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Sustainable Development of Rural Areas in Poland since 2004 in the Light of Sustainability Indicators

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Abstract: Sustainable development of a region requires sustainability of its rural parts, as a source of supplies and resources for the urbanized regions. The current climate changes, loss of biodiversity, limited resources, depopulation, deterioration of economic conditions or even poverty may limit the sustainable development of rural populations. This paper presents the study concerning assessment of sustainable development of rural areas in Poland since 2004, the date of Poland entrance to the European Union, in light of the selected Sustainable Development Indicators. The assessment was based on the set of 38 indicators covering environmental, social and economic pillars of sustainability. The results of this study indicate the significant progress in some aspects of rural development in Poland since 2004. However, several serious limits for rural sustainability were identified, including limited access to basic services including sanitation, anthropopressure on the natural environment, limited access to clear and renewable energy, depopulation, ageing, unfavorable economic conditions and relatively low productivity of agriculture.

Keywords: sustainable development; rural areas; environmental sustainability; social sustainability; economic sustainability; sustainable development indicators; Poland

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1. Introduction

The concept of sustainable development as used today was presented in 1987 by the World Commission on Environment and Development (WCED) [1] in their report, Our Common Future. It was also introduced in 1997 to Article No. 5 of the Constitution of the Republic of Poland [2]. According to the cited report, sustainable development was defined as a process aimed at satisfying the development aspirations of the present generation while preserving the possibility of satisfying the same aspirations by future generations. At the same time, it was strongly emphasized that sustainable development is a process in which there should be simultaneous integration and harmonization of activities in the economic, social and environmental spheres on a global scale [3,4]. The developed complicated and complex strategies of sustainable development, realized with respect to nature and the rule of intergenerational justice, should integrate all the above-mentioned circles of sustainability [5,6].

Within the Sustainable Development Strategy of the European Union [7], established in 2001 and modified in 2006, four main objectives of actions were defined, which included protection of the natural environment, justice and social cohesion, economic prosperity and implementation of the EU commitments on an international stage. The basic challenges of the strategy were climate change and clean energy, sustainable transport, consumption and production, protection and management of natural resources, public health, social integration, demography and migration, challenges in the field of global poverty and sustainable development.

The increasing popularity of sustainable development, as well as formulation and enactment of strategies of sustainable development, resulted in the necessity of quantified assessment of the natural environment, economics, law, social issues, etc., in relation to demands of concept of sustainable development. As the effect of interdisciplinary collaboration, which was triggered by the UN Agenda 21 plan [8], a number of Sustainable Development Indicators (SDIs) were formulated, allowing to quantify and assess the actual condition of the natural environment, as well as social, legal, political and economic affairs in relation to sustainability, e.g., [9–25].

The current set of the EU Sustainable Development Indicators consists of ten thematic areas (reflecting, among others, the seven challenges of the Sustainable Development Strategy), which include socio-economic development, sustainable production and consumption, social inclusion, demographic change, public health, climate change and energy, sustainable transport, natural resources, global partnership and good governance.

The scientific attempts of interdisciplinary assessment of the sustainable development of the selected country or region are usually based on approx. 10 to several dozens of applied SDIs. For example, in environmental assessment, there are such commonly used indicators as emission of pollutants to water, air and soil, (e.g., methane, CO_2, BOD, COD, phosphorus, greenhouse gases, production wastes, toxins, heavy metals, oil derivatives), available resources (e.g., water, coal, gas, oil), availability of resources (e.g., population supplied in tap water and the other basic services), use of resources (e.g., water, coal, oil and gas), use of energy (conventional, renewable), roads and railways infrastructure, melioration, use of fertilizers, use of pesticides, reliability, volume of collected sewage, amount of deposed wastes, biodiversity of ecosystems and system stability (e. g. ecosystem of watershed or river). As part of the economic assessment, the following indicators are taken into account: gross domestic product, gross domestic product per capita, income, income per capita, public debt, outside debt, inflation, industrial growth, arable land area and fallow land area. On the other hand, social activities are compared using indicators such as population, rural and municipal population, natural growth, mortality, infant mortality, length of life, poverty, illiteracy, unemployment, corruption, education, health care, parity, gender equality, political freedom, human rights, institutional readiness and social involvement [26–32].

Sustainable development of a population, understood in the larger scale, should not be only limited to urban sustainability, referring commonly to building and maintaining the cities without depleting the natural resources but also to the sustainability of the rural regions which are the supply sources of human and natural resources including, inter alia, food, fiber and energy [33,34]. Climate changes, urbanization, poverty and biodiversity loss leading to the global environmental crisis, posing a risk to communities in rural areas, make the sustainable development of rural areas a crucial issue in many regions [34–36]. Rural development is also closely related to the proximity of agricultural systems to the natural environment and requires a significant area of arable soil and irrigation by water. It was assumed than approx. 70% of the water uptake from groundwater aquifers, rivers, streams and lakes is used for agricultural production [37,38]. The Cork 2.0 declaration of the EU [39] titled “A better life in Rural Areas” indicated several policies allowing to support the rural development, including, among others, promoting rural prosperity, investing in rural viability and vitality, preserving the rural environment, managing rural resources, supporting knowledge and innovation, enhancing rural governance and improving performance and accountability. However, sustainable development of rural areas is a complicated task, meeting several serious limits and obstacles in different regions. The most important identified problems in most member states of the European Unions, reported also in the strategic plans for Common Agricultural Policy (CAP) [36,40–42] of the EU, were ageing, depopulation, poverty, social exclusion, lack of basic infrastructure (including water and sewage services), unemployment, lack of quality job opportunities and socio-economic gap between rural and urban areas. However, these problems are typical for many different regions of developing countries in various regions of the world [43–52].

The accession of Poland to the European Union in 2004 is being assessed as a crucial step in the country’s development, including Poland’s rural regions, in the 21st century.

Realization of the Common Agricultural Policy and numerous financing sources improved conditions in all circles of sustainability, environmental, social and economic areas [53–59]. However, the significant diversification of rural areas' development in each aspect of sustainability on the national scale is visible [60,61]. Due to the EU's financial support and direct payments to farm owners, the relation between agricultural and non-agricultural incomes was improved. However, the best effects were observed in cases of large-area farms [62]. The studies reported in 2015, by Widomski et al. [63] and covering ten years after the accession of Poland to the EU, were a considered attempt of sustainability assessment of one of the larger, mainly rural, regions of Poland, Lublin Voivodeship, based on a selected set of 21 Sustainable Development Indicators, indicating environmental, social and economic development. Nonetheless, the values of the studied SDIs determined for Poland and the Lublin region were clearly lower than for the leading member countries of the EU. Moreover, the determined values of SDIs for the Lublin region were lower than for the rest of the country. The significant diversification of development in various regions of Poland was reported in [64] after the survey of 16 sustainability indicators for rural areas. The recently published study [41] considering assessment of sustainable development diversity of rural areas in Poland, based on 14 selected SDIs (according to their usefulness, universality, measurability and accessibility), confirmed the reported earlier significant diversification or rural settlements in different parts of Poland. It was observed that the highest values of monitored indicators were noted for rural areas in the vicinity of the large urbanized agglomerations. The 2023–2027 CAP [65] strategy for Poland, published in 2022, assumes mainly to maintain production in the agricultural sectors with reduced emissions, to reduce the income gap between the small- and large-scale farm stakeholders, to increase the market orientation and competitiveness of farms and to increase access to basic infrastructure and services. The support will be provided by the additional payments and direct funding of investment projects and training or knowledge transfer.

This paper presents an original study concerning the sustainable development assessment of rural areas of Poland in light of sustainability indicators, performed for the time duration since 2004, its entrance to the European Union. The presented study was based on the selected set of Sustainable Development Indicators (SDIs) reflecting various aspects of environmental, social and economic sustainability. All the data used in this study were obtained from official databases of the Polish Central Office of Statistics and Eurostat. The main goals of this study were to determine the time-related dynamics of sustainability indicators values for rural parts of Poland and to draw attention to the critical aspects limiting its sustainable development. The actual values of Sustainable Development Indicators for rural Poland were also compared to the reported values of the member states of the European Union.

2. Materials and Methods

The aim of this study was to perform a review of time-related changes of Sustainable Development Indicators describing the sustainability of rural areas in Poland since 2004, as well as to compare the observed development indicators with values available for the urban areas in Poland and for the rural areas in the remaining member states of the EU. Additionally, this study was aimed to determine the critical aspects of rural development in Poland.

2.1. Study Area

The rural areas of Poland, including rural settlements, arable lands, meadows, vegetation and forests were the object of the study (excluding cities of various development density, industrial and mining areas, also under rehabilitation). According to the actual data presented by the governmental Central Office of Statistics [66] the area of the study covered approx. 90.1% of country area (the total area of Poland is equal 30,610,010 ha), including 59.9% share of arable lands and 30.2% of forests. The actual land usage in Poland is presented in Figure 1. According to the General Agricultural Register [67] performed in

2020, the number of agricultural farms in Poland was approx. 1,317,000 with the mean area of arable soils 11.1 hectares. The registered number of farms decreased since 2010 from approx. 1,509,000 but the average area of a single farm increased (from 9.8 ha). However, still more than 50% of farms in Poland have an area smaller than 5 hectares. The total registered population of Poland at the end of 2021 was 37,907,704, of which 15,283,690 were the residents of rural areas, consisting of 40.32% of Poland's population, see Figure 2.

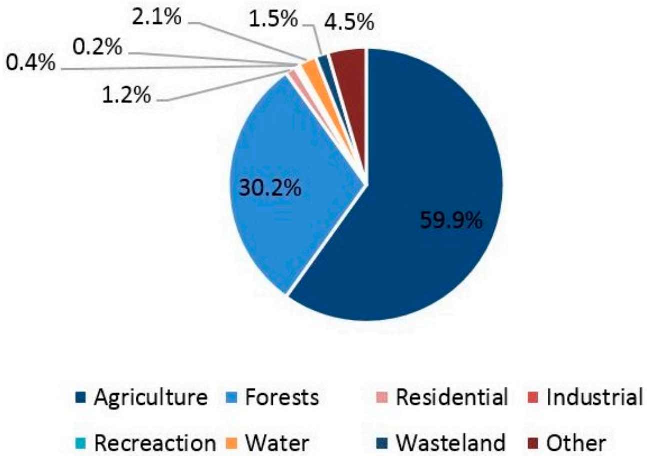

Figure 1. Land use in Poland, 2021, data obtained from [66].

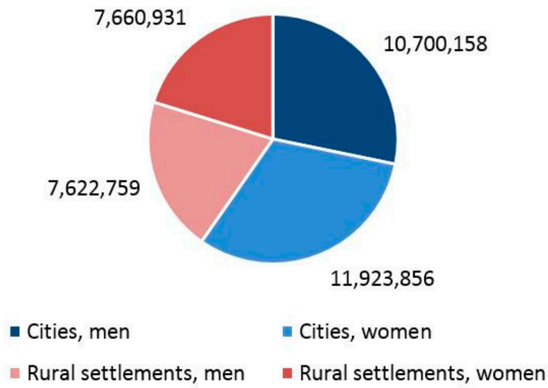

Figure 2. Rural and urban population in Poland, 31 December 2021, data obtained from [66].

The rural areas in Poland are divided into 1523 rural and 652 rural–urban communities governed by the local governments, selected in anonymous, universal, direct and equal elections [66,68]. According to abiding law in Poland, the local governments are responsible for assuring meeting the common requirements of self-governmental communities [69], including issues related to environmental, social and economic sustainability.

2.2. Method of the Study

The assessment of sustainable development of rural regions of Poland since 2004, the date of Poland's entry to the European Union, was based on the set of useful, measurable and easily accessible Sustainable Development Indicators (SDIs) presented in Table 1. The total number of 38 indicators, from three main circles of sustainability, i.e., environmental (16 indicators), social (10 indicators) and economic (12 indicators), was used. The assumed percentage, i.e., 42%, 26% and 32%, share of selected SDIs for each criterion corresponds to values reported by [34,35]. The indicator selection was influenced mostly by the official data availability for rural areas and for the period 2004–2021 under consideration; only several included SDIs with shorter data range were used in the study. The assumed set of indicators reflects also the commonly accepted selections to such analyses performed in the past for Poland, including its rural parts, and for the other regions [42,53,63,64].

However, the applied number of indicators in this study is greater than in the previously published studies [42,53,63,64]. Additionally, the proposed SDIs set is in agreement with the indicator selection suggested by the EU policy [70,71]. The values of indicators used in this study were obtained from the official Polish governmental database of the Central Office of Statistics [67] and the European Union database Eurostat [70].

Table 1. Sustainable Development Indicators used in the study.

Sustainable Development Indicator		
Environmental	**Social**	**Economic**
Population connected to organized water supply (%) Population connected to sewage network (%) Population connected to gas network (%) Energy consumption per 1 resident (kWh/resident) Drinking water from water network consumption per 1 resident (m^3) Difference between population connected to water supply and sewage systems (%) Rural water supply and sewage networks length (km) Rural landfills and their area (−) and (ha) Annual investments in rural water supply and sewage networks (EUR) Number of rural wastewater treatment plants, collective and individual (−) Number of annually constructed rural wastewater treatment plants, collective and individual (−) Groundwater quality (%) Ammonia emissions from agriculture (% of total emission) Greenhouse gas emissions from agriculture (% of total emission) Estimated soil loss by water erosion (tone/hectare) Area of organic farming (%)	Migrations (residents) Life expectancy (years) Birthrate per 1000 residents (−) Infant deaths per 1000 residents (−) Live births per 1000 residents (−) Deaths per 1000 residents (−) Rural population age distribution (−) Unemployment rate (%) Accidents at work in individual farming (−) Farm labor force (full−time equivalents)	Community income per 1 resident (EUR) Community expenditures per 1 resident (EUR) Mean disposable agricultural and self-employment income ratio (%) Agricultural production per 1 ha (EUR) Agricultural products purchase per 1 ha (kg) or (L) Mean retirement (EUR) Governmental funds granted to agricultural research and development (EUR/resident) People at risk of poverty or social exclusion (%) Gross value added to agriculture (EUR) Energy productivity (EUR/kg oil equivalent) Agritourist facilities (−) Use of agritourist accommodation (%)

The presented analysis was based on time-related changes in reported SDIs values for the assumed duration 2004–2021, as well as determined descriptive statistics, including minimal, maximal and mean values, calculated percentage increase/decrease in indicator value. The percentage increase in SDI was determined as follow:

$$\Delta SDI_{\%} = \frac{SDI_f - SDI_i}{SDI_i} \quad (1)$$

where: $\Delta SDI_{\%}$—percentage change of SDI value for given period, SDI_i—indicator value for the initial year of assessment, SDI_f—indicator value for the final year of assessment.

