European Research Studies Journal
Volume XXIV, Special Issue 3, 2021

pp. 351-364

Evaluation of Changes in Exclusion of Arable Land from Agricultural Production in Poland in the Context of Guidelines of the Strategy for Responsible Development

Submitted 11/07/21, 1st revision 02/08/21, 2nd revision 21/08/21, accepted 15/09/21

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Abstract:

Purpose: *The identification of changes in the exclusion of arable land from agricultural production in Poland and the demonstration of trends in the presence of the Strategy of Responsible Development (Polish acronym: SOR).*
Design/Methodology/Approach: *An analysis, parallel to a literature review, was conducted using the local databanks of Statistics Poland (GUS) concerning the exclusion of arable land in Poland, broken down into provinces (voivodeships). The research involved the use of an index of changes with the variable base. A forecast until 2030 was also elaborated, based on the logistic function.*
Findings: *The research results have shown that excluding arable land from agricultural production was not altered under the influence of the Strategy for Responsible Development (SOR). The research covering the period before the SOR (2010-2015) was developed and, while it was operational, did not indicate a change in tendencies. The largest share of exclusions was made for residential purposes, and the 2030 perspective envisages a further growth of this share.*
Practical Implications: *An objective of the SOR was to limit the expansion onto undeveloped areas by giving the preference to renewed use of land and thus putting the brakes on the uncontrolled urban sprawl. However, the latter tendency accelerates rather than slows down at the expense of arable land around urban centers.*
Originality/Value: *Because of the specific properties of land (it does not increase in size and is immovable) and because of the rise in the dynamics of exclusions of arable land from agricultural use, there is a need for constant research and elaboration of the theoretical background for rational management of agricultural real estate properties by the principles of sustainable development.*

Keywords: *Arable land, agricultural production, sustainable development, strategy for responsible development (SOR), Poland.*

JEL codes: *Q01, Q15, Q24, R141, R54.*

Paper Type: *Research article.*

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1. Introduction

Agricultural land remains a specific, rare asset (as it cannot increase in size or cannot be moved), demanding rational management by the fundamental principles of sustainable development. It is necessary to conduct a strategic policy of agricultural land management globally, within groups of countries (e.g., the European Union), and in every country. A rational policy in this respect should take into consideration food and energy security, as well as construction and development of the desired infrastructure in order to ensure the country's social and economic progress and improvement of living conditions (Grzybowska-Brzezińska and Kuberska and Wojarska, 2017; Marks-Bielska, 2020; Mickiewicz, Zaremba, and Bera, 2021).

The amount of agricultural land is rapidly decreasing around the world, which is a problem raised in numerous studies and analyses (Gurtin and MacCamy, 1974; Guckenheimer, Oster, and Ipaktchi, 1977; Ehrlich and Ehrlich, 1990; Ranta *et al.*, 1995; Bjørnstad, Ims, and Lambin, 1999; Korotayev, 2006; Łowicki, 2008; Gignoux, Henn, and Mountain, 2011; Mondal and Zhang, 2018; Kurowska, Marks-Bielska, Mika, and Leń, 2020). Studies commissioned by the UN demonstrate that the availability and use of cropland, which amounts to 1,500 million hectares globally, are not sufficient to satisfy the world population's rapidly growing demand for food. The co-called safe operating space is estimated at 1,640 million hectares (UNEP, 2014). Demographic forecasts and the widespread improvement in the quality of life (escaping the state of extreme poverty) in the most populous countries of China and India allows one to assume that the demand for agricultural land will be growing fast.

In the years 2000-2030, the area of agricultural land lost due to the expansion of cities will have reached from 48 to100 million hectares worldwide, depending on estimates (UNEP, 2014). The data gathered by Statistics Poland indicate that 6 million ha of arable land in Poland had been excluded from agricultural use in 1946-2016.

Poland stepped on the path of intense growth and socio-economic development during the state transformation of the 1990s, followed by its accession to the European Union in 2004. Along with economic growth, the standard of living is on the rise. Residential and infrastructural investments demand an ever-growing amount of land. The loss of agricultural land occurs in all European countries, although at varied intensity; this happens because the land is used for residential or infrastructural development and because some are abandoned by farmers (Wilkin, 2018).

