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REGIONALISATION OF UNUTILISED AGRICULTURAL AREA IN POLAND

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Abstract. Until the marketization of economy in 1990, practically there was no unutilised agricultural land in Poland. After the political transformation, the use of marginal land and part of small agricultural parcels located in areas of better soil agricultural suitability became unprofitable for economic reasons. Despite the reform of Polish agriculture, the problem of not using a large part of agricultural land is constantly present. There are currently no detailed data available on the actual scale of regionalisation and the structure of the landuse abandonment in Poland. Due to the above, the objective of this study is to fill knowledge gaps on this phenomenon. Analyses were performed based on cadastral maps for the whole country. It is the first comprehensive and detailed study of this issue, giving the full review of the regionalisation of abandoned land. Unutilised land defined as: cadastral parcels located on rural land, which is not declared as production area by farmers.

The study has shown that currently in Poland more than 2.7 million ha of agricultural land is not declared by the farmers as area for agricultural activity. This assessment includes 2.03 million ha of unutilised areas of effective production (parcels > 0.3 ha), which constitutes 14.2% of the overall agricultural area. A significant proportion of the unutilised agricultural land constitute medium and high productivity soils: 59.7 thousand ha of class III, 73.87 thousand ha of class IIIa, 116.6 thousand ha of class IIIb, 240 thousand ha of class IV, 225 thousand ha of class IVa,

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221 thousand ha of class IVb. Analyses showed clear regionalisation of the problem of unused potential in the agricultural production area. This situation is particularly visible in Małopolskie, Podkarpackie, Świętokrzyskie, Śląskie, and part of Mazowieckie voivodeships.

Keywords: unutilised agricultural areas, abandoned areas, land use and land-use change, spatial analysis

INTRODUCTION

Until the marketization of economy in 1990, there was no unutilised agricultural land in Poland. In 1944–1989, during the times of the People's Republic of Poland (PRL), the government pursued cheap-food policy, supporting the investment expenditures in agriculture, as well as ongoing production from the state budget. Such policy generated resources of "marginal" workforce (mainly in individual holdings), which entailed the use of all possible land resources for agricultural production, even poor quality land. After the political transformation in Poland, the use of marginal land and part of small agricultural parcels located in areas of better soil agricultural suitability became unprofitable for economic reasons. It was particularly visible in large state-owned agricultural holdings, which were soon subjected to privatisation (Michna 1998).

Additionally, changes in the demographic structure of the Polish rural areas led to a waning interest in pursuing farming activity in small agricultural holdings with fragmented field structure (GUS d). In 1992, the State Treasury Agricultural Property Agency (AWRSK) assigned 60 thousand ha of marginal soils to afforestation. In the next year, AWRSK identified more than 300 thousand ha of land, for which the exploitation costs exceeded the profits (Michna 1998). The described changes in agriculture which took place in the 1990s highly affected the agricultural landscape as well. In many regions, as a result of the abandonment of land use and the succession of natural vegetation, many agricultural parcels became covered with trees and shrubbery (Kostuch 2003). This effect may be observed even today, despite the activation of Polish agriculture after the Polish accession into the European Union. Since 2004, farmers can apply for financial support for their business activities. The aid paid to farmers by the Agency for Restructuring and Modernization of Agriculture (ARMiR) under the Rural Development Programme (PROW) is a relevant factor in economically viable food production, therefore, nearly every active agricultural holding (except for a small percentage) applies for this kind of financial aid. The PROW instruments influence also those owners of agricultural holdings, for whom agricultural activity is not the primary source of income. In such a case, farmers can apply for single areapayment (Polish: JPO) for the utilized agricultural area maintained in good agricultural condition. It is defined by ARiMR as the area maintained in condition which makes it suitable for grazing or cultivation by carrying out at least one of agrotechnical practices consisting of removal or destruction of undesirable vege-

tation before 31 July of the claim year. In areas with significant natural or other specific constraints, agricultural activity is supported under less favoured areas (LFA) payments scheme under the Measure 13 of PROW (2014–2020).