The groundwater quality in rural regions was assessed basing on the available results of the annual operational groundwater monitoring for selected sampling points in rural areas (rural settlements, arable lands, meadows, vegetation and forests) provided by The Polish Geological Institute National Research Institute [72] for period 2004–2021. The water quality was qualified according to the abiding Polish law [73,74] as five classes: I—very good quality, II—good quality, III—satisfactory quality, IV—unsatisfactory quality and V—bad quality, respectively. The groundwater quality class is determined according to threshold values of 55 water quality indicators [61,62].

3. Results

3.1. Environmental Sustainability

In our opinion, availability of freshwater resources endangered by anthropopressure related to sanitary sewage management and treatment is a crucial aspect of environmental sustainability. Figure 3 presents time-related groundwater quality in rural regions of Poland for the period 2004–2021 determined according to the legal water quality classes [73,74]. The presented annual monitoring results were obtained for variable monitoring points, in range 242–1067, located in rural regions of the country.

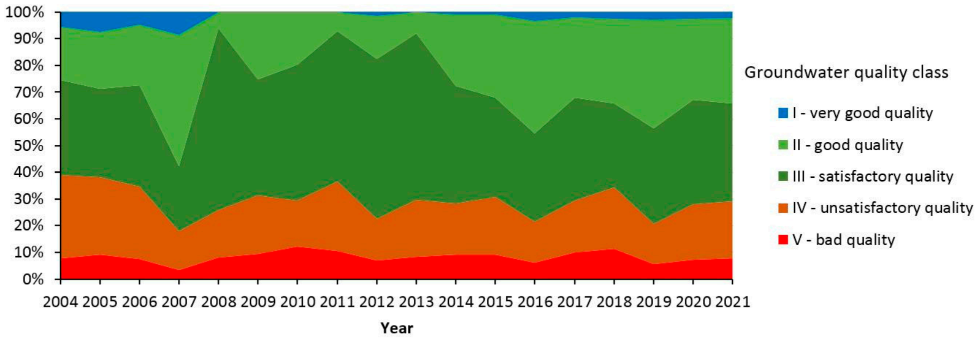

Figure 3. Time-related results of groundwater quality monitoring, quality classes according to [73,74], data obtained from [75].

As is visible in Figure 3, the class I of groundwater quality was determined only for limited number of observation points, up to 8.6%. However, the dominant classes are III and II, i.e., satisfactory and good quality. On the other hand, the significant share of unacceptable groundwater quality may be noted during the discussed time duration. The sum of unsatisfactory and bad quality reports covers 17.9–30.0% of all the rural monitoring stations.

According to Eurostat data for 2016, presented in Figure 4, the agricultural land in Poland is endangered by estimated soil erosion below the EU mean value, i.e., 1.5 tons per hectare in Poland versus 3.4 tons per hectare for the EU. Thus, the possible soil loss due to intensive soil erosion should not significantly limit the agricultural activities in the rural areas of Poland.

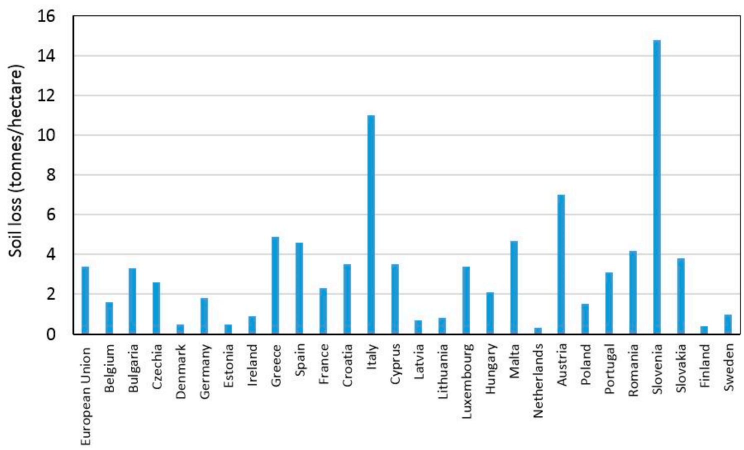

Figure 4. Estimated soil loss by water erosion in countries of the EU, data from [70], 2016.

The environmental quality in rural regions, directly affecting the quality of life of the rural population is, in our opinion, highly related to the development level of water and sewage services available for the residents. Figure 5 presents percentage share of the rural population in Poland connected to organized water, sanitary sewage and gas, as well as the difference (in % of population) between residents connected to water and sewage networks in rural and urban areas.

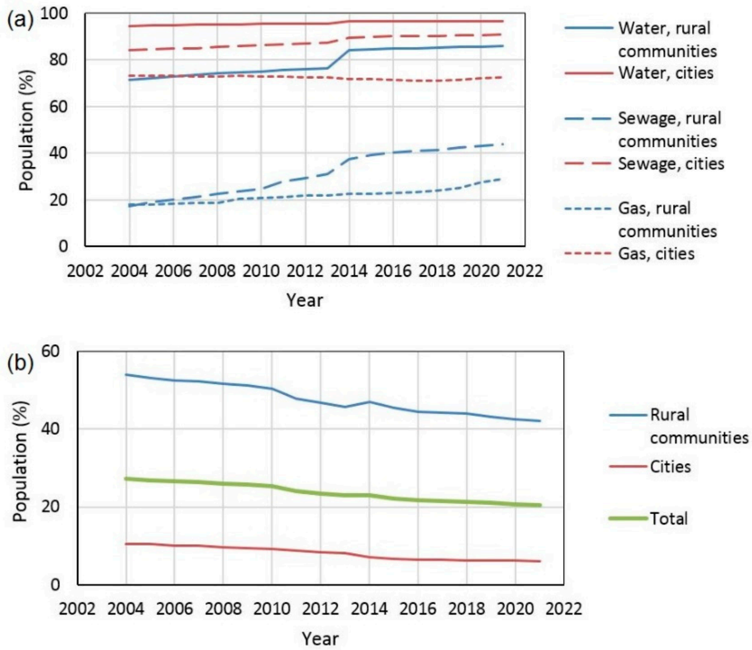

Figure 5. Accessibility of rural water, sewage and gas supply networks in Poland, data obtained from [66]: (**a**) rural and urban population connected to organized water, sewage and gas networks, (**b**) difference between population connected to water and sewage networks.

It is visible in Figure 5 that the tap water supply development in rural areas is satisfactory; in 2021, 85.9% of the rural population were connected to the organized water supply networks (the value for the urban population reaches 96.7%, see also Table 2). In 2004, these values were 71.3% and 94.4% for rural and urban residents, respectively. On the other hand, we may state that development of organized rural sanitary sewage system is unsatisfactory. In 2021, only 43.8% of the rural population in Poland had access to sewage systems. However, in 2004, this number was more than two times lower, i.e., 17.3% of rural residents. In comparison, the access to sewage by the urban population varied between 84.0% and 90.7% of residents. A similar situation may be noted for organized gas supply networks; currently, only 28.8% of the rural population (in comparison to 72.3% of urban residents) has access to clean fuel, allowing to reduce the significant anthropopressure on the natural environment exerted by the fossil fuels used for heating.

Table 2. Characteristics of environmental Sustainable Development Indicators used in the study.

Environmental SDI	Maximum	Minimum	Mean	Median	SD	$\Delta SDI_{\%}$ (%)
Rural population connected to organized water supply (%)	85.90	71.30	79.03	76.30	5.72	20.5
Rural population connected to sewage network (%)	43.80	17.30	31.37	30.15	9.54	153.2
Rural population connected to gas network (%)	28.80	17.80	21.91	21.85	3.14	61.8
Energy consumption per 1 resident in rural areas (kWh/resident)	859.10	431.90	743.52	749.15	94.14	98.9
Drinking water from water network consumption per 1 resident (m^3)	31.30	22.60	27.00	26.20	2.84	38.1
Difference between population connected to water supply and sewage systems (%)	54.00	42.10	47.67	46.80	4.02	−22.0
Rural water supply networks length (km)	255,154	193,687	229,263	232,630	19,767	31.7

Table 2. *Cont.*

Environmental SDI	Maximum	Minimum	Mean	Median	SD	$\Delta SDI_{\%}$ (%)
Rural sewage networks length (km)	108,460	34,446	73,856	77,568	24,674	214.9
Rural landfills (−)	991	292	572.67	504.50	247.60	−70.5
Rural landfills area (ha)	2403.80	1332.70	1853.28	1820.80	385.07	−44.6
Annual investments in rural water supply networks (EUR)	264,674,426	70,878,851	149,017,260	138,657,489	46,196,709	−17.3
Annual investments in rural sewage networks (EUR)	819,691,085	123,196,255	358,898,509	356,790,351	167,853,282	54.5
Number of collective rural wastewater treatment plants (−)	3092	2360	2763.89	2803.50	199.65	22.6
Number of individual rural wastewater treatment plants (−)	271,690	28,869	125,935.28	112,680.50	84,868.73	841.1
Ammonia emissions from agriculture (% of total emission)	21.50	18.40	20.21	20.20	0.73	14.7
Greenhouse gas emissions from agriculture (% of total emission)	9.10	7.70	8.18	8.20	0.35	11.0
Area of organic farming (%)	4.65	0.50	3.01	3.41	1.33	604.0
Renewable sources in electric energy production (%)	17.90	2.50	10.09	10.40	5.12	580.0

Figure 6 shows the time-related lengths of rural water and sewage networks and annual investments in these systems' development. It is visible that the state and local authorities were aware of the unsatisfactory development of rural sanitation and, in combination with the outside financial support of the EU, significant investments in sewage systems were provided, especially after 2009. The presented investments and increased length of rural water supply systems may be correlated to the visible increase in water consumption by rural residents, from 22.6 m^3 to 31.2 m^3 per resident, see Figure 7.

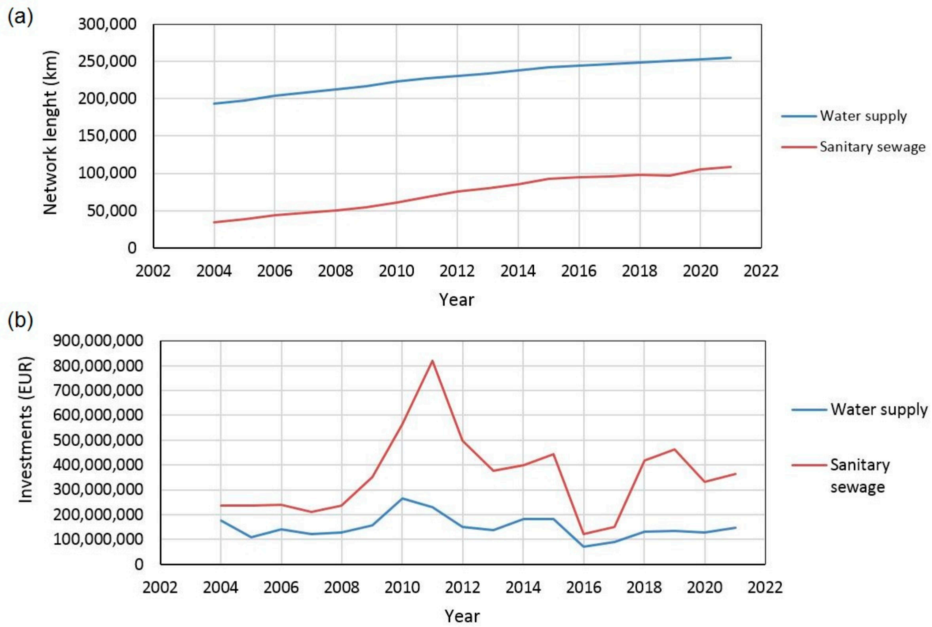

Figure 6. Development of rural water supply and sewage systems, data obtained from [66]: (**a**) length of rural water supply and sanitary sewage networks, (**b**) annual investments in rural water supply and sewage systems.

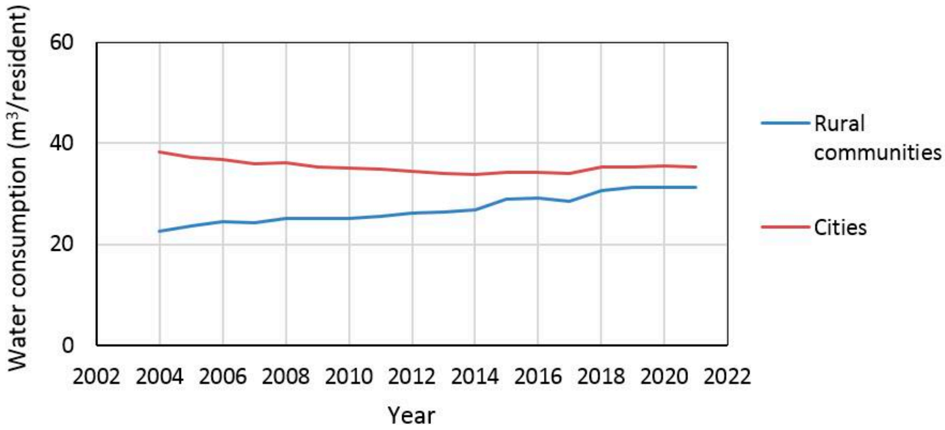

Figure 7. Annual tap water from water supply network consumption per 1 resident, data obtained from [66].

Thus, the progress in rural sanitation development is evident (see also Table 2), but there is still a lot of work and financial effort required. This statement is supported by data presented in Figure 5b, presenting the difference between population connected to water supply and sewage systems. In rural areas of Poland, over 40% of residents connected to water supply networks have no access to sanitary sewage and must organize individual manners of sewage management and treatment on their own.

Figure 8 shows the time-related development of centralized and registered individual wastewater treatment plants in rural areas of Poland during 2004–2021.