Rational management of assets, including agricultural properties, is a conscious, individual, or communal effort, which involves the distribution of limited resources between competing types of users based on rational assumptions, and the use of these resources for the optimal benefit, i.e., the production and distribution of assets (goods and services) in a manner satisfying social needs while simultaneously ensuring their frugal use with no harm to the natural environment or the living conditions of the society. Land management will continue to entail the protection of property rights and

stimulation of the real estate market. As such, it should be more proactive and focused on issues of complex environment protection and procedures of sustainable development (Źróbek *et al.,* 2014).

A document addressing these needs in Poland is the Strategy for Responsible Development (the Polish acronym: SOR) until 2020 with the 2030 year perspective (Gov.pl, 2017) adopted by the Council of Ministers on 14 February 2017. This is a crucial document issued by the Polish state regarding its medium- and long-term economic policy. It is consistent with the documents passed by the European Union for sustainable development and with sector strategies approved in Poland (9 integrated strategies, including the Strategy for the sustainable development of rural areas, agriculture, and fishing) and operational programs.

The Strategy determines the primary conditions, objectives, and directions for the development of Poland in the social, economic, regional, and spatial dimensions with the perspective until years 2020 and 2030. The SOR presents a new model of growth, namely responsible development and social and territorial sustainability. It is based on individual territorial potential, investments, innovation, development, export, and highly processed goods. The new model involves abandoning the support to all sectors and industries for the sake of support to strategic sectors, which may become the driving engine of the Polish economy. Its fundamental challenge is to rebuild the economic model so as it should serve the whole society.

All sector strategies and the SOR aim to enhance the competitiveness and innovation of the Polish economy and the effectiveness and efficiency of the state institutions; another objective is to level the differences between the provinces. Each Strategy, including the SOR, must comply with the principle stated in Article 5 of the Polish Constitution, "The Republic of Poland (…) shall ensure the protection of the natural environment under the principles of sustainable development." The forecast of the SOR's impact on the natural environment indicates that environmental protection issues should be perceived in the broader context of sustainable development (SD), and the provision of the Constitution should be construed as an aggregate guideline tantamount to the entire statute of specific principles.

The specific principles of sustainable development were expressed in numerous documents, such as the Rio Declaration, development documents of the UN, OECD, World Bank, European Union, in the European networks of cities of sustainable development, and other specific programs (Marks and Klikocka, 2020, Kurowska, Marks-Bielska, Bielski, Aleknavičius, and Kowalczyk, 2021). The environmental impact analysis of the SOR emphasized that the Strategy complies with the constitutional principle and the principles set in the strategic documents of the EU, in particular in the Europe 2020 Strategy and the 2030 Agenda for Sustainable Development. However, some concerns can be raised over the catalog of barriers limited to economic, social, and institutional factors. "Whereas the depletion of resources, climate change, loss of biodiversity, preservation of natural capital and their

impact on development constitute a key issue in the Agenda 2030 (see the chapter "Our World Today," point 14). There are no such references in the section devoted to the development forecast for Poland until the year 2030. It seems to be merely a projection of the future social and economic situation" (gov.pl, 2016).

Even at the level of the primary target, the Strategy does not identify environmental issues and natural capital as specific strategic areas. This lack of reference to the environmental capital as a foundation of the country's development constitutes a derogation from the European proposals in this scope. Although the analysis of SOR objectives did not indicate a direct negative impact on soil and land surface, potential adverse effects may arise from the areas and directions of interventions involving the creation of new enterprises. This entails the occupation of non-urban areas, including agricultural land. During the development of the SOR and the analysis of its impact, these effects were impossible to envisage.

After a few years since the SOR entered into force, a question arises if there is evidence of the growth in excluding agricultural land for non-agricultural purposes and if the tendencies in such exclusions have changed. So far, these exclusions were mainly due to housing estate developments, particularly around urban areas.

This research and analysis aimed to identify changes occurring in excluding arable land from agricultural production in Poland and demonstrating trends under the SOR operation.