The problem of rationalizing the use of the least fertile soils (marginal soils) was studied and described in depth in 1995–1998, within the framework of the national research project PBZ098-02, funded by the State Committee for Scientific Research (Michna and Rokicka 1998). The project demonstrated that, the weakest complexes of agricultural usefulness of soils: periodically dry complex No. 7 and water-saturated complex No. 6, constitute 13.6% of utilised agricultural area (UAA) which is equal to ca. 2 million ha. Due to their properties, these soils should be converted for landuse alternative to agricultural production (e.g. afforested), whereas sandy soils, which meet the farming criteria (complex No. 6 and periodically dry complex No. 5) constitute more than 18% of UAA (ca. 2.8 million ha). Based on the data from the Central Statistical Office (GUS), the total agricultural area currently amounts to more than 14.3 million ha, of which 14 241 thousand ha is the utilised agricultural area "in good condition" (data for 2016, Table 1). When analysing the changes in the area on which livestock and crop production is held, attention should be paid to the landuse structure. The main classes are: arable land, meadows and pastures, which constitute respectively 74, 18 and 3% of agricultural land (2016).

Table 1. Changes in the utilised agricultural area in Poland in the years 1990–2016 (thous. ha)

Classes of utilised agricultural area	1990*a)	1995*a)	1996*b)	2002*b)	2005*c)	2010*b)	2016*c)
Utilised agricultural area	18 720	18 622	18 475	16 899	15 906	15 503	14 376
arable	14 388	14 286	14 088	13 066	12 085	10 945	10 734
meadows	2 475	2 417	2 760	2 531	2 529	2 629	2 658*d)
pastures (grazing areas)	1 585	1 629	1 365	1 031	858	654	435*d)
utilised area in good agricultural condition, acc. to the new def.						14 603	14 241

a) Statistical Pocketbook 2000 , p. 275 (GUS)
b) agricultural census 1996, 2002, 2010 (GUS)
c) Local Data Bank (GUS)
d) Statistical Yearbooks of agriculture and rural areas 2016 (GUS)

Figure 1 presents a decreasing trend in utilised agricultural area, observed since the political and economic transformation in Poland. The chart based on the data from Table 1 visualizes the cadastral changes subsequent to formal changes in

the land use, that is conversion of the agricultural production area to built-up area, intended for infrastructure or afforestation. Before the direct payment scheme became effective and obliging farmers to submit land use declarations, the Central Statistical Office had limited possibilities of assessing the scale of land-use abandonment, especially in case of small private agricultural holdings. Therefore, the presented data for the years 1990 refer to the formal situation and do not represent the actual production area. For this period the most reliable data could be found in the agricultural census (1996, 2002, 2010). According to the Central Statistical Office, the utilised agricultural area currently amounts to 10.7 million ha of arable land and decreased by 25.3% in comparison to the year 1990. In case of permanent grasslands (meadows and pastures), currently 3.09 million ha is utilised (change by 23.9% compared to 1990) (GUS: stat.gov.pl). Meadows are the only landuse class where increase of the area can be observed, followed by subsequent reduction of area under pastures. This resulted from changes in cattle farming.

Changes in the utilised agricultural area were the subject of many publications during the last 3 decades. Błoch and Faber (2007) analysed the trends and pace of changes in particular voivodeships (NUTS-2) in the years 1995–2005. Sajnóg and Wójcik (2013) presented possibilities of marginal and abandoned land management in the process of land reparcelling and consolidation, while the barriers for agrarian structure transformation in Polish agriculture were dis-