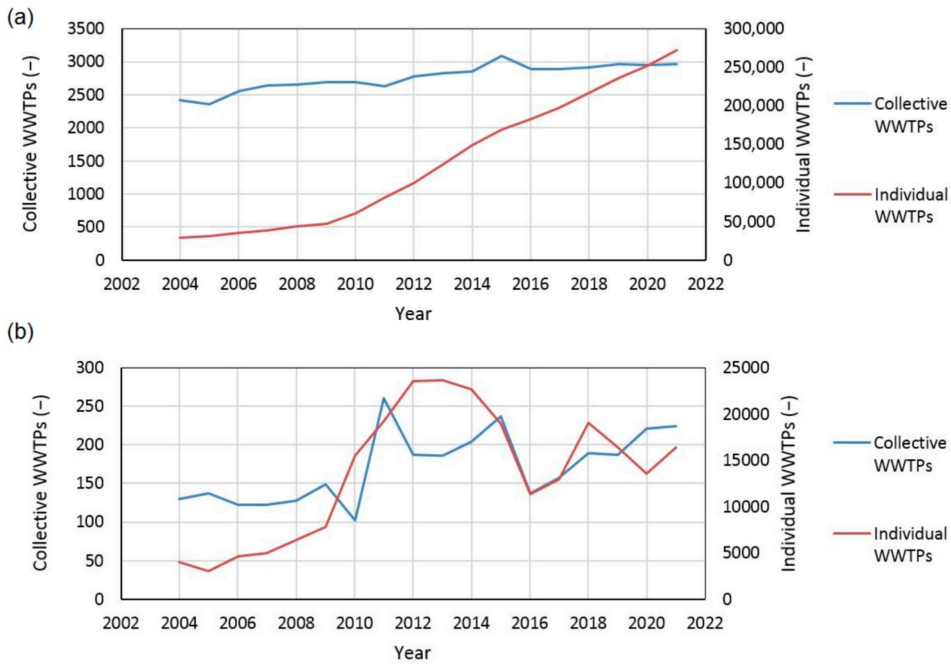

Figure 8. Development of rural wastewater treatment plants in 2004–20201, data obtained from [66]: (**a**) number of collective and individual rural wastewater treatment plants, (**b**) annual number of constructed collective and individual rural wastewater treatment plants.

Figure 8a,b show that sewage management in rural regions of Poland is mostly based on individual on-site wastewater treatment plants. In 2021, 2961 operational organized collective (of annual capacity 2,048,763.3 m^3) and 271,690 individual domestic WWTPs were registered, with an evident over 800% increase in individual WWTP numbers in relation to 2004 (see Table 2).

The development of rural areas and their increased productivity (presented later in the text) result in increased energy consumption by the rural population. Figure 9 presents time-related domestic electric energy consumption per one resident in rural communities related to total consumption in Poland combined with the share of renewable sources in the total energy production in Poland. During approx. the last two decades, the energy consumption by one member of rural populations increased by nearly 100%, from 431.9 kWh to 859.1 kWh (see also Table 2). Moreover, since 2014, the individual energy consumption in rural areas of Poland is higher than the total consumption in the country. It is visible that the increase in energy consumption during the last two decades was accompanied by the increase in the application of renewable sources to electric energy production but the achieved level, less than 20% of the total energy production in Poland, is rather low. Thus, the anthropopressure related to fossil fuels consumption may be significant, also in the rural areas. In comparison, according to Eurostat data, the mean usage of renewable sources for energy production in the European Union in 2020 reached the level of 37% [76]. The leading member countries in the EU used the following share of renewables in electric energy production: Austria—approx. 78%, Sweden—approx. 75%, Denmark—approx. 65%.

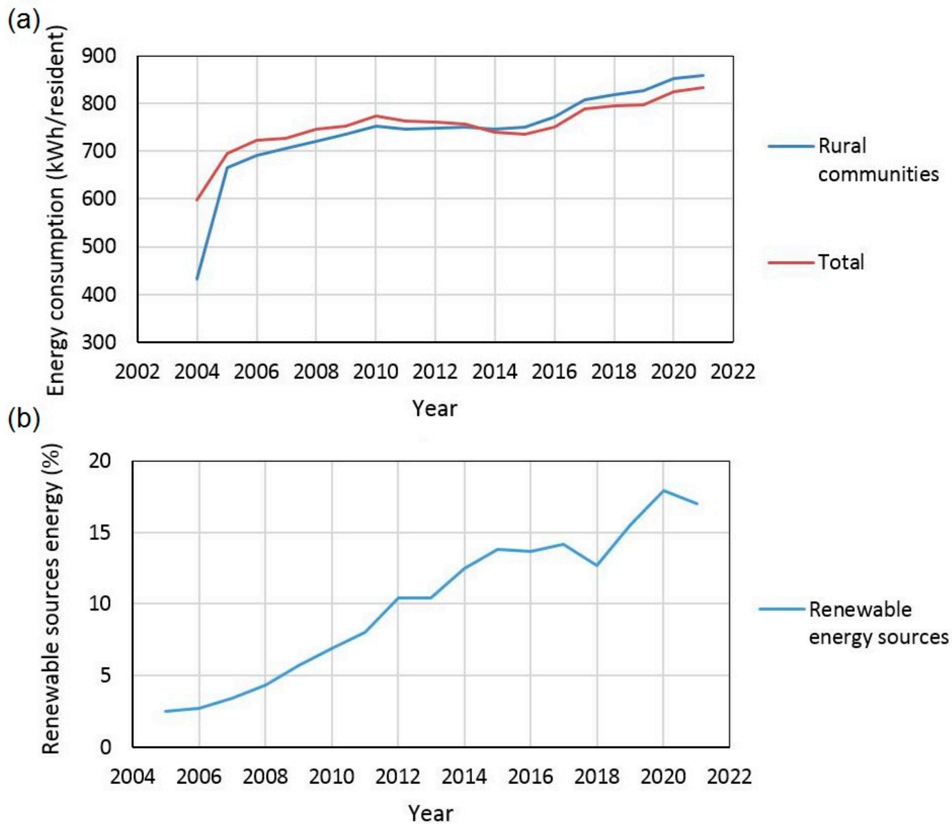

Figure 9. Electric energy in rural areas of Poland, data obtained from [66]: (**a**) annual domestic electric energy consumption per one resident, (**b**) share of the renewable energy sources in the total production of energy in Poland.

The environmental sustainability of rural regions may be also affected by the municipal waste management. Figure 10 presents the number and area of rural municipal waste landfill sites in rural Poland for the period 2004–2021. Both the number and area of rural landfills available for waste deposition for the rural population reduced during the assessment period duration. The available data for Poland's population (no data for rural population are available in the GUS database) show that the total amount of collected wastes reduced from 237.1 kg/resident in 2004 to 216.7 kg/resident in 2021. Moreover, in the whole country, the selective collection of municipal waste is being performed in 2477 communities, i.e., in all communities in the country. Figure 10b also shows the effective control of illegal waste dumping sites in Poland. Each year since 2008 (earlier data are unavailable), approx. 10,000–15,000 illegal sites have been liquidated, leaving approx. 2000–3000 of the observed existing sites as of 31 December.

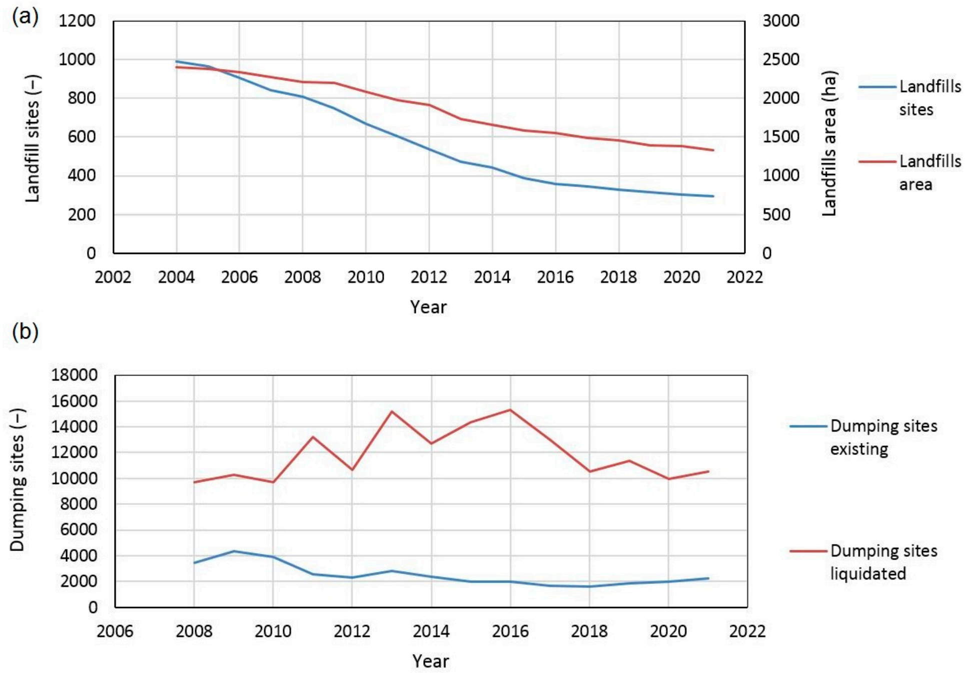

Figure 10. Waste management in rural areas of Poland, data obtained from [66]: (**a**) number and area of rural landfill sites in 2004–2021, (**b**) illegal rural waste dumping sites, 2008–2021.

The actual data presented in Figure 11 show negative anthropopressure exerted by Poland's agriculture on the natural environment, i.e., ammonia and greenhouse gas emissions from agriculture as the percentage of the total emission. Percentage agricultural emissions of ammonia in Poland is one of the highest in the European Union, 96.9%, while mean value for the EU is 90.9%. Only in Ireland and Cyprus, the percentage emission was higher in 2020, 99.2% and 97.3%, respectively, but both these countries have total and arable/agricultural area significantly smaller than Poland. On the other hand, the annual agricultural ammonia emission in Poland in 2020 reached the level of 21.1 kg per hectare and was clearly lower than the ones noted in Malta (123.3 kg/ha), Cyprus (62.7 kg/ha), the Netherlands (57.4 kg/ha) and Belgium (45.5 kg/ha). Contrarily, there are several countries in which agricultural ammonia emission is lower than or equal to approx. 10 kg/ha, i.e., Bulgaria, Estonia, Latvia, Romania and Greece. The percentage of agricultural greenhouse gas emission in Poland in 2020 was 9.1% and was lower than the EU mean value, 11.4%. Lower-percentage gas emissions in agriculture than in Poland were observed only among countries with significantly developed agriculture, such as in Belgium, Germany, Czechia, Italy and Slovakia. Thus, the above numbers showed than the ammonia fertilizers used in Polish agriculture may be the main source of anthropopressure exerted on the natural environment. This pressure may be reduced in future by an increase in area of organic farming, which (see Figure 12) in 2020 in Poland was equal to only 3.52% of total arable land and was far below the European Union mean—9.08%.

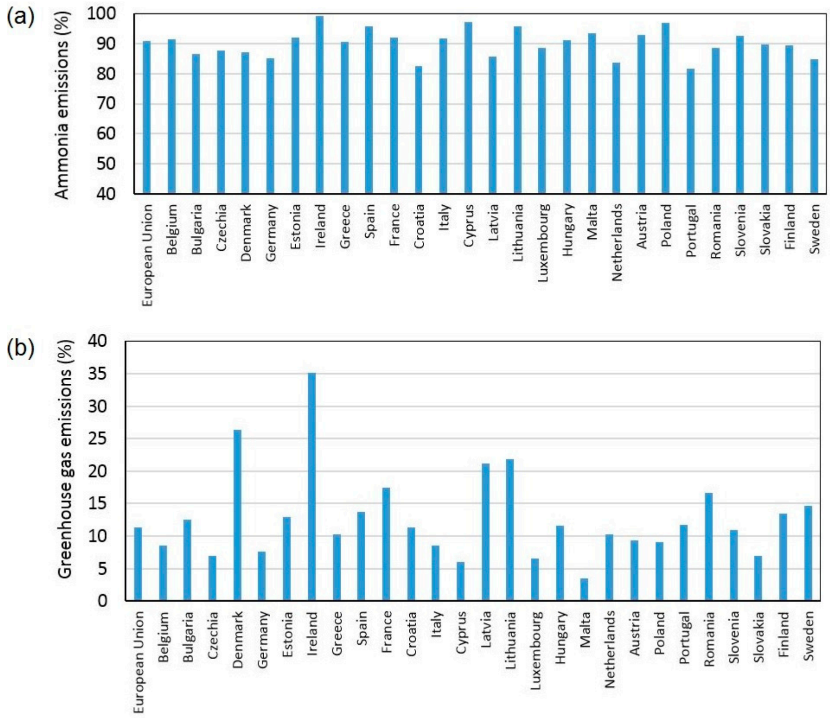

Figure 11. Anthropopressure of agriculture in Poland and the EU in 2020, data from Eurostat [70]: (**a**) ammonia emissions from agriculture as % of the total emission, (**b**) greenhouse gas emissions from agriculture as % of the total emission.

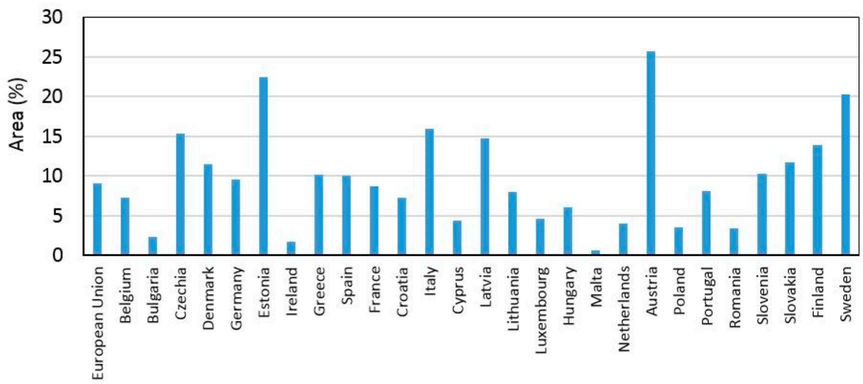

Figure 12. Area of organic farming in the EU as % of the total farming area, data source Eurostat [70].

The descriptive statistics of studied environmental Sustainable Development Indicators values for the period under consideration are presented in Table 2.