2. Research Methodology

The analyses concerning the exclusion of land from agricultural production were conducted using statistical data furnished by the Local Database of Statistics Poland (GUS). The research covered all the Polish provinces (voivodeships) in the years 2010-2019. The starting year was 2010, seven years before the Strategy for Responsible Development (SOR) entered into force. This facilitated a deeper trend analysis and enabled us to resolve whether the implementation of the SOR impacted the trends in agricultural land exclusion and if the concerns expressed in the prognosis of the environmental impact did materialize during the SOR implementation since 2017. An index of changes with the variable base was applied in this study. Furthermore, a forecast until 2030 was elaborated using the logistic function.

A good fit for historical data characterizes the logistic function. Continuation of the current situation is probably within the horizon of predictability (Peitgen, Jurgens, and Saute, 2002). The applied function solves the logistic equation of the following type (Strużak 2009):

$$\frac{dy}{dt} = y(1 - y) \tag{1}$$

In the simplest form, the function can be written as follows (Strużak, 2009):

$$y = \frac{1}{1+\exp(-t)} \tag{2}$$

where:
y – function of growth (maximum value 1),
t – time
In order to apply this function in practice, it was modified by introducing three time-constant numeral parameters determining the course of the function – a, b, and c (Grzegorek and Wierzbicki, 2009, Świdyńska, 2021):

$$y = \frac{\mathrm{a}}{1+\mathrm{b}\,\exp(-\mathrm{c}\times \mathrm{t})} \tag{3}$$

where:
$\mathrm{a}, \mathrm{b}, \mathrm{c} \geq 0$,
a – heuristically determined saturation of a given phenomenon,
b, c – parameters of the function selected by statistical estimation.

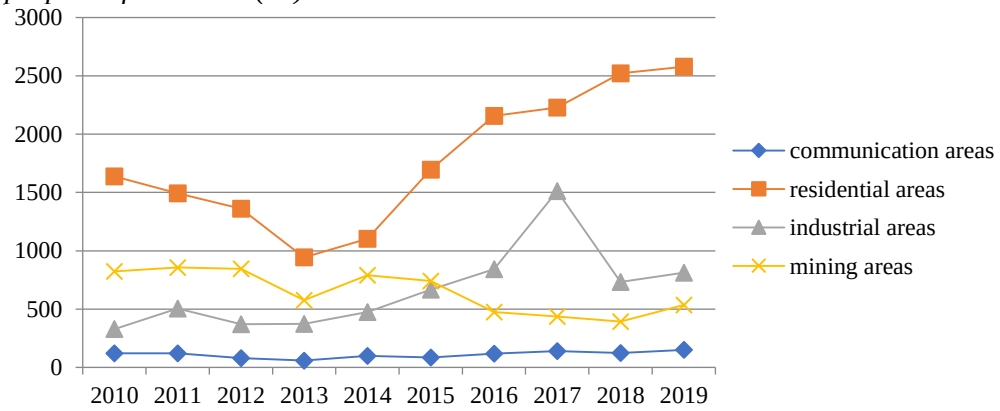
The value of parameters a, b, c must be adjusted to historical data, while the shortest time series should include at least three elements to yield credible results; the longer the time series, the better the estimation, as random errors become less relevant.

In this research, parameter a, which determines the natural level of saturation, was adopted at levels equal to the sum of the highest level of exclusion in the studied years and the range, that is, the difference between the highest and lowest value of the statistical characteristic in the set (100%). Based on the data for the years 2010-2016, using the STATISTICA statistical and analytical software, a prognostic chart was prepared for particular purposes of farmland exclusion. The logistic function's application helped us identify the developmental trends until 2030 based on the time series.

3. Results and Discussion

The results of the analyses described above demonstrate that some changes in the directions and magnitude of the exclusions took place in the period for which the SOR was devised. In the analyzed years 2010-2019, the exclusions of agricultural land for transport purposes stabilized at the same level (Figure 1). The highest increase in the exclusions was for residential purposes. This rise was exceptionally high after 2016; similarly, exclusions for industrial purposes were higher in 2016-2018 than in 2010-2015, but the difference was not as significant as in the case of residential purposes, and the increase was less stable. Finally, there was a decrease in the exclusions for mining purposes, particularly after 2016.