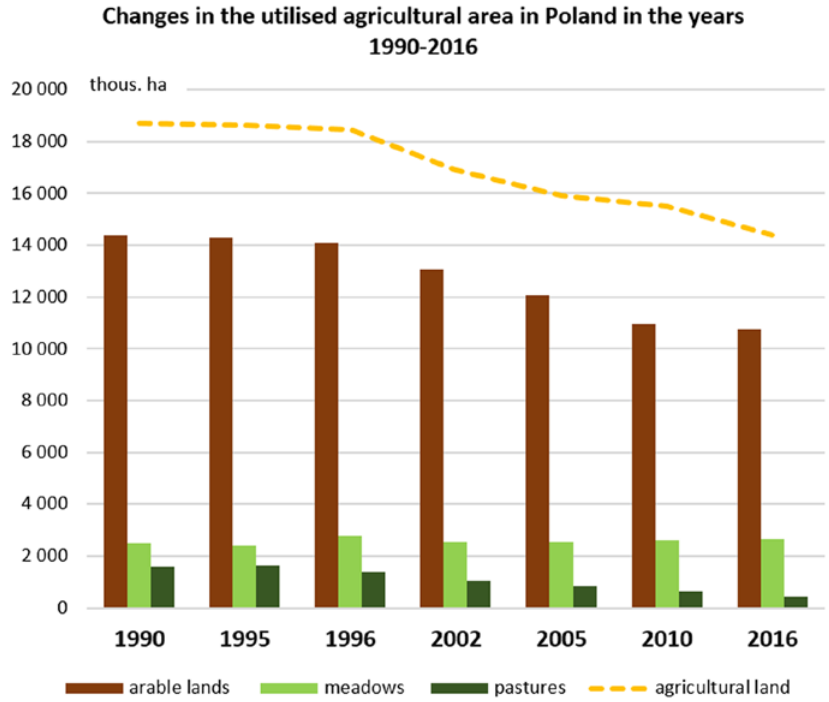

Fig. 1. Trend in changes of utilised agricultural area in the years 1990–2016

cussed by Musiał and Wojewodzic (2015). The scale of land use abandonment is regionally diversified. Kolecka and the team (2017) presented the case of set-aside lands in Polish Carpathians, perceived as the region where natural succession on arable land is a distinctive component of the landscape.

The problem of set-aside land concerns not only Poland. Orłowski and Nowak (2004) identified the urbanization of rural area together with socio-economic determinants as the main causes of this phenomenon both in Europe and in North America. The CAP model adopted in EU member states has a determining influence on (the directions of) agricultural production and land-use changes. Modelling of this impact, with particular focus on the dynamics of setting land aside, was the aim of the analyses performed in the SENSOR project (Helming 2008, 2011), as well as by the teams led by Renwick (2013) and van der Zanden (2017). Lasanta *et al.* (2017) characterised the range of set-aside land in Europe, its subsequent stages, as well as reasons for the process to occur.

Despite the statistical data presented, there are currently no data available on the actual scale of regionalization and the structure of the land use abandonment in Poland. Due to the above, the objective of this study is to fill knowledge gaps on this phenomenon. Analyses were performed based on cadastral maps for the whole country. It is the first comprehensive and detailed study of this issue, giving the full review of the regionalisation of abandoned land. Unutilised land defined as: cadastral parcels located on rural land, which is not declared as production area, and consequently, their owners, do not apply to ARiMR for direct payments. This criterion has been adopted as a definition of "unutilised agricultural area".

The research was conducted based on spatial analysis method in the GIS environment. The results were summarized for local administrative units of the second national level (Polish: *powiat*), which is equivalent of LAU-1 (or NUTS-4) according to the EUROSTAT nomenclature. It allowed to visualize the regionalisation of the studied phenomenon with using a choropleth map. The databases created were incorporated in the Integrated Spatial Information System for Agricultural Production in Poland, systematically developed by IUNG – PIB, Puławy (Stuczyński *et al*. 2006).

MATERIALS AND METHODS

Databases

The analysis was carried out based on data from the Agency for Restructuring and Modernization of Agriculture, collected for the purpose of Rural Development Programme implementation. The data were obtained in spatial (shp) and tabular (csv) formats. Spatial data specify the location of all the cadastral parcels in Poland. Database for the year 2016 contains more than 34.7 million polygons

representing single objects together with their attribute tables. The main attribute is a unique number consisting of the TERYT (TERC) code and the number of the parcel in the cadastral region. The tabular data used in the analyses were derived from two databases. The first one, based on the farmers' declarations submitted to ARiMR as a part of their applications for direct payments, provides information on the use of agricultural parcels, which are part of cadastral parcels. The complete list of this database consists of more than 21.7 million of data records. The second tabular database specifies the use class, the so-called *klasoużytek*. In the land and buildings register (EGiB), it is identical with the landuse designation (OFU), and in case of land covered by soil classification, it is determined by the combination of land use designation associated with the soil valuation class (OZU) and the designation of soil valuation class itself (OZK). OZU and OZK attributes in the land and buildings register must be presented combined (Dz.U. z 2001 r. Nr 38). The complete list of this database consists of more than 67.3 million of data records.