3.2. Social Sustainability

According to the available data, the number of rural residents was not constant and increased from 38.61% in 2004 to 40.32% in 2021 (see also Table 3), which meant 14,703,749 and 15,283,690, respectively. This increase in rural population may be related to the deurbanization of Polish cities caused by the migration of the middle class to single-family buildings located in the close vicinity of the major cities [66,67,77–79]. Figure 13 presents the registered migration balance to and from rural settlements in Poland during the period 2004–2021. It is visible that over the studied period, the number of new registered rural residents was higher than the number of the population leaving rural settlements.

Table 3. Characteristics of social Sustainable Development Indicators used in the study.

Social SDI	Maximum	Minimum	Mean	Median	SD	ΔSDI% (%)
Rural migrations in (residents)	247,928	178,201	200,454.28	195,978.5	16,918.86	7.5
Rural migrations out (residents)	200,024	151,242	164,542.72	160,317.5	13,983.9	4.8
Life expectancy men (years)	73.40	70.30	71.86	71.85	1.15	1.6
Life expectancy women (years)	81.93	79.50	80.77	80.80	0.85	0.1
Rural birthrate per 1000 residents (−)	1.51	−3.91	0.18	0.45	1.30	−1448.3
Rural infant deaths per 1000 residents (−)	6.53	3.70	4.86	4.81	0.89	−38.4
Rural live births per 1000 residents (−)	11.62	8.98	10.48	10.38	0.65	−12.2
Rural deaths per 1000 residents (−)	12.88	9.63	10.30	10.04	0.79	29.4
Rural unemployment rate (%)	10.46	4.68	7.41	7.14	2.30	−45.1
Accidents at work in individual farming (−)	28,033	7872	15,901.67	16,171.5	4714.35	−65.8
Lethal accidents at work in individual farming (−)	173.00	35.00	86.89	82.00	31.90	−74.0

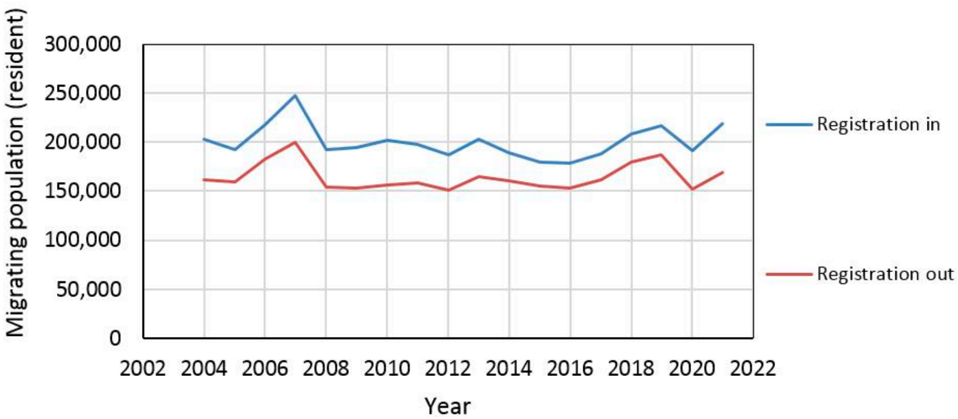

Figure 13. Annual registered migrations to and from rural settlements in Poland in 2004–2021, data obtained from [66].

The social quality of life, the efficiency of health care and conditions of the natural environment in rural settlements may be reflected by the several SDIs presented in Figures 14–17. Figure 14 presents life expectancy for both sexes of rural and urban residents actually born (class age less than 1 year) in Poland. The predicted life expectancy for women living in cities and in rural settlements was longer than for men during the whole duration of the assessed period. The life expectancy for women varied between 79.5 yrs. in the countryside and 79.1 yrs. in the cities in 2004, and 79.6 yrs. in the countryside and 79.8 yrs. in the cities in 2021 (see also Table 3). On the other hand, life expectancy for men was lower, i.e., 70.3 yrs. in the countryside and 70.9 yrs. in the cities in 2004, and 71.4 yrs. in rural settlements and 72.0 yrs. in the cities in 2021. According to Eurostat data [70], the actual (i.e., 2021) mean life expectancy for the age class less than 1 year in the European Union is longer for both genders, i.e., 77.2 yrs. for males and 82.2 for females, than in Poland. An indicator lower or comparable to Poland's life expectancy for newborns was determined mainly in countries of the former Eastern Bloc, including Bulgaria, Romania, Lithuania, Latvia, Hungary, Estonia and Czechia.

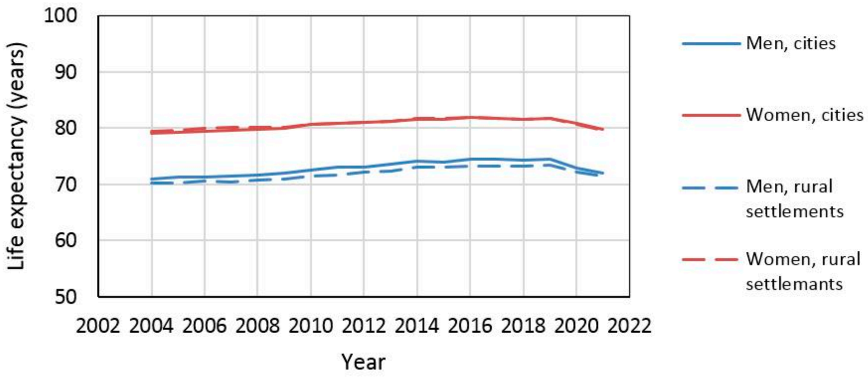

Figure 14. Life expectancy for urban and rural populations in Poland, age class less than 1 year, data obtained from [66].

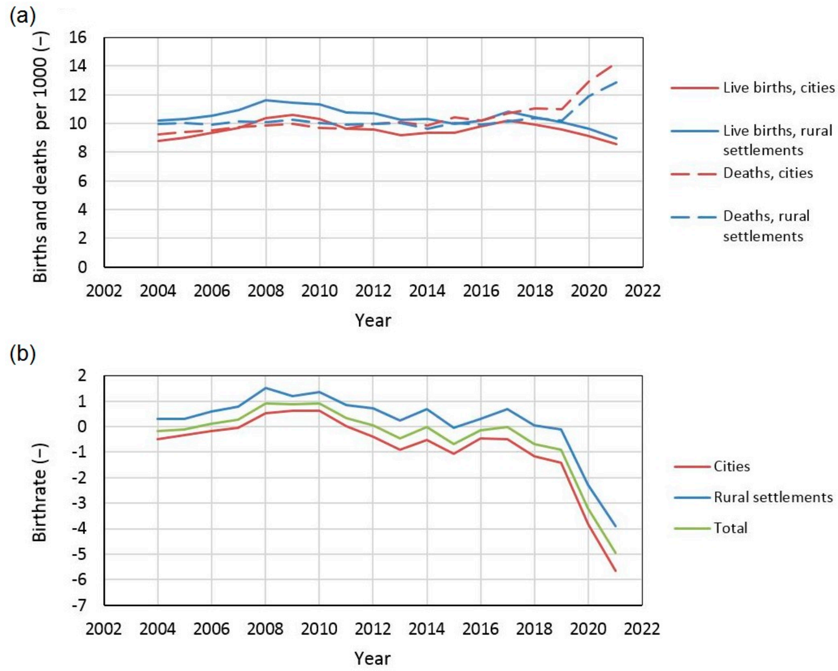

Figure 15. Population growth dynamics in Poland in 2002–2021, data obtained from [66]: (**a**) live births and deaths per 1000 residents for rural and urban populations, (**b**) birthrate in Poland.

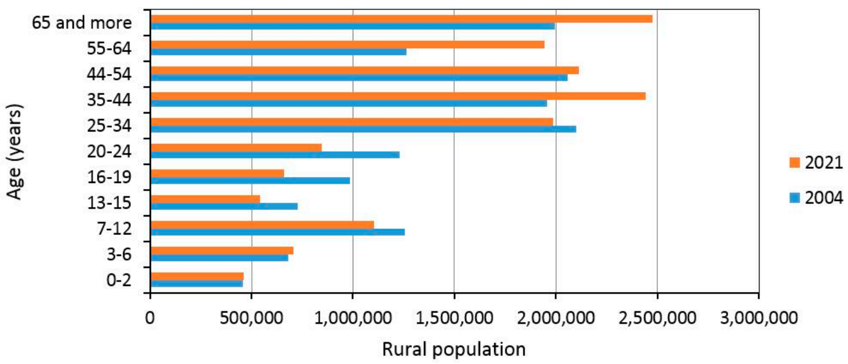

Figure 16. Rural population age distribution in 2004 and 2021, data obtained from [66].

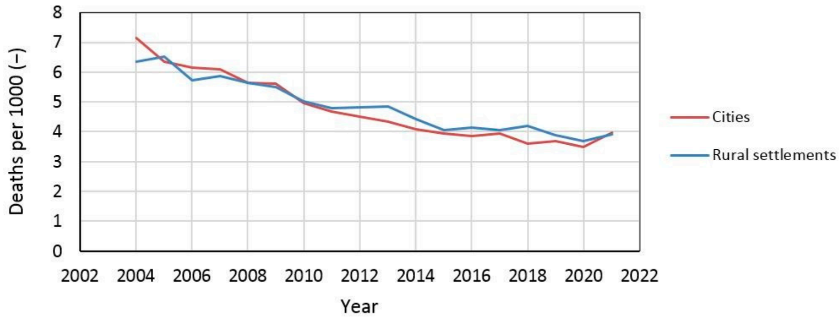

Figure 17. Infant deaths per 1000 in urban and rural regions of Poland, 2004–2021, data obtained from [66].

Figure 15 shows population dynamics, i.e., live births and deaths, for 1000 rural and urban residents combined with the birthrate for 1000 residents. During the studied period, the number of live births was higher in the rural population than in urban. Since 2014, the death rate was also lower for rural populations. However, since 2017, a decrease in live births for both studied regions occurred. Moreover, it is visible that since the outbreak of the COVID-19 SARS-Cov-2 pandemic, the number of registered deaths significantly increased, especially in the denser populated cities, from 10.92 deaths per 1000 residents in 2019 to 14.21 deaths per 1000 residents in 2021. The above observations are proven with the birthrate analysis presented in Figure 15b. The birthrates observed in rural and urban populations present comparable changes in time, but again, a higher birthrate was noted for the rural population. The positive birthrate in the rural population was stopped and diverted to negative values in 2019, after the beginning of the COVID-19 pandemic. On the other hand, a positive birthrate in urban populations was observed only in the short period between 2008 and 2011. Despite the governmental social program "500+" [80] assuming extra financial support, initially for the second and next children, later for all children, the total birthrate in Poland, in rural and as well as in urban populations, decreased until the collapse in 2019. During the assessment duration, as is presented in Table 3, the birthrate of the rural population decreased by over 1400%.

The above-discussed changes in rural population are also reflected by the changes in rural residents' age distribution, presented in Figure 16, for two years, the initial and final year of this study, i.e., 2004 and 2021, respectively. It is visible that the number of children from 0 to 6 years old is comparable. Then, the number of children and teenagers, 7–19 years old, was clearly lower in 2021 than in 2004. The same observation is possible for young adults, i.e., 20–24 yrs. old. A different situation is visible in the case of adults and seniors. The number of rural populations ranging in age from 35 to over 65 is greater in 2021 than it was in 2004. Thus, the rural population in Poland has become an ageing society, with a significant share of people over 55 yrs., equal to approx. 28.9%.

Figure 17 presents another important SDI allowing assessment of life conditions and healthcare, the infant deaths per 1000 residents, for the rural and urban population in Poland during the period 2004–2021 (see also Table 3). It is visible that the infant death indicator was on a comparable level in both groups and was significantly reduced during assessment period duration. The discussed indicator decrease for residents of rural settlements was from 6.35 to 3.31, while for urban residents it was from 7.14 to 3.96. Thus, the development of healthcare and improvement of living conditions since 2004, the entrance of Poland to the European Union, is visible.

According to the available Eurostat data for 2013, see Figure 18, the annual farm labor force in Poland agriculture presented in full-time equivalents (FTEs) was second in the European Union with a result of 3,558,710 FTEs. Only Romania in 2013 noted a higher value of farm labor force, reaching 6,577,930 FTEs. Moreover, the physical work in Polish farms was performed mainly by family members, with 3,480,250 full-time equivalents giving 97.8% of the labor force.

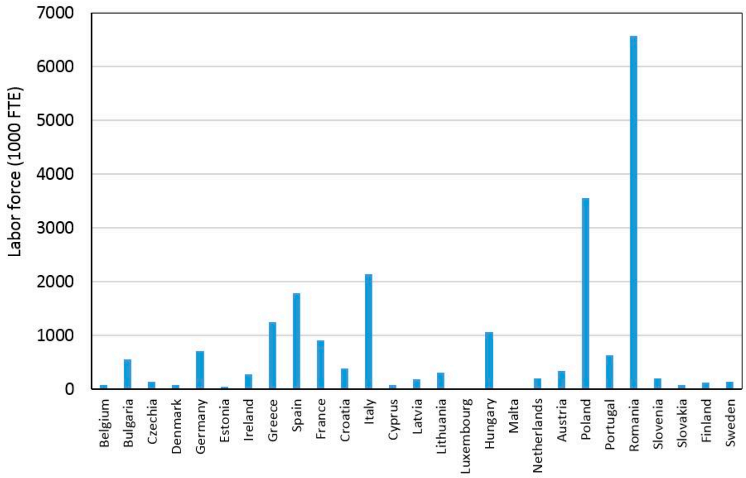

Figure 18. Farm labor force in member countries of the EU in 2013, FTE—full-time equivalents, data obtained from [70].

Figure 19 presents registered unemployment in the rural population of Poland since 2012 (data for the period 2004–2011 and rural population are unavailable). It is visible that registered, official unemployment decreased to the level of approx. 5.3% and mostly reflects the changes in the total unemployment in Poland.

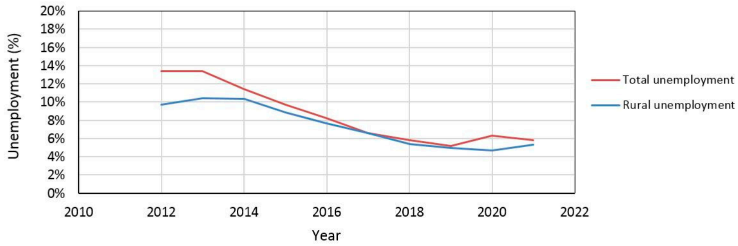

Figure 19. Registered total and rural unemployment in Poland, data obtained from [66].