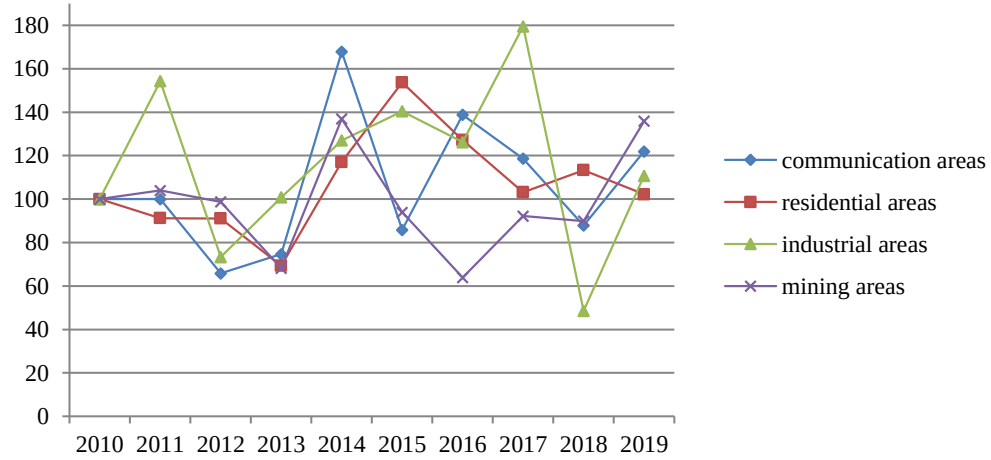
***Figure 1**. Amount of agricultural land excluded from farming according to the purpose of exclusion (ha)*



***Source:** The authors, based on data by GUS, BDL.*

The calculated dynamics of changes (Figure 2) led to a more detailed analysis. Short-term changes emerged using an index of changes with the variable base, where the base year was assumed to be every preceding year. The flattest curve is the one illustrating exclusions for residential areas. This implicates a stable trend. Since 2014, every year has witnessed the dynamics of change in the exclusions for residential areas exceeding 100%, which is no less than in the previous year. Regarding the other purposes of exclusions, there were significant fluctuations, particularly for industrial areas, after the year 2016.

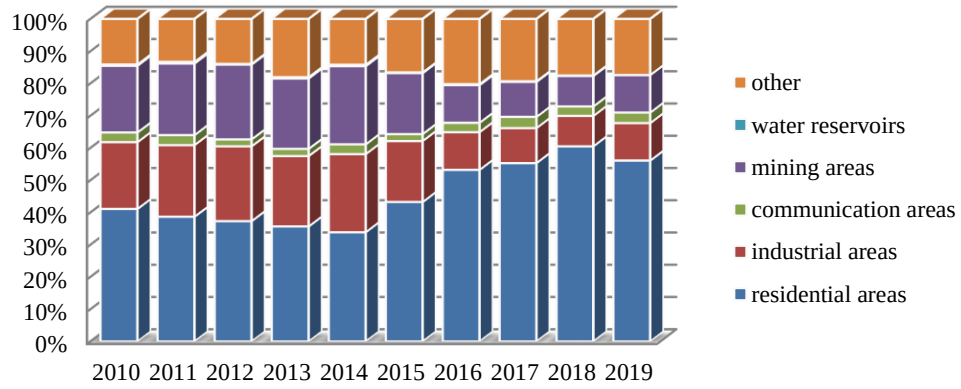
***Figure 2.** Dynamics of change (%) in the exclusion of agricultural land by the purpose of exclusion (index of changes with the variable base, where the base year is the previous year)*



***Source:** The authors, based on data by GUS, BDL*

Noteworthy is the significant change since 2016 in the structure of exclusion directions (Figure 3).