Selection criteria

It was assumed that the unutilised agricultural land is a cadastral parcel (or a part of it) having the attributes of an agricultural land (arable land, meadow, pasture, orchard, arable land with trees or shrubs), which is not included in the declarations submitted to ARiMR (in applications for direct payments). Agricultural land such as agricultural land under buildings, roads, ponds or ditches were excluded from the analysis. For the above types the OFU nomenclature was used. It should be noted, that the above definition of the selection criteria does not concern the actual fallow land only, but also the utilised land which is not reported toARiMR. The land classified by the OFU as agricultural wasteland also was not included in the analysis due to its marginal importance for the potential agri-food production.

Spatial analyses

The analysis model is shown in Figure 2. In step one, all the information was imported to the PostgreSQL relational database. Data in the GIS format can be imported thanks to PostGIS extension, which enables coupling of geometrical data with the tabular data structure. The choice of the database as the analysis tool was dictated by the size of input data, which significantly limited the possibility of applying the commonly used tools of geographic processing offered by desktop GIS software. Next, a relational database was created. It is possible to assign land use classes and soil valuation classes (*klasoużytki*) to spatial location of polygons thanks to the common index number, which is the unique number of the cadastral parcel. It should be noted, however, that in such a structure of data a one-to-many relationship occurs, which means that one cadastral parcel may correspond to many records from the database (*klasoużytki*) (Fig. 2, step 2).

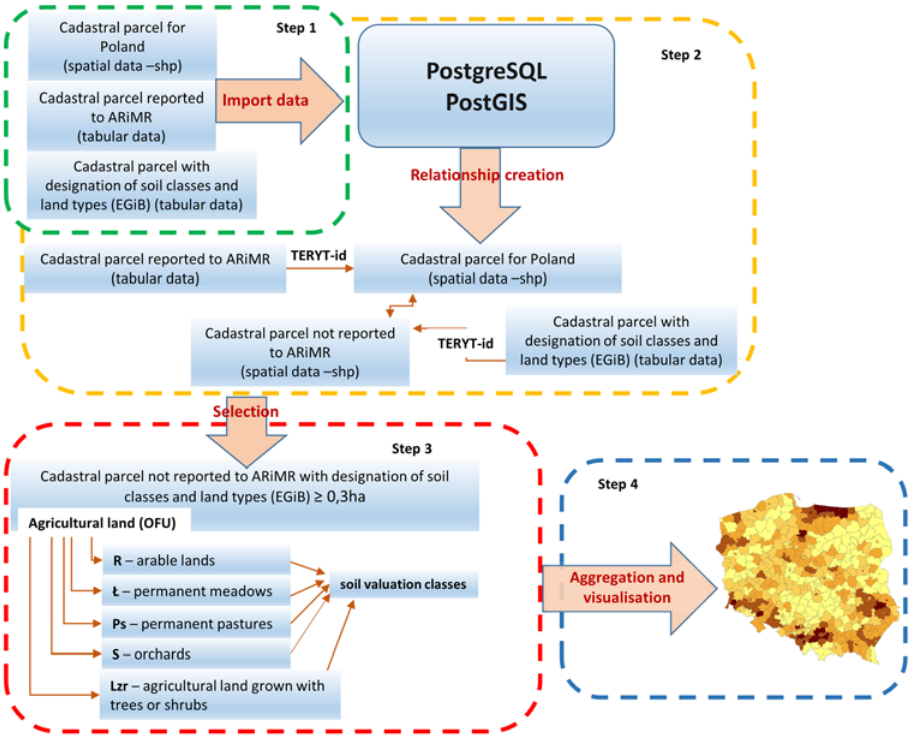

Fig. 2. Flowchart of analysis. Step 1: databases import; Step 2: developing relational database; Step 3: geoprocessing; Step 4: visualisation by choropleth map

From this structure of data, the following cadastral parcels were selected:

- not entitled to direct payments and larger or equal 0.3 ha,
- within which the following uses of area were identified (based on OFU): arable lands (R), permanent meadows (Ł), permanent pastures (Ps), orchards (S) or agricultural land grown with trees or shrubs (Lzr).

Then, the database of parcels selected by above methods was coupled with the attributes of EGiB/OZK database. Thanks to this, it was possible to list all the existing combinations "land use type" – "valuation class" that meet the assumed criteria and define the area for each of the records from this table (Fig. 2, step 3).