The social sustainability of the rural society may be also reflected by the quality of work conditions limiting the number of accidents at work. Figure 20 presents the number of accidents at work in individual farming in Poland and the number of lethal accidents for the period 2004–2021. The total number of accidents at work decreased significantly from 28,033 in 2004 to 9595 in 2021. During the same period, the number of lethal accidents in farming decreased from 173 to 45. The above-presented 65.8% and 74.0% decrease in the number of accidents and their fatal victims, respectively, shows an improvement of working conditions in individual farming in Poland.

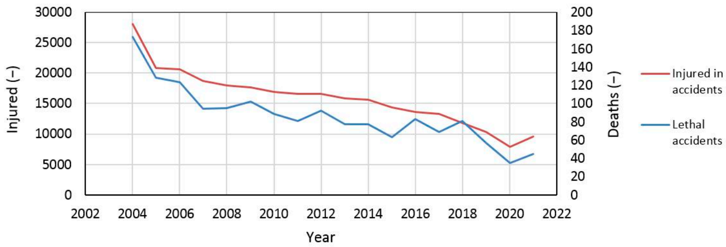

Figure 20. Accidents at work in individual farming in Poland, 2002–2021, data obtained from [66].

The summary of social Sustainable Development Indicators presented above is shown in Table 3.

3.3. Economic Sustainability

The issue of economic sustainability of rural regions may be assessed in several ways, by assessment of rural communities' incomes and expenditures, total agriculture productivity, as well by the selected economic indicators determined for the individual farmers.

Figure 21a,b present total incomes of rural and urban communities, as local self-governments, combined with their expenditures (including also culture, education, heritage), for one resident, both for the studied period 2004–2021. It is visible that both incomes and expenditures of rural communities increased approx. by 302.8% and 270.6%, respectively, despite being clearly lower than incomes and expenditures of urban communities (see also Table 4). On the other hand, it is worth noting than the increase in expenditures per one resident of rural communities during the tested period exceeded the increase in expenses of the urban self-governments.

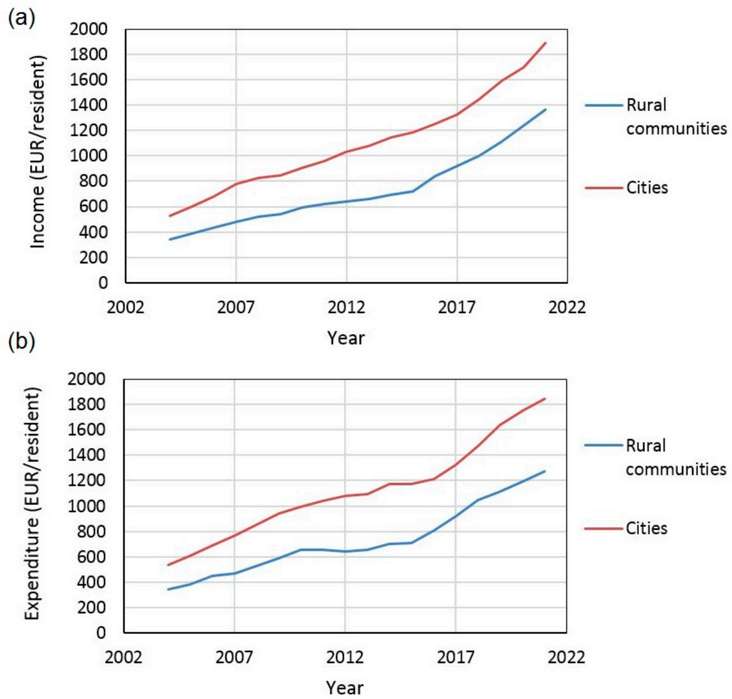

Figure 21. Rural and urban communities economics in 2004–2021, data obtained from [66]: (**a**) communities incomes per 1 resident, (**b**) communities expenditures per 1 resident.

Figure 22 presents the annual mean disposable income per one residents in individual farming in Poland related to the mean income in self-employment during the studied time duration. The reported disposable income ratio was unfavorable for the individual farming throughout the whole period of assessment and varied between approx. 33.3 and 55.5% (see Table 4), reaching the bottom values in the recent period, i.e., 2019–21. Thus, individual farming in Poland is far less profitable than the other possible manners of self-employment. The above may be related to the fact that the dominant (52.5% of all farms) area of individual farms in Poland is smaller than 5 hectares [67].

Unfortunately, the above disparity is also reflected in the mean monthly retirement in agriculture and in non-agriculture sectors, see Figure 23. During the entire duration of the studied period, the agricultural retirement, available to men over 65 yrs. and women over 60 yrs. (after at least 25 yrs.), of the contribution period [81] was significantly lower than in the other sectors and this difference increases. In 2004, the agricultural retirement was equal to 65.5% of the mean obtained in the other benches of activity. In 2021, the last year of assessment, this share decreased to 54.5% (see Table 4). Such a situation causes clear and visible unrest in the rural population, pressing for the reform of the agricultural retirement system in Poland [82–85].

Table 4. Characteristics of studied economic Sustainable Development Indicators.

Economic SDI	Maximum	Minimum	Mean	Median	SD	ΔSDI% (%)
Farm labor force (full-time equivalents)	5111.47	3558.71	4374.88	4414.68	808.53	−30.4
Community income per 1 resident (EUR)	1363.50	338.51	728.37	651.17	294.46	302.8
Community expenditures per 1 resident (EUR)	1274.30	343.83	729.88	654.97	277.57	270.6
Mean disposable agricultural and self-employment income ratio (%)	55.50	33.30	44.84	44.65	7.04	−34.7
Agricultural production per 1 ha (EUR)	1924.68	781.70	1293.84	1336.38	358.33	146.2
Agricultural mean retirement (EUR)	304.01	158.99	225.05	231.50	45.37	91.2
Governmental funds granted to agricultural research and development (EUR/resident)	3.80	0.10	1.36	1.45	1.02	3700.0
Rural population at risk of poverty or social exclusion (%)	29.30	23.20	25.03	24.20	2.20	−20.8
Gross value added to agriculture (million EUR)	12,103.63	7848.33	9152.10	9119.42	769.44	35.1
Energy productivity (EUR/kg oil equivalent)	4.72	3.02	3.87	3.93	0.55	56.3
Agritourist facilities (−)	811	610	740.2	752.5	71.61	−14.6
Use of agritourist accommodation (%)	17.3	10.9	13.8	13.95	2.07	37.3

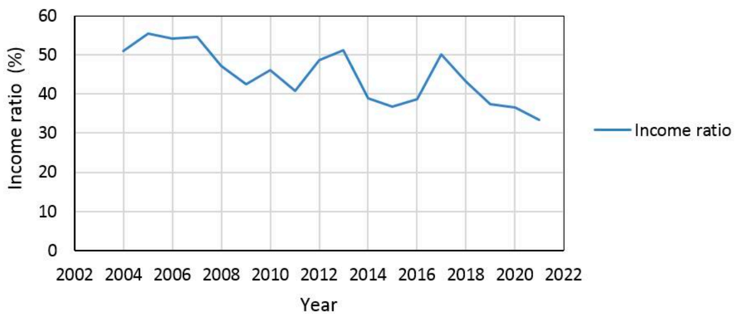

Figure 22. Mean disposable agricultural income related to self-employment income in Poland, 2004–2021, data obtained from [66].

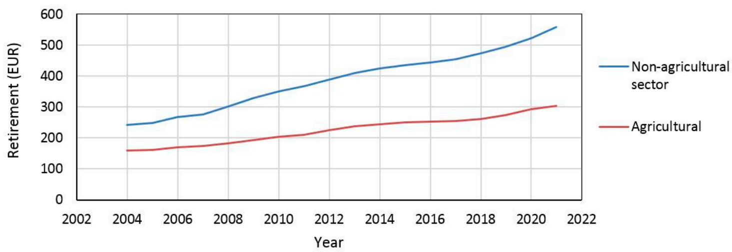

Figure 23. Mean monthly retirement in agricultural and non-agricultural sectors in Poland, 2004–2021, data obtained from [66].

One of the most important economic indicators of sustainable development relates to population at risk of poverty or social exclusion. According to Eurostat data for 2020, presented in Figure 24, 23.2% of the population in rural areas of Poland was in danger of poverty or social exclusion (a clear decrease in relation to 29.3% in 2015, see Table 4). This value is comparable with the EU mean (22.5%) but is higher than the indicator determined for the EUR currency zone (19.7%). At the same time, only 12.1% of the population of large cities in Poland were assumed to be at risk of poverty. On the other hand, the reported value for rural Poland is significantly lower than SDIs reported for Romania (50.1%), Bulgaria (42.5%) and Greece (34.0%). The lowest share of a rural population endangered by poverty or social exclusion was observed in Czechia (9.6%) and Austria (11.9%).

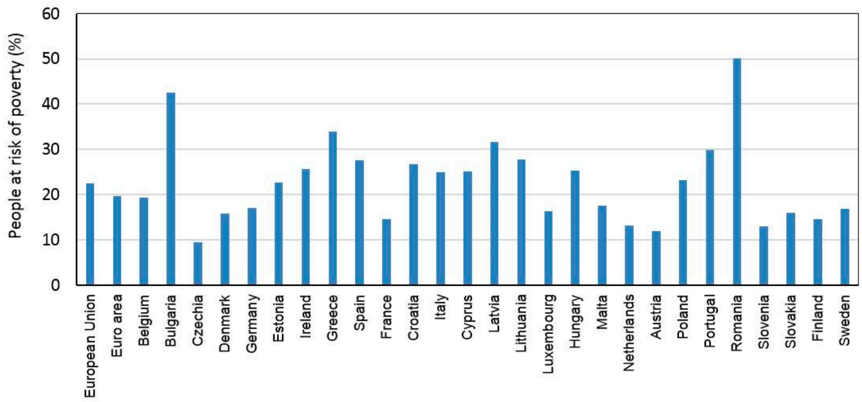

Figure 24. People at risk of poverty and social exclusions in rural areas of the EU in 2020, data from Eurostat [70].

The general productivity of agriculture in Poland in relation to the remaining member states of the EU is presented in Figure 25, showing gross value added for agriculture in basic prices in 2020. The determined value of this indicator for Polish agriculture was EUR 12,103.63 million, which was approx. 5.5% of value for the EU and became the fifth result, after France, Italy, Germany and Spain.

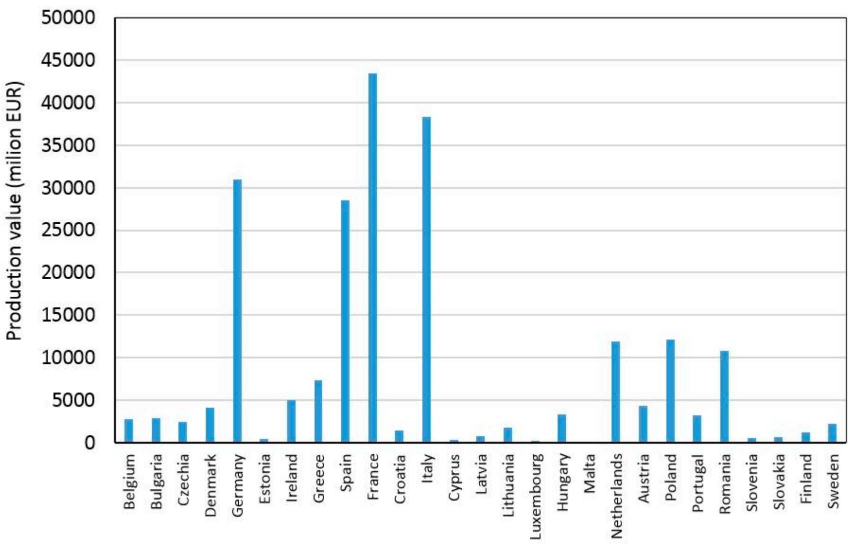

Figure 25. Gross value added of agriculture at basic prices in the member countries of the EU in 2020, data from Eurostat [70].

The changes in productivity of Polish farming, as the main bench of agriculture, may also be represented by the agricultural production purchase by 1 hectare and structure of products purchased per 1 ha—see Figure 26. The total value of Polish agriculture farming products purchase increased during the tested time duration from PLN 3674.00 to PLN 9046.00, which may be recalculated to approx. EUR 782–1925, without nearly unchanged structure 43.0–43.8% of crops and 57.0–56.2% animal production. The farming products purchase structure in 2021 was dominated by sugar beet, milk and grains.

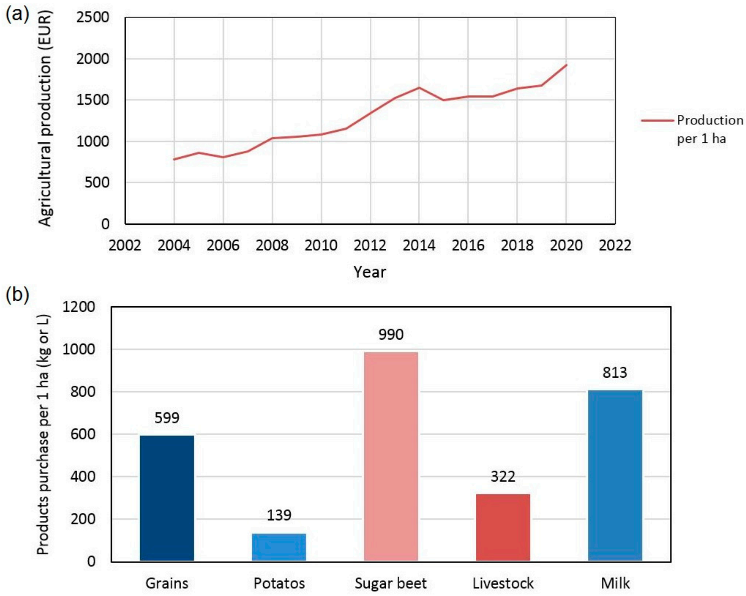

Figure 26. Agricultural productivity in Poland, data obtained from [66]: (**a**) agricultural production purchase value per 1 hectare in 2004–2021, (**b**) agricultural products purchase per 1 ha structure in 2021.