Figure 3. *Structure of directions in agricultural land exclusions*



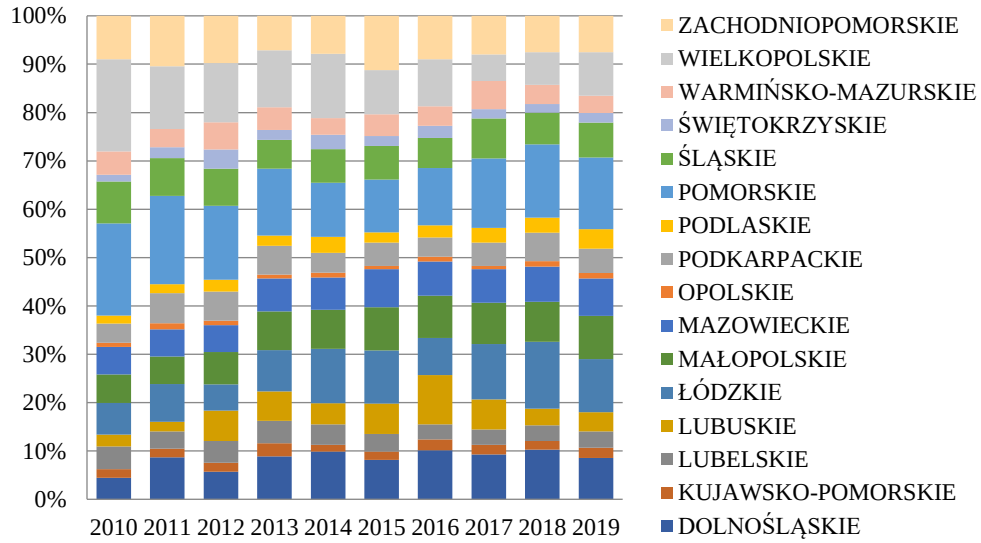
Source: *The authors, based on data by GUS, BDL.*

Between 2015 and 2019, the share of land excluded for residential purposes went up by nine percentage points, coinciding with decreasing exclusions for industrial and mining areas. Since 2012, there was an evident decrease in the exclusions for water reservoirs.

The area of excluded agricultural land varied between regions (Figure 4). The largest share of exclusions was in the provinces: pomorskie, łódzkie, wielkopolskie, dolnośląskie. A remarkable drop in the exclusions after the year 2016 was noted in the lubuskie province. The research results by Kurowska, Kryszk, Marks-Bielska, Mika, and Leń (2020) demonstrated that the province łódzkie and pomorskie are least susceptible to the loss of agricultural land and woodland resulting from the possibility of change in the designated use of land. These regions have cities (Łódź, Gdańsk, Gdynia, and Sopot) which the national spatial management plan envisages to play the role of metropolitan centers. The result of our earlier studies (Marks-Bielska and Kurowska, 2017), where the indicator of institutional effectiveness of municipalities was calculated, demonstrated that municipalities in these regions had a relatively large area covered by valid local spatial management plans, as well as high levels of own income per capita. A municipality's revenue enables it to achieve the objectives defined in the adopted and implemented spatial policy.

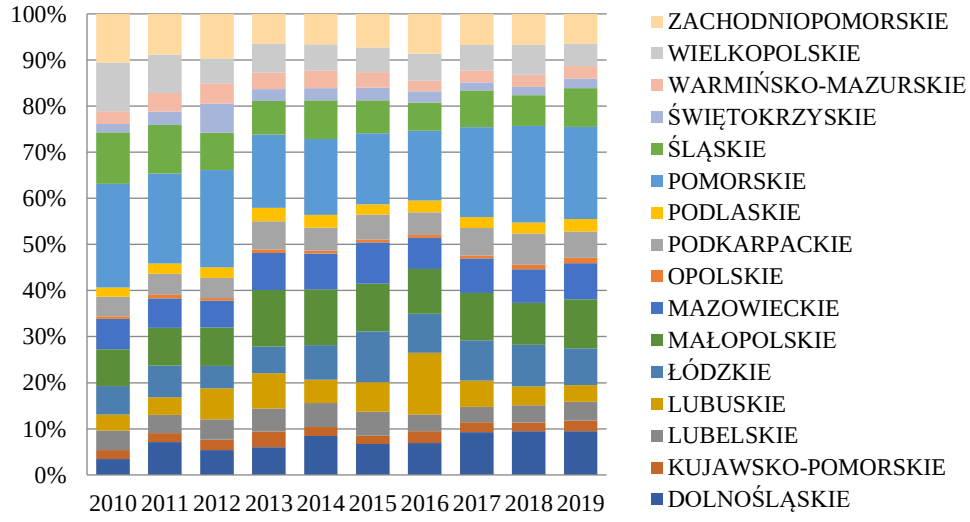
The most stable share in exclusions in the provinces was noted in farmland exclusions for residential areas (Figure 5). An increase in the value of this component since 2016 occurred in the provinces pomorskie and dolnośląskie. Exclusions for industrial areas differed significantly between the provinces and the analyzed years.