Visualisation of results

Regionalisation of the unutilised agricultural land in Poland was carried out through a result tabulated for NUTS-4 units, which consisted in summarizing the area of all units defined in step 3 of the analyses (Fig. 2, step 4). General statistics were also presented, relating to the area of the particular valuation classes, which are not utilised in Poland.

RESULTS AND DISCUSSION

The study has shown that currently in Poland more than 2.7 million ha of rural land is not declared by the farmers as the area for agricultural activity, and cadastral parcels with areas exceeding 0.3 ha constitute 2 million ha of that group. In this study, the area of 0.3 ha is adopted as a reference value for determining the area directly affecting food production in Poland. Moreover, small cadastral parcels with attributes such as those accepted in the study (Lzr, Ł, Ps, R, S) are often, in fact, building plots excluded from agricultural area and designated for housing. Another reason for limiting the size of an agricultural parcel is the provision of applicable law, Art. 1 of the Act on Shaping of the Agricultural System (Dz.U. 2017.0.2196) states that it cannot be applied to agricultural property covering an area of less than 0.3 ha – thus, defining the areas that may be subject to land use change, especially when allowed by land development conditions included in local land development plans.

Figure 3 presents regionalisation of unutilised agricultural land in Poland. The choropleth map includes 315 out of 380 NUTS-4 (excluding 65 urban units). Based on the map, administrative units with high and low percentage of unutilised agricultural area can be already identified at the level of NUTS-4. The problem of setting land aside mostly concerns the south-eastern part of the country, where 5 "hot" regions can be identified: Carpathians, northern part of the Śląskie and Świętokrzyskie voivodeships, Podkarpackie voivodeship, and units located around the Warsaw district. This area is dominated with unutilised agricultural area exceeding 50% of the total area declared for single areapayments. In case of Carpathians, the obtained results are in agreement with the study of Kolecka *et al.* (2017), which additionally includes a detailed analysis of the underlying causes of this phenomenon. Other regions with high percentage of abandoned land are located in the north of Poland (Pomorskie and Zachodniopomorskie voivodeships) and in the western cluster of NUTS-4 along the border from Kotlina Kłodzka to the estuary of the Nysa Łużycka river. The map below (Fig. 3) includes also the main rivers in Poland. A comparison of the course of rivers and the regionalisation of unutilised agricultural area reveals spatial correlation between the two. It can be seen particularly for the Odra, Bóbr, Lower Noteć and Bug rivers. It confirms the observed regularity that abandoned land is usually located alongside rivers and traffic routes. However, a full analysis of this correlation will be possible after conducting a comparative study of the buffer zones along the linear objects.

From the point of view of the economics of agricultural production, abandoned land should be located on the lowest quality soils and marginal soils (Michna 1998, Michna and Rokicka 1998). However, the study of the percentage of particular soil valuation classes proves otherwise (Fig. 4). Although, as expected, the highest percentage of abandoned land falls for soils of V and VI