Figure 27 presents energy productivity in the member states of the EU, determining the amount of economic output that is produced per unit of gross available energy in EUR per kg of oil equivalent, shows that productivity in Poland, including agriculture, is one of the lowest in the EU. The determined value of 4.72 EUR/kg oil equivalent is higher only than indicators reported for Estonia, Czechia and Bulgaria and is definitely lower than the mean EU value of 8.57 EUR/kg oil equivalent. However, it worth noting that in 2004, the energy productivity in Poland was even lower, 3.02 EUR/kg oil equivalent.

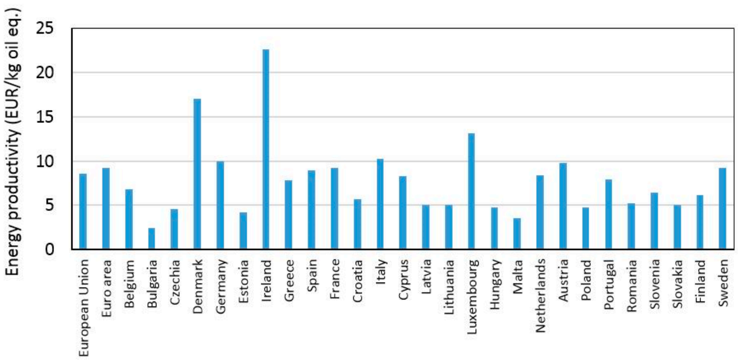

Figure 27. Energy productivity in agriculture in the member countries of the EU in 2020, data from Eurostat [70].

The general economic sustainability of rural areas in Poland may be also reflected by the governmental funds granted to agricultural research and development (R&D), allowing to assess how much priority is placed on R&D by state budget fund allocations. Figure 28, presenting governmental support for R&D activities in agriculture in Poland in 2020, shows that the sum of EUR 3.8 per resident is far below the mean EU value equal 7.2 EUR/resident. This value is also several times lower than in countries significantly supporting agricultural R&D, i.e., Ireland, Denmark, the Netherlands, Germany and Finland. However, it is worth mentioning than in 2004, the budget allocation for agricultural research and development in Poland was equal only to 0.1 EUR/resident (see also Table 4).

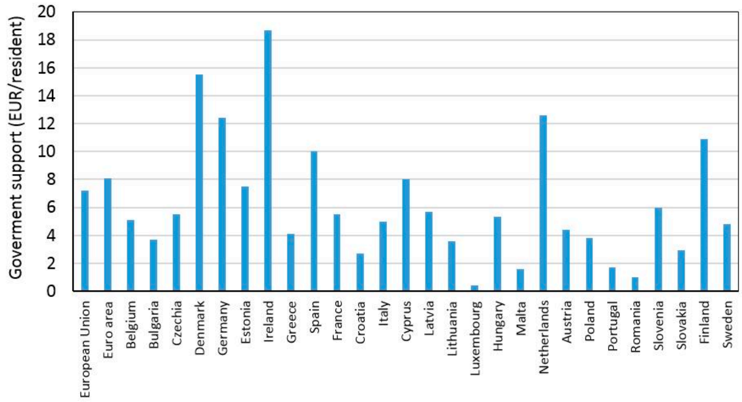

Figure 28. Governmental financial support for agricultural research and development in the member states of the EU, 2020, data from Eurostat [70].

Economic sustainability of the rural population in Poland may be, as is reported for other regions [86–88], improved by additional activities including offering an accommodation base for agritourism. According to the official regulations in Poland, agritourist accommodation is understood as facilities where hotel services may be provided, including rooms or tent sites, rented from farmers on farms run by them [89]. Figure 29 presents the number of agritourist facilities available in Poland in the period 2012–2022 and the percentage of use of the accommodation. The number of registered facilities constantly decreased since 2015, from a value of 811 facilities with 13, 351 places to 583 facilities with 10,440 places. The highest decrease was noted for the COVID-19 pandemic duration, since 2019. However, the number of clients using the available accommodation, besides COVID-19 pandemic duration, was not reduced so clearly, which is reflected in increased use of accommodation. Thus, it seems to be clear that the development of agritourism may be beneficial for the improvement of economic conditions of rural populations, especially in the numerous environmentally attractive regions of Poland—mountains, seaside and lake districts.

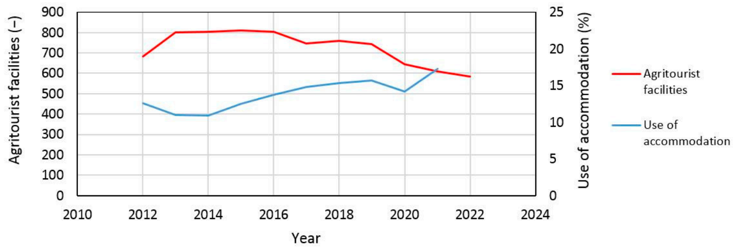

Figure 29. Agritourism facilities in rural Poland and use of available accommodation in 2012–2022, according [66].

A summary of the studied economic Sustainable Development Indicators for the time duration under consideration is presented in Table 4.

4. Discussion

The performed survey of time-related changes in the values of the proposed set of Sustainable Development Indicators for rural areas of Poland since 2004 and analyses of the determined percentage indicator value changes showed a clear progress in numerous aspects of development during the assessment period. The positive changes in rural Poland's environmental, social and economic growth reported by several studies since the second decade of the 21st century [42,53–56,59,62] were sustained. However, in many cases, the discussed values are far below the ones indicated for the leading European countries or even the mean for 27 member states. Additionally, as was mentioned before, the generally globally recognized limits to the sustainable development of rural regions, including issues of anthropopressure exerted by agriculture on the natural environment, limited access to resources and basic services, including water and sanitation, depopulation and the socio-economic gap between rural and urban regions, even leading to poverty and social exclusion [43–52], may be recognized in the results of the presented survey.

According to data presented by the Polish Inspectorate of Environmental Protection the first free water table groundwater aquifer, supplied by infiltration water, is more endangered by pollution than the confined aquifers. The main described cause of unsatisfactory or bad groundwater quality determined for studied cases exceeded the quality threshold values, mainly for the following indicators: K (15 mg K/dm^3), B (1 mg B/dm^3), NO_3 (50 mg NO_3/dm^3), NH_4 (1.5 mg NH_4/dm^3) and SO_4 (250 mg SO_4/dm^3). Disorganized water and sanitary sewage management, inappropriate municipal waste management, as well as the road transport-related issues, combined with the insufficient isolation of the groundwater table from infiltrating surface water, were recognized as the main reasons for groundwater pollution in rural areas of Poland. Similar observations were reported for other countries all around the world [45,90–94]. However, it should be mentioned that according to several scientific reports, construction and operation of organized rural sewage systems under actual conditions in Poland is unprofitable and financially ineffective, which may result in a low level of rural population acceptance and willingness to pay [67–69,95–102]. The individual devices of sanitary sewage management and treatment, as an alternative to costly organized systems, became popular in Poland after 2009, when a clear increase in their installation was observed. This popularity may be highly related to the possible higher economic profitability and cost-efficiency of the individual manners of sewage management and treatment under the conditions of rural Poland [95,96].

The increased domestic tap water demand may be significantly reduced, even by approx. 50%, by replacing drinking water by non-potable water collected by rainwater harvesting (RWH) systems and used in toilets and laundry facilities, cleaning, garden irrigation and washing vehicles [103–107]. However, the performed research [108] concerning application of 13 various designs of RWH for single-family buildings under the climatic and economic conditions of Eastern Poland showed that, in most cases, such designs are unprofitable for the investors. Moreover, the available governmental funding support for RWH devices covering two programs for the area of the quoted study was insufficient, allowing to refund from 50% to 100% of costs but only to the value of approx. EUR 660–1100 per installation. Such state co-funding was, in many studied cases, insufficient, especially for the sophisticated, up-to-date and complex systems of collection, storage, treatment and reuse of rainwater (the actual cost of just one rainwater control station purchase in Poland varies between EUR 650 and 1400) [109,110] may be also related to air pollution. According to the actual official mandatory register of heat sources in the residential buildings in Poland [111], covering in total 13,764,724 heat sources, the dominant sources are solid fuel boilers and ovens (55.20%), gas boilers (23.79%), electric heating (11.74%), municipal sources (3.11%), solar panels (2.99%), heat pumps (2.18%) and oil boilers (0.99%). The same source identifies the soiled fuels used in residential buildings in Poland as coal (55.6%), wood (37.4%), wood pellet (6.1%) and other biomass (0.8%). According to the data by the Polish Ministry of Climate and Environment, in 2020, there were 67,300 geothermal heat pumps installed in the whole country. During the 2018–2021 program "Clean air" of heat source replacement in Poland, covering 296,653 heat sources, only approx. 17% of zero-emission air and ground-source heat pumps were installed, 13.95% and 3.31%, respectively [112]. Thus, low installation costs and quick-assembly heating devices are preferable by individual investors, so application of the low-temperature geothermal sources of heating energy is highly undeveloped.

The analysis of social development indicators presented above shows that rural society in Poland encounters problems typical for similar populations, not only in new member states (since 2004) of the European Union, but also visible for the other Eastern European countries [42,50,52,55,60–62,113–118]. These issues are depopulation and the ageing of the rural population, negative birthrate, shorter life expectancy than in urbanized regions and significant workload required for agriculture. The observed improvement of sanitary conditions of the rural population in Poland and available healthcare, related not only to previously discussed environmental sustainability indicators, but also visible by the significant decrease in infant deaths per capita, was, in confrontation with the COVID-19 SARS-CoV-2 pandemic, insufficient to prevent the negative changes in rural population demographics. However, in this case, the economic factors including, inter alia, low agricultural disposable income, low retirement and relatively low productivity of agriculture combined with the high energy consumption, creating a visible gap between the economics of rural and urban populations, may affect both the social and economic development of the rural population, despite the observed positive trends [46,62,119–123]. It is worth mentioning that the development of an agritourist accommodation base in Poland's countryside, despite also being affected by COVID-19 lockdowns, presents a clear example of economic opportunity outside the traditional agriculture sector, similar to the wide touristic potential of other countries [86–88].

To summarize the discussion, we may state that, in our opinion, the following limits to the sustainable development of rural areas in Poland during the period 2004–2021 may be identified in the three studied circles of sustainability:

1. Environmental sustainability limits
    - Quality of available groundwater resources endangered by anthropopressure related to the undeveloped collective and individual sanitary sewage services and ammonia emissions from agriculture.
    - Increasing tap water demand and electric energy consumption combined with the undeveloped usage of rainwater harvesting and renewable energy sources, including off-grid.
    - Limited area of organic farming.
    - Limited availability of renewable and clear energy for heating.
2. Social sustainability limits
    - Negative birthrate and distorted age group distributions (especially towards people over 55 yrs.) combined with low value of life expectancy indicates the ageing of rural population in Poland.
    - Relatively high value of labor force, provided mainly by the family members of the farm owner, reflects low productivity of Poland's agriculture.
3. Economic sustainability limits
    - Unfavorable economic conditions of rural population, leading to the significant risk of poverty and social exclusion, reflected by i) low value of disposable income in agriculture (far less than 50% of disposable income in self-employment in different sectors), ii) low monthly retirement in agriculture.
    - Lower incomes and expenditures of rural self-governments in relation to urban areas.
    - Low productivity of Poland's agriculture reflected by low gross value added to agriculture and low energy productivity.
    - Very low value of governmental support to agricultural research and development.

5. Conclusions

The performed analysis of Sustainable Development Indicators for rural areas in Poland since 2004, based on the proposed set of 38 indicators of environmental, social and economic development, allowed the following conclusions:

- The environmental, social and economic development of rural areas of Poland since 2004, understood as positive changes in values of studied sustainability indicators, is clearly visible.
- However, in many cases, the actual values of the studied Sustainable Development Indicators are below the mean for the European Union and are sometimes several times worse than in the case of the leading EU countries.

- There is also a visible difference between the values of numerous sustainability indicators determined for the rural and urban regions of Poland, showing that rural settlements develop slower.
- Several serious threats limiting the sustainable development of the rural areas and agriculture in Poland were identified, affecting availability of natural resources, limiting the economic profitability of agricultural production and the stable social growth of rural population.
- In many cases, state intervention is required to sustain the development of the rural population in Poland, mainly by increased productivity and development of agriculture, limiting risk of poverty and social exclusion, as well as allowing the improvement of rural population demographics.
- Financial support for local domestic installations of rainwater harvesting allowing a significant reduction in tap water demand by offering treated rainwater should also be provided.
- Governmental support is also required in development of individual off-grid renewable energy sources and providing clear energy for heating, significantly reducing the anthropopressure exerted on the natural environment by burning fossils.
- The development of non-agricultural economic activities by the rural population, including agritourism, should also be encouraged and supported by the state.

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References

1. Our Common Future. Report of the World Commission on Environment and Development. United Nations 1987. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiqksTtpM78AhVqw4sKHRyDAn8QFnoECA8QAQ&url=https%3A%2F%2Fsustainabledevelopment.un.org%2Fcontent%2Fdocuments%2F5987our-common-future.pdf&usg=AOvVaw293_rr5E8NxDhKDKPVja0e (accessed on 16 January 2023).
2. Dz. U. 1997 No. 78 Item 483. The Constitution of The Republic of Poland. 1997. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu19970780483 (accessed on 16 January 2023).
3. Harding, R. Ecologically sustainable development: Origins, implementation and challenges. *Desalination* **2006**, *187*, 229–239. [CrossRef]
4. Harris, J.M.; Wise, T.A.; Gallagher, K.P.; Goodwin, N.R. *A Survey of Sustainable Development, Social and Economic Dimensions*; Island Press: Washington, DC, USA; Covelo, CA, USA; London, UK, 2001.
5. Pawłowski, A. Rewolucja rozwoju zrównoważonego. *Probl. Sustain. Dev.* **2009**, *4*, 65–76.
6. Pawłowski, A. The role of environmental engineering in introducing sustainable development. *Ecol. Chem. Eng. Soc.* **2010**, *17*, 264–278.
7. Communication from the Commission. A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52001DC0264 (accessed on 16 January 2023).
8. Agenda 21: The United Nations Programme of Action form Rio; United Nations: New York, NY, USA. 1992. Available online: https://sustainabledevelopment.un.org/outcomedocuments/agenda21 (accessed on 16 January 2023).
9. Sustainable Seattle. Indicators of Sustainable Community. A Report to Citizens on Long-Term Trends in Our Community. Seattle: Sustainable Seattle. 1998. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjGp-aGqc78AhWElYsKHeS5BNcQFnoECAYQAQ&url=https%3A%2F%2Fise.unige.ch%2Fisdd%2FIMG%2Fpdf%2FIndicateurs.pdf&usg=AOvVaw1EZXjOuHGw-Vw5wQXaZRFE (accessed on 16 January 2023).