Figure 4. *Structure of agricultural land exclusions in total, by provinces*



Source: *The authors, based on data by GUS, BDL.*

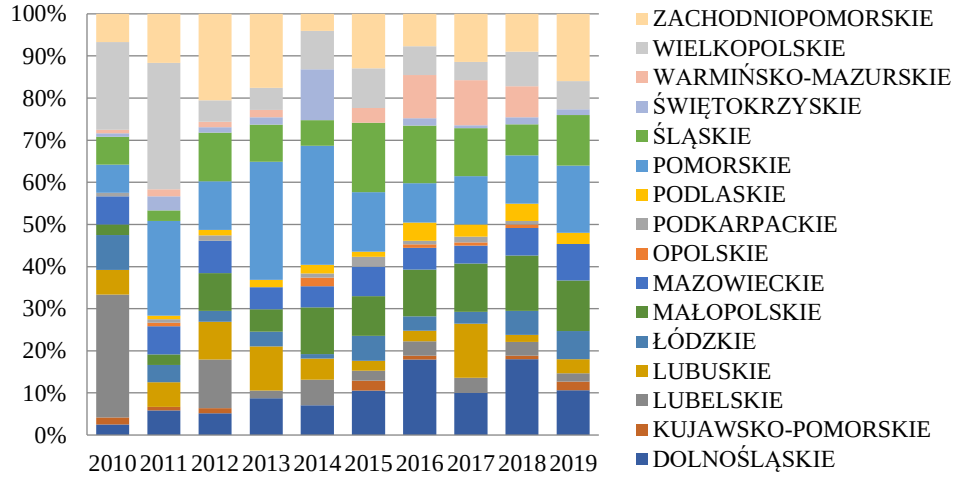
Figure 5. *Structure of agricultural land exclusions for residential areas, by provinces*



Source: *The authors, based on data by GUS, BDL.*

After 2016, a greater share of exclusions for industrial areas has been noted in *warmińsko-mazurskie*, *śląskie* and *małopolskie* (Figure 6).

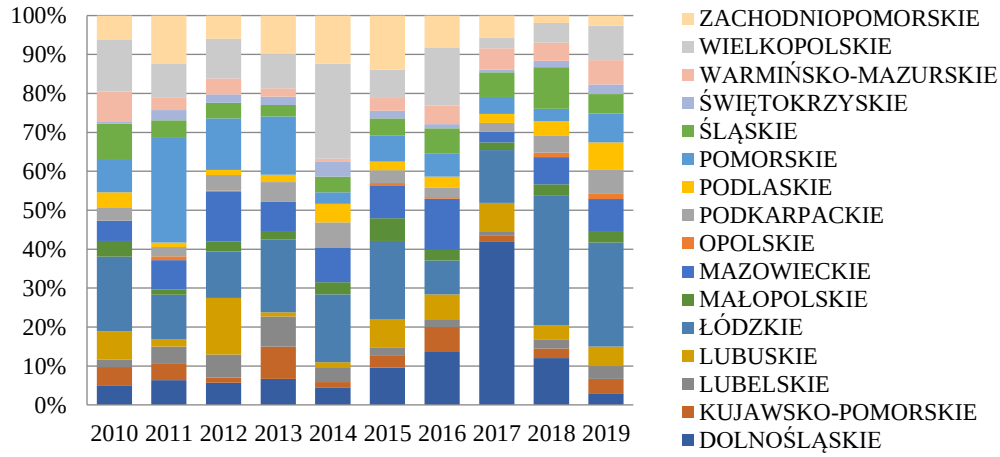
Figure 6. *Structure of agricultural land exclusions for industrial areas, by provinces*