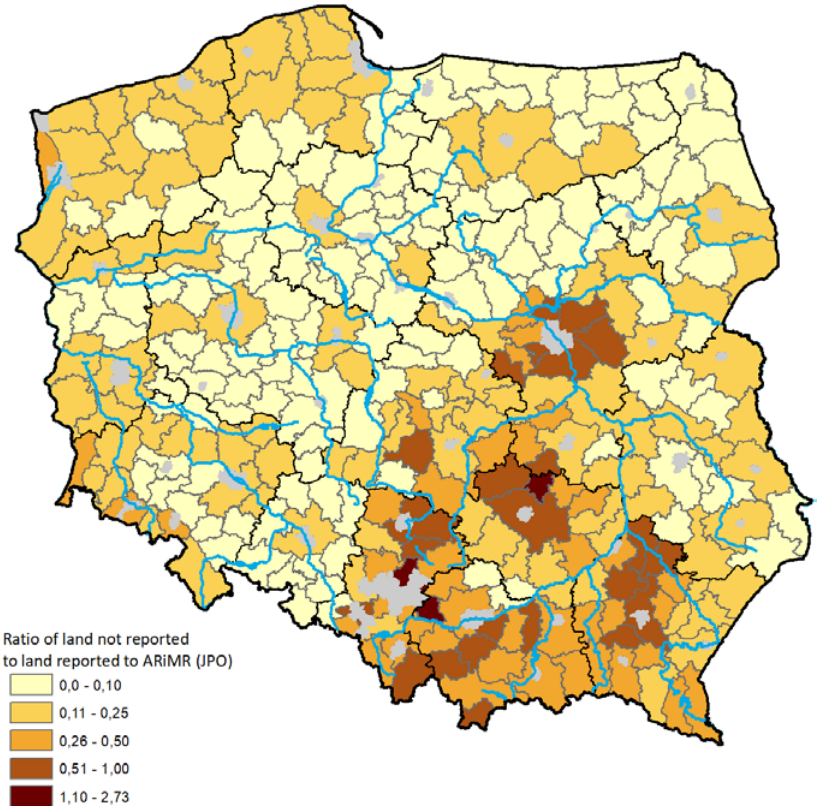

Fig. 3. Regionalisation of unutilised agricultural area

valuation classes, which due to their natural conditions in many cases may be converted for other types of land use without serious consequences for agriculture. It is estimated that more than 440 thousand ha of arable land on soils of IV class and ca. 170 thousand ha on soils of III class is unutilised. In case of class IV there is additionally 240 thousand ha of unutilised grasslands and pastures. The best and very good quality soils (class I and II) constitute a negligible share of abandoned land, therefore, it is surprising that on soils of II valuation class there is 20 thousand ha of unutilised arable land. Considering the quality of soil, the percentage of abandoned land for these valuation classes should be close to zero, as it is in case of valuation class I. On soils of VIz valuation class, as well as areas covered with trees and shrubbery (Lzr), the percentage of unutilized area is insignificant. In the first case, class VIz represents small areas in comparison to other classes, which translates into actually unutilised areas. Likewise in the second case, where it should be noted that this land-use class does not formally represent the situation when trees and bushes appear as a result of natural succession on abandoned land.

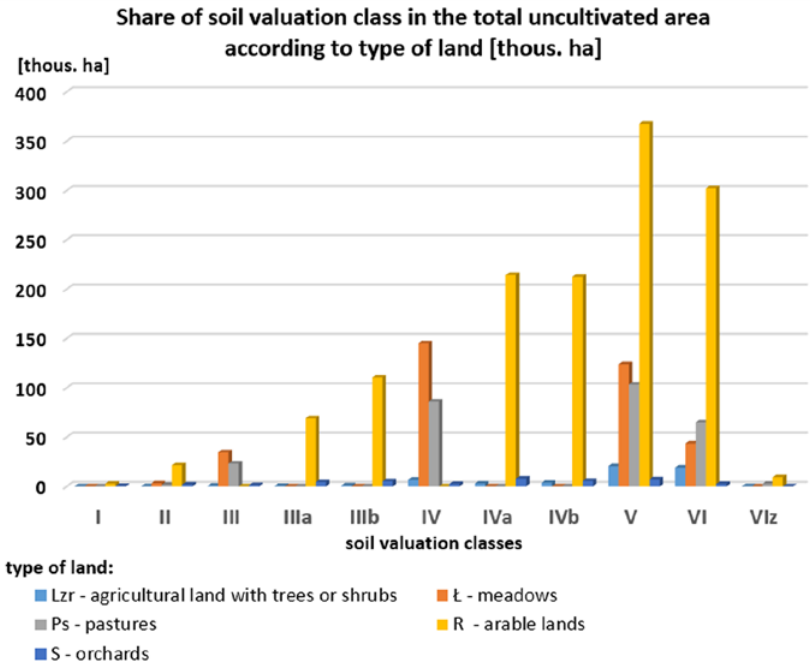

Fig. 4. Share of valuation class (I – VIz) in the total uncultivated area according to landuse classes. Valuation classes: I – best quality soils, II – very good quality soils, III – good quality soils (Ł, Ps), IIIa – good quality soils (R, S), IIIb – fairly-good quality soils (R, S), IV – medium quality soils (Ł, Ps; in case of arable land and orchards, a/better, b/worse), V – poor quality soils (Ł, Ps, R, S), VI – the poorest quality soils (Ł, Ps, R, S), VIz – the poorest quality soils, permanently dry or water-saturated/wet (R, S)

Data quality evaluation and its impact on the results of analyses

Performed calculations of areas were based on the EGiB database. Therefore, the error of estimation is directly related to data quality. There is a limitation resulting from the encoding precision of *klasoużytki* area (two decimal places), which does not have a major impact on particular parcels, but may affect the results in case of the sum of areas in theregion. Furthermore, the sum of areas of *klasoużytki* within a cadastral parcel often significantly differs from the total area of the parcel computed based on the shape of a polygon. It confirms the existing discrepancies between the spatial data of ARiMR and the cadastral data from EGiB. In both cases, the discrepancies result from their autonomous development and ongoing database updates, occurring with different regularity.

