork in Poland. In order to select the most fragmented relics of field patchwork for possible preservation programs, we examined the Białystok land district which spans some 25 kilometers north, 60 kilometers east, 30 kilometers south and 50 kilometers west from Białystok (Figure 1 and 2).

At present, almost all areas of extreme field patchwork in the district relate to three types of landscape:

- pine forests, usually planted in the 1950s,
- periodically inundated riverside meadows,
- wastelands.

None of the extremely fragmented field patchwork areas still serves as arable. Their fragmentation can be revealed by cadastral maps only, with no relevant visual attributes in real landscape: their baulks are seldom visible, and in most cases they are completely blurred.

The cadastral structure of TFA is fixed by mixed ownership, i.e. every single field strip belongs to two or more co-owners who usually do not agree with each other about possible sale or consolidation of the selion. According to anecdotal reports, there are still frequent cases of single plots possessed by a dozen or more co-owners or their descendants and inheritors. Given that legal circumference, consolidation is unlikely because of co-owners clash of interests. Every other ordered land use is unlikely, as well.

Nevertheless, we prioritize two areas of extremely fragmented field patchwork, as possible preservation areas. The first one is located in Białystok, the other in Łapy, a town some 20 kilometers south-west from Białystok.

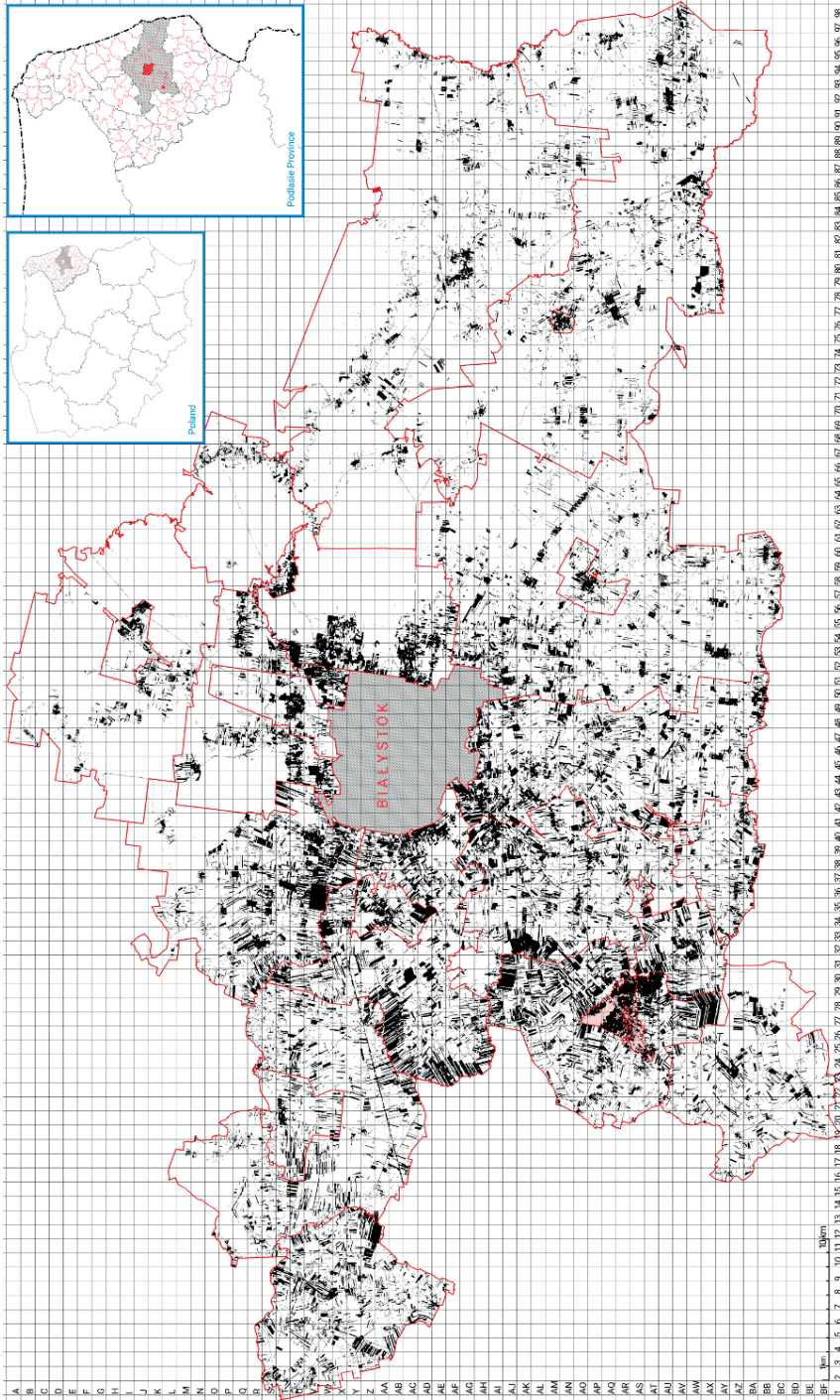


Fig. 1. Distribution of landscapes with prevailing plots narrower than 30 m in the Białystok land district

Source: own elaboration based on 2019 cadastral data.