Source: *The authors, based on data by GUS, BDL*

Exclusions for transport areas (Figure 7) and mining areas (Figure 8) were characterized by large diversity in particular years and regions. The largest share of exclusions for transport areas occurred in *łódzkie* and *dolnośląskie*.

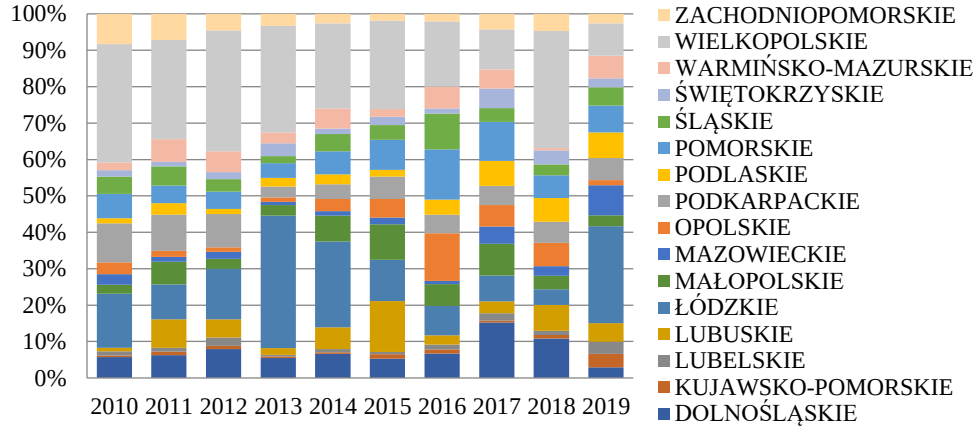
Figure 7. *Structure of agricultural land exclusions for transport areas, by provinces*



Source: *The authors, based on data by GUS, BDL.*

Exclusions for mining areas in Poland have declined by 9 pp since 2016, mainly due to the decrease in such exclusions in wielkopolskie. In 2018, this province had a large, 30% share of such exclusions, while in 2019, there was a 20% share in łódzkie. These two are the provinces with a relatively significant contribution of farmland exclusions for this purpose in 2010, which continued to decrease until 2018 (Figure 8).

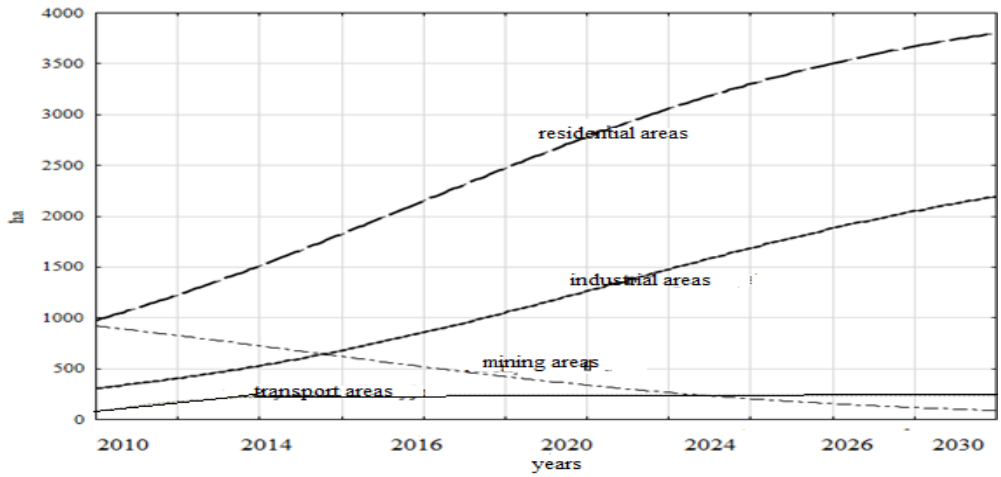
Figure 8. *Structure of agricultural land exclusions for mining areas, by provinces*