Moreover, it can be observed that although a small percentage of farmers maintained their land in good agricultural and environmental condition, they do not report it to the Agency for Restructuring and Modernization of Agriculture. In consequence, they do not receive the financial support. It concerns mainly small agricultural holdings and farmers having low social awareness. This situa-

tion obviously leads to an overestimation of results obtained using this method. Due to lack of statistical data, further analyses of the utilized agricultural area which is not reported to the ARiMR will be performed using remote sensing methods for the selected cadastral parcels.

Initial verification of the results by remote sensing methods and planned further research

In the regions characterised by the highest percentage of unutilised agricultural area, there is a possibility that it is a long-term process having a permanent impact on the landscape (Kolecka *et al*. 2017, Kostuch 2003, Lasanta *et al*. 2017). Therefore, a preliminary assessment of the progress stage of natural succession on abandoned land has been attempted using aerial photography (orthophoto map) of cadastral parcels classified according to the above methodology as unutilised. The results have shown that in three administrative units the unutilized area exceeds the utilized one – in the NUTS-4: będziński, chrzanowski and skarżyski (there area of abandoned land exceeds the utilized area 2.7 times!). Figure 5 presents a representative sample, which verified the correctness of the performed analyses. In the presented area, cadastral parcels are, in fact, unutilised (red line) and the natural succession indicated that the area was abandoned many years ago. In the majority of cases, abandoned are usually small parcels (<1ha), located on low quality soils. For the remaining areas the results obtained were similar.

Fig. 5. Example of landscape from the region characterised by the highest percentage of unutilised agricultural area – NUTS-4: skarżyski, NUTS-5: Bliżyn. Blue lines: boundaries of the cadastral parcels, red lines: unutilised parcels

Source of ortophoto map: geoportal.gov.pl

The research was possible thanks to the development of a thematically dedicated subsystem (project) within the Integrated Spatial Information System for Agricultural Production in Poland. The subsystem is one of the GIS based modules (models), which can be called "Model of Unutilised Land". It constitutes the basis for future analyses, which will aim to specify and validate the results of this study. In the next step, all the cadastral parcels classified as "unutilised" will be verified using remote sensing methods based on Sentinel satellite images. The classification will regard identification of parcels under agricultural use which were not reported to the Agency for Restructuring and Modernization of Agriculture due to different reasons. Then, the obtained results will be subjected to economic and environmental analyses in order to identify the optimum strategy for restoring fallow land to agricultural production or its conversion for other purposes (environmental or infrastructural).

CONCLUSIONS

Based on the current development stage of the "Model of Unutilised Land", the following conclusions may be formulated:

1. Unutilised land may cover even 2.03 million ha, which constitutes 14.2% of the overall agricultural area.
2. A significant proportion of the unutilised agricultural land constitute medium and high productivity soils: 59.7 thousand ha of class III, 73.87 thousand ha of class IIIa, 116.6 thousand ha of class IIIb, 240 thousand ha of class IV, 225 thousand ha of class IVa, 221 thousand ha of class IVb.
3. Analyses showed clear regionalization of the problem of unused potential in the agricultural production area. The problem is particularly visible in the following voivodeships: Małopolskie, Podkarpackie, Świętokrzyskie, Śląskie, and part of Mazowieckie.
4. For 28 units of 315 analysed NUTS-4, the agricultural area which was not reported to the ARiMR in applications for area payments constitutes more than half of the area declared by the farmers for single area payments. In 3 of these regions the unutilised area exceeds the area agriculturally utilised.
5. Analyses confirmed that the main problem in fallowing rural land in Poland is high fragmentation of agricultural holdings with the simultaneous occurrence of low fertility soils.

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