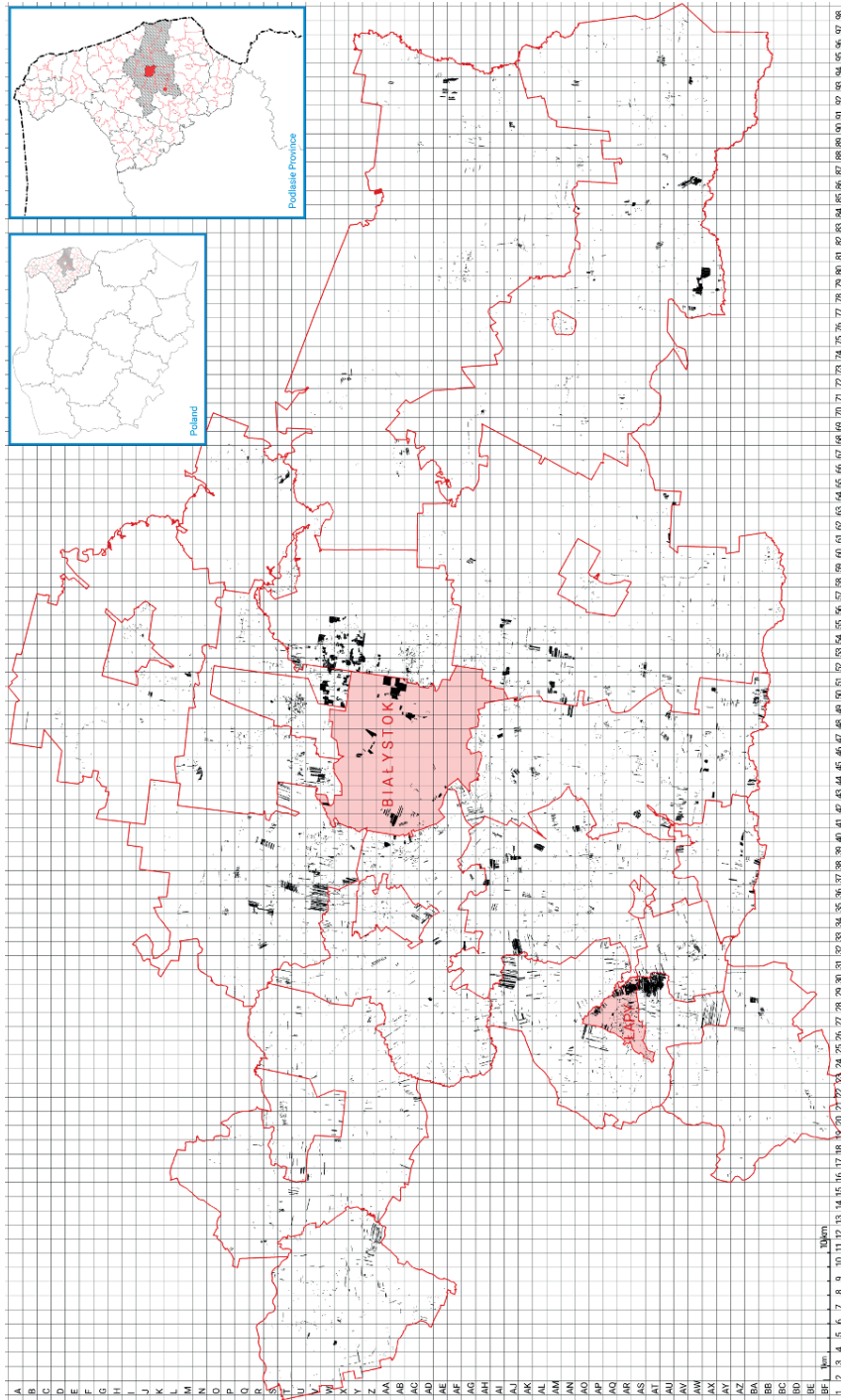


Fig. 2. Distribution of landscapes with prevailing plots narrower than 15 m in the Białystok land district

Source: own elaboration based on 2019 cadastral data.

The case of Białystok

Białystok covers 102 km² of which 32 km² is agricultural land; urban forests occupy 17.5 km², and 1.7 km² is waste land (2021 Census data). Most of its 28 districts were just villages in the past. Because of its semi-rural origin, Białystok has still maintained post-agricultural lands or waste lands with an extremely fragmented cadastral structure. (Figure 3) We estimate that such lands cover *ca.* 2.5 km² or 2.5 per cent of the total urban area, most of them being artificially or naturally reforested during the recent decades.

Białystok is the largest known city with extensive areas of extremely fragmented fields. Such 'urban checkered fields' have already lost their visual and functional constituents – baulks, thus becoming mere urban wastelands usually. Therefore, we suggest restitution of their baulks system as part of urban heritage preservation program.

The most extensive areas of extremely fragmented post-agricultural wasteland are located in eastern districts of the city, just eastwards to the city center. We suggest those relics of extremely fragmented field patchwork to be reused as allotment gardens with their parcels derived from the original structure of extremely elongated fields. We also suggest restoration and maintenance of their semi-natural baulks.

The case of Łapy

Łapy is a town of 16,000 inhabitants and covers 12 km² (2010 Census, 2021 Census). The town originated as a conglomerate of 13 small hamlets that were unique, owing to their extremely fragmented cadastral structure. Łapy has still retained some of the most fragmented land, particularly in the eastern part of the town. For example, Łapy III plot No. 1,265 is 530 meters long while only 1.3 meters wide.

Furthermore, in the very vicinity there are extremely fragmented lands that belong to two villages Łapy-Szołajdy and Łapy-Dębowina. For instance, Łapy Dębowina plot No. 1396 is 420 meters long while 1.2 meters wide (Figure 4).

All the relics of TFA in Łapy and around the town are riverside meadows with no baulks (Figure 5). They also include reed meadows and periodically inundated grasslands. In contrast to the Białystok case, TFA in Łapy cannot be re-formed and made visually discernible without funding programs. Such a funding should cover:

- general landscape design,
- baulk restoration and maintenance,
- periodical scything or mowing reed and grass,
- designing and creating facilities for visitors, including scenery observation towers, etc.
- surveillance.