10. Mitchell, G.; May, A.; McDonald, A. PICABUE: A methodological framework for the development of indicators of sustainable development. *Int. J. Sustain. Dev.* **1995**, *2*, 104–123. [CrossRef]
11. Gilbert, A. Criteria for sustainability in the development of indicators for sustainable development. *Chemosphere* **1996**, *33*, 1739–1748. [CrossRef]
12. Alegre, H.; Hirner, W.; Baptista, J.M.; Parena, R. *Manual of Best Practice. Performance Indicators for Water Supply Services*; IWA Publishing: London, UK, 2000.
13. Ashley, R.; Hopkinson, P. Sewer systems and performance indicators into the 21st century. *Urban Water* **2002**, *4*, 123–135. [CrossRef]
14. Balkema, A.J.; Preisig, H.A.; Otterpohl, R.; Lambert, F.J.D. Indicators for the sustainability assessment of wastewater treatment systems. *Urban Water* **2002**, *4*, 153–161. [CrossRef]
15. Foxon, T.J.; McIlkenny, G.; Gilmour, D.; Oltean-Dumbrava, C.; Souter, N.; Ashley, R.; Butler, D.; Pearson, P.; Jowitt, P.; Moir, J. Sustainability criteria for decision support in the UK water industry. *J. Environ. Plan. Manag.* **2002**, *45*, 285–301. [CrossRef]
16. Kondratyev, S.; Gronskaya, T.; Ignatieva, N.; Blinova, I.; Telesh, I.; Yefremova, L. Assessment of present state of water resources of Lake Ladoga and its drainage basin using Sustainable Development Indicators. *Ecol. Indic.* **2002**, *2*, 79–92. [CrossRef]
17. Mactavish, A. *Towards Sustainability*; UK Water Industry Research: London, UK, 2003.
18. Hezri, A.A.; Hasan, N.M. Management framework for sustainable development indicators in the State of Selangor, Malaysia. *Ecol. Indic.* **2004**, *4*, 287–304. [CrossRef]
19. Clouston, S.; Hunton-Clarke, L.; Wakerley, S. *Additional UK Water Industry Sustainability Indicators*; UK Water Industry Research: London, UK, 2005.
20. Malmqvist, P.A.; Palmquist, H. Decision support tools for urban water and wastewater systems focussing on hazardous flows assessment. *Water Sci. Technol.* **2005**, *51*, 41–49. [CrossRef] [PubMed]
21. Palme, U.; Lundin, M.; Tillman, A.M.; Molander, S. Sustainable development indicators for wastewater systems—Researchers and indicator users in a co-operative case study. *Resour. Conserv. Recycl.* **2005**, *43*, 293–311. [CrossRef]
22. Indicators of Sustainable Development: Guidelines and Methodologies, 3rd ed.; United Nations: New York, NY, USA. 2007. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjwtrXXrsT8AhXsoosKHUIZADsQFnoECA4QAQ&url=https%3A%2F%2Fsustainabledevelopment.un.org%2Fcontent%2Fdocuments%2Fguidelines.pdf&usg=AOvVaw01tD7sQGh93_p74N-Q7w0z (accessed on 16 January 2023).
23. Palme, U.; Tillman, A.M. Sustainable development indicators: How are they used in Swedish water utilities. *J. Clean. Prod.* **2008**, *16*, 1346–1357. [CrossRef]
24. Ivanovic, M.O.D.; Golusin, M.T.; Dodic, S.N.; Dodic, J.M. Perspectives of sustainable development in countries of Southeastern Europe. *Renew. Sustain. Energy Rev.* **2009**, *13*, 2079–2087. [CrossRef]
25. Ioris, A.A.R.; Hunter, C.; Walker, S. The development and application of water management sustainability indicators in Brazil and Scotland. *J. Environ. Manag.* **2008**, *88*, 1190–1201. [CrossRef]
26. Ledoux, L.; Mertens, R.; Wolff, P. EU sustainable development indicators: An overview. *Nat. Resour. Forum* **2005**, *29*, 392–403. [CrossRef]
27. Prescott-Allen, R. *The Well-Being of Nations. A Country-by-Country Index of Quality of Life and the Environment*; Island Press: Washington, DC, USA, 2001.
28. Tsai, W.T. Energy sustainability from analysis of sustainable development indicators: A case study in Taiwan. *Renew. Sustain. Energy Rev.* **2010**, *14*, 2131–2138. [CrossRef]
29. Kestemont, B.; Frendo, L.; Zaccaï, E. Indicators of the impacts of development on environment: A comparison of Africa and Europe. *Ecol. Indic.* **2011**, *11*, 848–856. [CrossRef]
30. Eustachio, P.J.H.P.; Caldana, A.C.F.; Liboni, L.B.; Martinelli, D.P. Systemic indicator of sustainable development: Proposal and application of a framework. *J. Clean. Prod.* **2019**, *241*, 118383. [CrossRef]
31. Maurya, S.P.; Singh, P.K.; Ohri, A.; Singh, R. Identification of indicators for sustainable urban water development planning. *Ecol. Indic.* **2020**, *108*, 105691. [CrossRef]
32. Rogelj, M.J.; Mikuš, O.; Hadelan, L. Selection of economic indicators for measuring sustainable rural development. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural. Dev.* **2020**, *20*, 285–296.
33. Huang, G. Urban Sustainability at the Cost of Rural Unsustainability. *Sustainability* **2021**, *13*, 5466. [CrossRef]
34. Nelson, K.S.; Nguyen, T.D.; Francois, J.R.; Ojha, S. Rural sustainability methods, drivers, and outcomes: A systematic review. *Sustain. Dev.* **2022**, 1–24. [CrossRef]
35. Yuan, Z.; Wen, B.; He, C.; Zhou, J.; Zhou, Z.; Xu, F. Application of Multi-Criteria Decision-Making Analysis to Rural Spatial Sustainability Evaluation: A Systematic Review. *Int. J. Environ. Res. Public Health* **2022**, *19*, 6572. [CrossRef] [PubMed]
36. Wieliczko, B.; Kurdys-Kujawska, A.; Florianczyk, Z. EU Rural Policy's Capacity to Facilitate a Just Sustainability Transition of the Rural Areas. *Energies* **2021**, *14*, 5050. [CrossRef]
37. Lewandowski, I. (Ed.) *Bioeconomy Shaping the Transition to a Sustainable, Biobased Economy*; Springer: Stuttgart, Germany, 2018; p. 354.
38. Zinchuk, T.; Kutsmus, N.; Kovalchuk, O.; Charucka, O. Challenges of sustainable development of rural economy. *MTSRBID* **2018**, *40*, 609–619. [CrossRef]

39. European Union. *Cork 2.0 Declaration "A Better Life in Rural Areas"*, 1st ed.; Publications Office of the European Union: Luxembourg, 2016.
40. Agriculture and Rural Development. Available online: https://agriculture.ec.europa.eu/index_en (accessed on 16 January 2023).
41. Wyrwa, J.; Barska, A. Disparities in social development of rural areas in the context of sustainable development of polish voivodeships. *Probl. Agric. Econ.* **2021**, *4*, 45–77. [CrossRef]
42. Barska, A.; Jędrzejczak-Gas, J.; Wyrwa, J.; Kononowicz, K. Multidimensional Assessment of the Social Development of EU Countries in the Context of Implementing the Concept of Sustainable Development. *Sustainability* **2020**, *12*, 7821. [CrossRef]
43. Wegren, S.K. The Quest for Rural Sustainability in Russia. *Sustainability* **2016**, *8*, 602. [CrossRef]
44. Eliamringi, L.; Kazumba, S. Assessment of sustainability of rural water supply services in Tanzania: The case study of Dodoma region. *Water Supply* **2017**, *17*, 372–380. [CrossRef]
45. Jiménez, A.; Jawara, D.; LeDeunff, H.; Naylor, K.A.; Scharp, C. Sustainability in Practice: Experiences from Rural Water and Sanitation Services in West Africa. *Sustainability* **2017**, *9*, 403. [CrossRef]
46. Montalván, R.A.V.; Araujo, L.A.; Giehl, A.L.; Feliciano, A.M. Conception of Managing Practices as Key Factor to Achieve Rural Development and Sustainability in Southern Brazil. *Eur. J. Sustain. Dev.* **2017**, *6*, 361–369. [CrossRef]
47. Hvenegaard, G.T.; Hallstrom, L.K.; Brand, K.L.P. Implementation Dynamics for Sustainability Planning in Rural Canada. *JRCD* **2019**, *14*, 54–76.
48. Wang, M.; Gong, H. Expected Rural Wastewater Treatment Promoted by Provincial Local Discharge Limit Legislation in China. *Sustainability* **2019**, *11*, 2756. [CrossRef]
49. Caparrós-Martínez, J.L.; Rueda-Lópe, N.; Milán-García, J.; De Pablo, J. Public policies for sustainability and water security: The case of Almeria (Spain). *Glob. Ecol. Conserv.* **2020**, *23*, e01037. [CrossRef]
50. Gibbes, C.; Hopkins, A.L.; Díaz, A.I.; Jimenez-Osornio, J. Defining and measuring sustainability: A systematic review of studies in rural Latin America and the Caribbean. *Environ. Dev. Sustain.* **2020**, *22*, 447–468. [CrossRef]
51. Haywood, L.K.; Nortje, K.; Dafuleya, G.; Nethengwe, T.; Sumbana, F. An assessment for enhancing sustainability in rural tourism products in South Africa. *Dev. S. Afr.* **2020**, *37*, 1033–1050. [CrossRef]
52. Trigueros, M.A.; Prieto, E.M. Sustainability and rural development policies: The case of Tierra de Campos Valladolid. *Cuad. Geográficos* **2020**, *59*, 224–246. [CrossRef]
53. Raszkowski, A.; Bartniczak, B. On the Road to Sustainability: Implementation of the 2030 Agenda Sustainable Development Goals (SDG) in Poland. *Sustainability* **2019**, *11*, 366. [CrossRef]
54. Dziekański, P.; Prus, P. Financial Diversity and the Development Process: Case study of Rural Communes of Eastern Poland in 2009–2018. *Sustainability* **2020**, *12*, 6446. [CrossRef]
55. Burny, P.; Gaziński, B.; Nieżurawski, L.; Sobków, C. Gospodarka Polski w porównaniu do Unii Europejskiej w świetle wybranych wskaźników rozwoju społeczno-gospodarczego. *Rocz. Kol. Anal. Ekon.* **2019**, *54*, 125–141. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwif7LGWkf78AhWMjYsKHdUuBOsQFnoECAgQAQ&url=https%3A%2F%2Frocznikikae.sgh.waw.pl%2Fp%2Froczniki_kae_z54_10.pdf&usg=AOvVaw2pTlZtLFn8aJ_CmHX22PEg (accessed on 16 January 2023).
56. Wilkin, J.; Hałasiewcz, A. *Polska Wieś 2020. Raport o Stanie Wsi*; Wydawnictwo Naukowe Scholar: Warszawa, Poland, 2020; Available online: https://scholar.com.pl/pl/glowna/4058-polska-wies-2020br-raport-o-stanie-wsi.html (accessed on 16 January 2023).
57. Dudek, M.; Wrzochalska, A. Making Development More Sustainable? The EU Cohesion Policy and Socio-Economic Growth of Rural Regions in Poland. *Eur. J. Sustain. Dev.* **2017**, *6*, 189. [CrossRef]
58. Fura, B. Zróżnicowanie poziomu rozwoju zrównoważonego województw Polski z wykorzystaniem analizy wielowymiarowej. *Nierówności Społeczne Wzrost Gospod.* **2015**, *44*, 108–117. [CrossRef]
59. Barska, A.; Jędrzejczak-Gas, J.; Wyrwa, J. Poland on the Path towards Sustainable Development—A Multidimensional Comparative Analysis of the Socio-Economic Development of Polish Regions. *Sustainability* **2022**, *14*, 10319. [CrossRef]
60. Siudek, T.; Czarnecki, E.; Vashchyk, M. Assessment of the Sustainability of Rural Development in the European Union Member States. *Acta Sci. Polonorum. Oeconomia* **2016**, *15*, 101–113.
61. Stec, M.; Filip, P.; Grzebyk, M.; Pierścieniak, A. Socio-Economic Development in the EU Member States-Concept and Classification. *Eng. Econ.* **2014**, *25*, 504–512. [CrossRef]
62. Smędzik-Ambroży, K.; Guth, M.; Stępień, S.; Brelik, A. The Influence of the European Union's Common Agricultural Policy on the Socio-Economic Sustainability of Farms (the Case of Poland). *Sustainability* **2019**, *11*, 7173. [CrossRef]
63. Widomski, K.M.; Gleń, P.; Łagód, G.; Jaromin-Gleń, K.M. Sustainable Development of One of the Poorest Province of the European Union: Lublin Voivodeship, Poland—Attempt of Assessment. *Probl. Sustain. Dev.* **2015**, *10*, 137–149. [CrossRef]
64. Barska, A.; Jędrzejczak-Gas, J. Indicator Analysis of the Economic Development of Polish Regions in the Context of the Implementation of the Concept of Sustainable Development. *Eur. J. Sustain. Dev.* **2019**, *8*, 210. [CrossRef]
65. Europen Commission. Agriculture and Rural Development. Available online: https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans/approved-csp-0_en?f%5B0%5D=document_country_document_country%3Ahttp%3A//publications.europa.eu/resource/authority/country/POL (accessed on 16 January 2023).
66. Central Office of Statistics. GUS. Available online: https://stat.gov.pl/ (accessed on 16 January 2023).
67. GUS Powszechny Spis Rolny 2020. Available online: https://spisrolny.gov.pl/aktualnosci/wyniki-wstepne-powszechnego-spisu-rolnego-2020 (accessed on 16 January 2023).