Source: *The authors, based on data by GUS, BLD.*

The forecasting analysis allowed us to predict changes in exclusions of agricultural land, as it involves scientific modeling of a probable course of future events. Besides, the informative function of forecasts should be seen as factors that stimulate measures to attain good predictions and avert unfavorable developments (Strużak, 2009). Based on the research results (Figure 9), it should be predicted that the exclusion of agricultural land for residential areas will progress further, while exclusions for industrial areas will remain lower and slower. Therefore, the concerns for the natural environment will mainly arise from the urbanization of rural areas around cities and acceleration in the development of entrepreneurship envisaged by the SOR.

Figure 9. *Forecast of the total amount of farmland excluded from agricultural production (in ha) in Poland during the SOR operation*



Source: *The authors, based on data by GUS, BLD.*

Another distinct trend is the decrease in the total land area for mining areas in the 2030 perspective. The exclusions for transport areas will stabilize at the current level.

It should be emphasized that the amount of exclusions of agricultural land for mining purposes has decreased significantly. The level of these exclusions is predicted to fall further. It is difficult, however, to identify the leading cause. One indicator which may explain this decrease is the domestic material consumption (DMC), which in 2017 amounted to 654 million tons. This value has been declining since 2011. Non-metallic minerals constitute approximately half of the DMC (this category includes building materials, like sand or gravel), biomass – 29%, fossil fuels/energy carriers – 20%, and metal ores account for the remaining 10% (Polityka Ekologiczna Państwa, 2019).

4. Conclusions

With the immense competition from various sectors of the economy (for example, construction industry, infrastructure) for agricultural land, which is a limited resource, the state's intervention seems unavoidable because the free market mechanism may fail in this case and lead to the allocation of land into the most economically practical types of land use, but undesirable from the point of view of respecting the principles of sustainable development (irreversible depletion of agricultural land supply for future generations).

The Strategy for Responsible Development is the first document that defines a new way of creating public policy in Poland from the medium-term perspective. This new approach consists of complex analysis, recommendations, and announcements of specific actions. It is a multi-faceted document in which the state signaled the resignation from conducting public policy as a set of sector-specific mechanisms of public intervention serving to solve functional problems of the society caused by existing or predicted disturbances of the free market mechanism. Although the strategy's primary focus is on social and economic issues, it cannot depart from sustainable development. This was indicated in the forecast of the SOR's impact on the environment, which stressed the compatibility of the SOR with European documents and programs and global guidelines on sustainable development.

Ever since the Strategy for Responsible Development entered into force, doubts have arisen whether the emphasis on territorially coherent development will not lead to significant changes in the exclusion of agricultural land for industrial purposes, in particular in eastern Poland, where the challenges are the shortage of jobs outside agriculture and inadequate transport infrastructure. The Strategy for Responsible Development assumed the optimal reinforcement and employment of territorial capital, which different types of areas possess, to build sustainable competitiveness and improve the quality of life of the local population.

The research demonstrates that the process of excluding arable land from agricultural production has not changed under the influence of the SOR. The analyses covering

the period before the SOR was adopted (2010-2015) and during its operation did not change the tendencies. The largest share of exclusions during the period studied was for residential purposes, and the 2030 perspective assumes a further growth of this share. One of the SOR objectives was to limit the expansion to undeveloped areas by giving the preference to renewed land use, thus putting the brakes on the uncontrolled urban sprawl. In reality, the mentioned trend accelerates rather than slows down. This happens at the expense of agricultural land around cities.

In addition, it cannot be said that the SOR has had a significant impact on the exclusions for transport or industry. The province warmińsko-mazurskie is an exception as it has witnessed an evident increase in the exclusions for industrial areas since 2016. Exclusions for transport areas in the studied period and forecasts in this regard remain on a stable level, but there is much diversity between regions and years of the researched period.

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