Conclusions

Extreme fragmentation of agricultural land in northeastern Poland was assessed in the article as a cultural phenomenon. Its relics have been found in northeastern Poland,

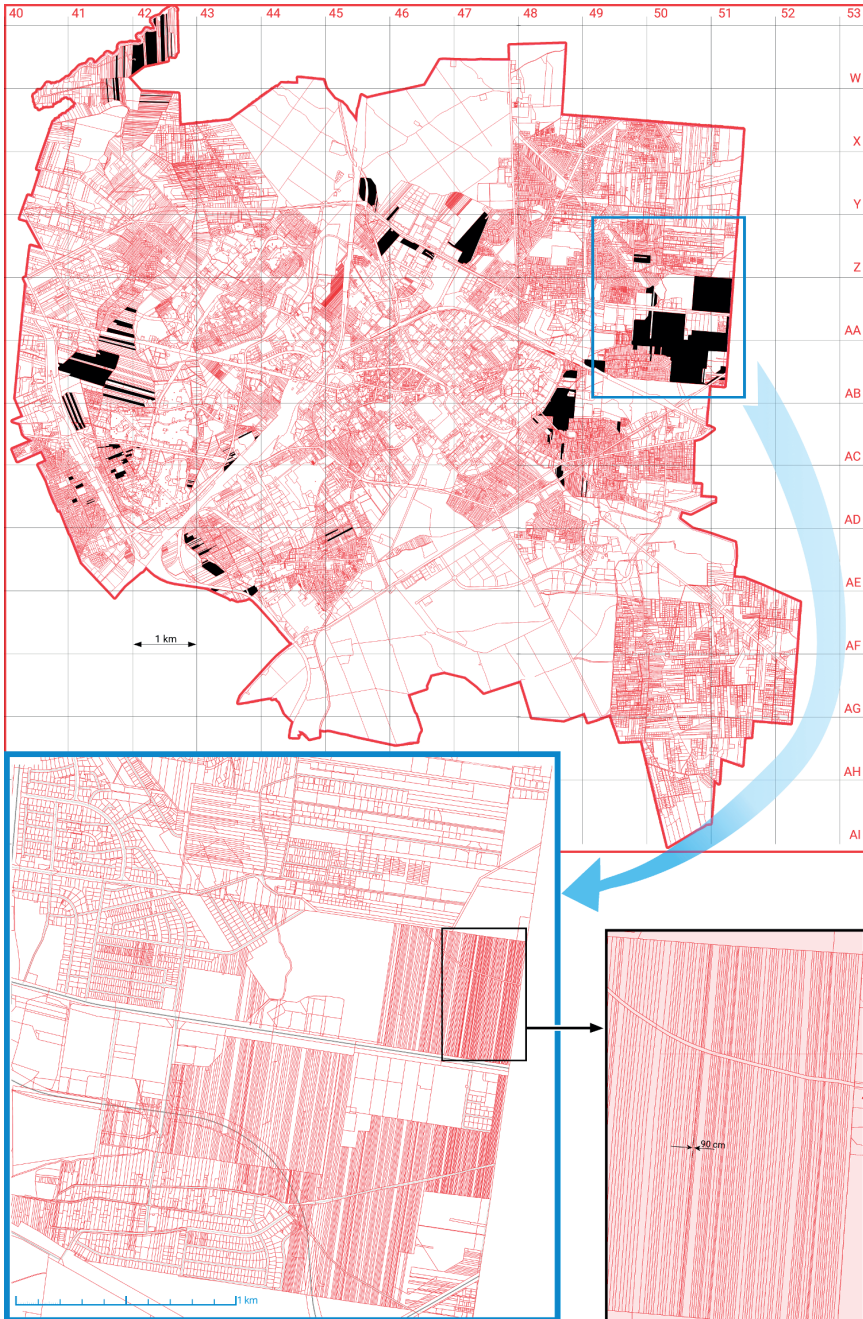


Fig. 3. Cadastral maps of Białystok (distribution of extensive sets of plots narrower than 10 m has been marked black)

Source: own elaboration.



Fig. 4. Cadastral maps of Łapy Dębowa plot No. 1396

Source: own elaboration.