68. Ustawa z Dnia 5 Stycznia 2011 r.—Kodeks Wyborczy. Dz.U. 2011 No. 21 Item 112. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu20110210112 (accessed on 16 January 2023).
69. Ustawa z Dnia 8 Marca 1990 r. o Samorządzie Gminnym. Dz.U. 1990 No. 16 Item 95. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU19900160095 (accessed on 16 January 2023).
70. European Union Data Base Eurostat. Available online: https://ec.europa.eu/eurostat/databrowser/explore/all/tb_eu?lang=en&subtheme=sdg&display=list&sort=category (accessed on 16 January 2023).
71. Sustainable Development Goals (SDGs)—Overview. Available online: https://ec.europa.eu/eurostat/web/sdi (accessed on 16 January 2023).
72. The Polish Geological Institute—National Research Institute. Available online: https://mjwp.gios.gov.pl/wyniki-badan/wyniki-badan-2021-a.html (accessed on 16 January 2023).
73. Regulation Minister for Maritime Affairs and Inland Waterways of 21st December 2015 on Criteria and How to Assess the Status of Groundwater Bodies, Dz.U. 2016, Item 85. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20160001985 (accessed on 16 January 2023). (In Polish)
74. Regulation Minister for Maritime Affairs and Inland Waterways of 11th October 2019 on Criteria and How to Assess the Status of Groundwater Bodies, Dz.U. 2019 Item 2148. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190002148 (accessed on 16 January 2023). (In Polish)
75. Monitoring Jakości Wód Podziemnych. Available online: https://mjwp.gios.gov.pl/wyniki-badan/wyniki-badan-2020.html (accessed on 16 January 2023).
76. Eurostat: W UE już 37% Energii Pochodzi z Odnawialnych Źródeł. Available online: https://e-magazyny.pl/zielone-wiadomosci/eurostat-w-ue-juz-37-energii-pochodzi-z-odnawialnych-zrodel/ (accessed on 16 January 2023).
77. Miasta Pustoszeją, Wsie Zaludniają Się. Jak Handel Zareaguje? Available online: https://www.dlahandlu.pl/detal-hurt/wiadomosci/miasta-pustoszeja-wsie-zaludniaja-sie-jak-handel-zareaguje,109077.html (accessed on 16 January 2023).
78. Polskie Miasta Pustoszeją Wynika z Danych GUS. Available online: https://legaartis.pl/blog/2022/06/19/polskie-miasta-pustoszeja-wynika-z-danych-gus/ (accessed on 16 January 2023).
79. Miasta Pustoszeją. Poznaliśmy Pierwsze Wyniki Spisu Powszechnego. Available online: https://olsztyn.tvp.pl/62910058/miasta-pustoszeja-poznalismy-pierwsze-wyniki-spisu-powszechnego (accessed on 16 January 2023).
80. Dz.U. 2016 Item 195. Ustawa z Dnia 11 Lutego 2016 r. o Pomocy Państwa w Wychowywaniu Dzieci. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu20160000195 (accessed on 16 January 2023).
81. Dz.U. 2022 Item 1155. Ustawa z Dnia 28 Kwietnia 2022 r. o Zmianie Ustawy o Ubezpieczeniu Społecznym Rolników. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20220001155 (accessed on 16 January 2023).
82. Emerytury rolnicze bardzo niskie. System wymaga reform. Available online: https://www.tygodnik-rolniczy.pl/articles/pieniadze-i-prawo/emerytury-rolnicze-bardzo-niskie-system-wymaga-reformy/ (accessed on 16 January 2023).
83. Rolnicy Spodziewali się Wyższych Emerytur z KRUS po Waloryzacji. Available online: https://www.tygodnik-rolniczy.pl/articles/pieniadze-i-prawo/rolnicy-spodziewali-sie-wyzszych-emerytur-z-krus-po-waloryzacji/ (accessed on 16 January 2023).
84. Dlaczego Emerytury z KRUS nie są Waloryzowane jak Emerytury z ZUS? Rolnicy Czują się Poszkodowani. Available online: https://www.wrp.pl/dlaczego-emerytury-z-krus-nie-sa-waloryzowane-jak-emerytury-z-zus-rolnicy-czuja-sie-poszkodowani/ (accessed on 16 January 2023).
85. Obecne Przepisy są Dyskryminujące dla Rolników: Czas na Waloryzację Emerytur! Available online: https://www.topagrar.pl/articles/aktualnosci/obecne-przepisy-sa-dyskryminujace-dla-rolnikow-czas-na-waloryzacje-emerytur/ (accessed on 16 January 2023).
86. Bloyer, J.M.; Gustke, L.D.; Leung, Y. Indicators for Sustainable Tourism Development: Crossing the Divide from Definitions to Actions. *WIT Trans. Ecol. Environ.* **2004**, *76*, 7. [CrossRef]
87. Park, D.B.; Yoon, Y.S. Developing sustainable rural tourism evaluation indicators. *Int. J. Tour. Res.* **2011**, *13*, 401–415. [CrossRef]
88. Karampela, S.; Andreopoulos, A.; Koutsouris, A. "Agro", "Agri", or "Rural": The Different Viewpoints of Tourism Research Combined with Sustainability and Sustainable Development. *Sustainability* **2021**, *13*, 9550. [CrossRef]
89. Dz.U. 1997 No. 133 Item 884. Ustawa z Dnia 29 Sierpnia 1997 r. o Usługach Hotelarskich Oraz Usługach Pilotów Wycieczek i Przewodników Turystycznych. Available online: https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=wdu19971330884 (accessed on 16 January 2023).
90. Wiech, A.K.; Marciniewicz-Mykieta, M.; Toczko, B. (Eds.) Stan Środowiska w Polsce. Raport 2018. Biblioteka Monitoringu Środowiska, Warszawa 2018. Available online: https://webcache.googleusercontent.com/search?q=cache:C4cB6sf054IJ:https://www.gios.gov.pl/pl/aktualnosci/521-stan-srodowiska-w-polsce-raport-2018&cd=1&hl=pl&ct=clnk&gl=pl&client=firefox-b-d (accessed on 16 January 2023).
91. Tincani, L.; Ross, I.; Zaman, R.; Burr, P.; Mujica, A.; Evans, B. Regional Assessment of the Operational Sustainability of Water and Sanitation Services in Sub-Saharan Africa. 2015. Oxford Policy Management Project. Available online: www.vfm-wash.org (accessed on 16 January 2023).
92. Jiménez, A.; Mtango, F.; Cairncross, S. What role for local government in sanitation promotion? Lessons from Tanzania. *Water Policy* **2014**, *16*, 1104–1120. [CrossRef]
93. Montgomery, M.; Bartram, J.; Elimelech, M. Increasing Functional Sustainability of Water and Sanitation Supplies in Rural Sub-Saharan Africa. *Environ. Eng. Sci.* **2009**, *26*, 1017–1023. [CrossRef]

94. Jiménez, A.; Pérez-Foguet, A. The relationship between technology and functionality of rural water points: Evidence from Tanzania. *Water Sci. Technol.* **2011**, *63*, 949–956. [CrossRef] [PubMed]
95. Zapasa, A.; Musz-Pomorska, A.; Gołębiowska, J.; Widomski, M.K. Financial, environmental and social sustainability of rural sanitary wastewater system: Case study. *Appl. Water Sci.* **2022**, *12*, 277. [CrossRef]
96. Brzusek, A.; Widomski, M.K.; Musz-Pomorska, A. Socio-Economic Aspects of Centralized Wastewater System for Rural Settlement under Conditions of Eastern Poland. *Water* **2022**, *14*, 1667. [CrossRef]
97. Byambadorj, A.; Lee, H.S. Household Willingness to Pay for Wastewater Treatment and Water Supply System Improvement in a Ger Area in Ulaanbaatar City, Mongolia. *Water* **2019**, *11*, 1856. [CrossRef]
98. Osman, K.K.; Claveria, J.B.; Faust, K.M.; Hernandez, S. Temporal Dynamics of Willingness to Pay for Alternatives That Increase the Reliability of Water and Wastewater Service. *J. Constr. Eng. Manag.* **2019**, *145*, 04019041. [CrossRef]
99. Menegaki, A.N.; Mellon, R.C.; Vrentzou, A.; Koumakis, G.; Tsagarakis, K.P. What's in a name: Framing treated wastewater as recycled water increases willingness to use and willingness to pay. *J. Econ. Psychol.* **2009**, *30*, 285–292. [CrossRef]
100. Vásquez, W.F.; Mozumder, P.; Hernández-Arce, J.; Berrens, R.P. Willingness to pay for safe drinking water: Evidence from Parral, Mexico. *J. Environ. Manag.* **2009**, *90*, 3391–3400. [CrossRef] [PubMed]
101. Faust, K.M.; Hernandez, S.; Anderson, J. Willingness to Pay for Perceived Increased Costs of Water and Wastewater Service in Shrinking US Cities: A Latent Class Approach. *J. Water Resour. Plan. Manag.* **2018**, *144*, 04018033. [CrossRef]
102. Tudela-Mamani, J.W. Willingness to pay for improvements in wastewater treatment: Application of the contingent valuation method in Puno, Peru. *Rev. Chapingo Ser. Cienc. For. Ambient.* **2017**, *23*, 341–352. [CrossRef]
103. Daudey, L. The cost of urban sanitation solutions: A literature review. *J. Water Sanit. Hyg. Dev.* **2018**, *8*, 176–195. [CrossRef]
104. Suleiman, L.; Olofsson, B.; Saurí, D.; Palau-Rof, L. A breakthrough in urban rain-harvesting schemes through planning for urban greening: Case studies from Stockholm and Barcelona. *Urban For. Urban Green* **2020**, *51*, 126678. [CrossRef]
105. Mourad, K.A.; Berndtsson, J.C.; Berndtsson, R. Potential fresh water saving using greywater in toilet flushing in Syria. *J. Environ. Manag.* **2011**, *92*, 2447–2453. [CrossRef]
106. Silva, C.M.; Sousa, V.; Carvalho, N.V. Evaluation of rainwater harvesting in Portugal: Application to single-family residences. *Resour. Conserv. Recycl.* **2015**, *94*, 21–34. [CrossRef]
107. Sepehri, M.; Malekinezehad, H.; Ilderomi, A.R.; Talebi, A.; Hosseini, S.Z. Studying the effect of rain water harvesting from roof surfaces on runoff and household consumption reduction. *Sustain. Cities Soc.* **2018**, *43*, 317–324. [CrossRef]
108. Musz-Pomorska, A.; Widomski, M.K.; Gołębiowska, J. Financial Sustainability of Selected Rain Water Harvesting Systems for Single-Family House under Conditions of Eastern Poland. *Sustainability* **2020**, *12*, 4853. [CrossRef]
109. City of Białystok. Available online: https://www.bialystok.pl/pl/dla_mieszkancow/fundusze_unijne/realizowane/okresprogramowania20142020/zagospodarowanie-wod-deszczowych-poprzez-budowe-kanalizacji-deszczowej-i-zbiornikow-retencyjnych-w-bialymstoku.html (accessed on 5 May 2020).
110. City of Lublin. Available online: https://lublin.eu/mieszkancy/srodowisko/aktualnosci/juz-jest-projekt-programu-zlap-deszczowke,276,1945,1.html (accessed on 5 May 2020).
111. Główny Urząd Nadzoru Budowlanego. Available online: https://www.gunb.gov.pl/strona/statystyki (accessed on 16 January 2023).
112. Kozdrój, W.; Ryżyński, G. Ciepło Ziemi: Geotermia Niskotemperaturowa—Innowacyjne Rozwiązania, Kierunki Rozwoju. XII Forum Innowacyjności: Klimat Wobec Wyzwań XXI Wieku, Rola Geologii w Energetyce Niskoemisyjnej i Magazynowaniu Energii. Państwowy Instytut Geologiczny—Państwowy Instytut Badawczy. 2021. Available online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwivwerKob_8AhVr_SoKHc3mBfEQFnoECA8QAQ&url=https%3A%2F%2Fwww.pgi.gov.pl%2Fdokumenty-pig-pib-all%2Faktualnosci-2022%2F9064-geotermia-niskotemperaturowa-innowacyjne-rozwiazania-kierunki-rozwoju.html&usg=AOvVaw1YOfzHVtIKBQwToWOs4yh2 (accessed on 16 January 2023).
113. Jaramillo, M.; Wright, G.D. Participatory Democracy and Effective Policy: Is There a Link? Evidence from Rural Peru. *World Dev.* **2015**, *66*, 280–292. [CrossRef]
114. Li, Y.; Fan, P.; Liu, Y. What makes better village development in traditional agricultural areas of China? Evidence from long-term observation of typical villages. *Habitat Int.* **2019**, *83*, 111–124. [CrossRef]
115. Moir, E.; Leyshon, M. The design of decision-making: Participatory budgeting and the production of localism. *Local Environ.* **2013**, *18*, 1002–1023. [CrossRef]
116. Beuermann, D.W.; Amelina, M. Does participatory budgeting improve decentralized public service delivery? Experimental evidence from rural Russia. *Econ. Gov.* **2018**, *19*, 339–379. [CrossRef]
117. Kafkova, M.P.; Vidovicova, L.; Wija, P. Older Adults and Civic Engagement in Rural Areas of the Czech Republic. *Eur. Countrys.* **2018**, *10*, 247–262. [CrossRef]
118. Kvartiuk, V.; Curtiss, J. Participatory rural development without participation: Insights from Ukraine. *J. Rural Stud.* **2019**, *69*, 76–86. [CrossRef]
119. Nourry, M. Measuring sustainable development: Some empirical evidence for France from eight alternative indicators. *Ecol. Econ.* **2008**, *67*, 441–456. [CrossRef]
120. Paprotny, D. Measuring Central and Eastern Europe's Socio-Economic Development Using Time Lags. *Soc. Indic. Res.* **2016**, *127*, 939–957. [CrossRef]

121. Golusin, M.; Munitlak Ivanovic, O.; Teodorovic, N. The review of the achieved degree of sustainable development in South Eastern Europe—The use of linear regression method. *Renew. Sustain. Energy Rev.* **2011**, *15*, 766–772. [CrossRef]
122. Rogelio, M.A. Assessment of Socio Economic Development through Country Classifications: A Cluster Analysis of the Latin America and the Caribbean (LAC) and the European Union (EU). *Rev. Econ. Mund.* **2017**, *47*, 43–64.
123. Bednarska-Olejniczak, D.; Olejniczak, J.; Svobodová, L. How a Participatory Budget Can Support Sustainable Rural Development—Lessons from Poland. *Sustainability* **2020**, *12*, 2620. [CrossRef]