Fig. 5. A photo of relics of extremely fragmented meadows in AT-AS/29 sector (as shown in Fig. 4) as of March 2020

Source: own elaboration.

mostly scattered along river valleys and around towns. Cadastral data shows that the narrowest land plots in the region are as narrow as 80 cm and a few hundred meters long; the longest ones are more than a kilometer long and a few meters wide. Such elongated plots form larger ribbon patterns which are relics of the extremely fragmented arable land of the past. The most extreme examples appear rather sparsely among consolidated arable land. However, field surveys showed that EFLs have already lost their visual markers and can only be detected from cadastral data.

More detailed surveys were conducted to find EFL relics in the Białystok land district. In the central and western parts of the district, the cadastral land structure is 'saturated' with EFL. The capital city Białystok and its vicinity, and the peripheral town Łapy, contain the most fragmented land structure.

At present, EFLs relate to various types of landscape. If they are located along river valleys, old TFA relics are now mostly riverside meadows. Otherwise, they are wastelands or reforested arables. As a rule, their cadastral structure has blurred in visual scenery. Preservation and restoration of the historic visual scenery of the EFL is possible, but require various methods that depend on the category of landscape.

Protection perspectives

We have presented draft protection proposals for two EFL territories, one in Białystok and the other one in Łapy. The proposed actions included the following functions for EPL relics: private or allotment gardens in the case of Białystok, and municipally-funded and surveilled reserve in the case of Łapy. In both cases, baulks restoration should be provided.

Recommendations should also be made for the protection of relics of land fragmentation as a unique form of cultural landscape in the urban zone, which could significantly diversify the landscape structure of the city and increase its biodiversity. In the authors' opinion, the analyzed, highly fragmented land currently not used, disfigures the city landscape. It could easily be developed by restoring naturalized baulks between the plots, which would provide an enclave for the development of natural biodiversity and, at the same time, emphasize the existing cultural divisions of the properties. The plots of land themselves, on the other hand, should be landscaped with naturalized greenery in the form of multi-species floral meadows, diversified with, for example, hydrophilous or herbaceous vegetation to improve the water retention of the land and thus support the urban structure in terms of limiting the adverse changes to the city's climate.

We believe that the assessment, interpretation and possible proposal for the protection of the extremely fragmented landscapes in both Białystok and its vicinity, could serve as a model for similar studies and conservation attempts for other territories in Poland. The selected Polish cases are conspicuous by their spatial scale, fragmentation degree and heterogeneity of spatial context (urban and rural locations).

The discussed Polish cases can serve as an example or possibly as a frame of reference when considering the needs and possibilities of protecting fragmented land in countries other than Poland, except the fact that the relevance of the factors that constitute the historical and cultural values of such landscapes will then be different.

Of course, the disadvantages of fragmented land should also be taken into account. In general, land fragmentation hinders or prevents the use of efficient agricultural machinery and industrial farming methods, thus reducing the efficiency of agricultural production; it also generates costs of management, so that it is detrimental to the economic efficiency of land use, while it promotes the preservation of biodiversity, enriches the visual aesthetics of the landscape and boosts its tourist attractiveness. The visual and tourist attractiveness of fragmented landscapes correlates with the exposure of baulks.

There is also a need to develop a scenario that would allow for the development of sustainable planning, taking into account the preservation and protection of relics of fragmented landscapes, but preventing excessive loss of agricultural land and other negative effects of land fragmentation.

Future research perspectives

Based on our research to date, we have not assessed ownership parameters, such as mean number of plots per farm or the average number of co-owners per plot. Their use is expected to benefit future EFL examination with 'social' factors. They are alternative measures for land fragmentation. Will the EFL distribution map assessed with 'plots geometry' match the relevant EFL distribution map measured with 'plots per farm' parameter or with 'co-ownership parameter'? At present, we do not know the answer to this question.

The results of the study also prompt further questions related to any “fossil landscapes” that include EFL: Do they still affect the landscape, where and how? Should they be the target of conservation efforts?

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Conflict of interest

The authors declare no conflict of interest.

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