GEOMATICS AND ENVIRONMENTAL ENGINEERING • Volume 17 • Number 1 • 2023

https://doi.org/10.7494/geom.2023.17.1.5

Marek Ogryzek[1]

The Sustainable Development Paradigm

Abstract: The article discusses the evolution of the concept of sustainable development and briefly discusses its definition. The study, based on Polish and foreign literature sources, uses the method of literature analysis with elements of inductive reasoning. This is a review article, whose aim is to present both positive and critical approaches to the idea of the sustainable development of space.

Keywords: sustainability, paradigm, land management, land management eco-philosophy, sustainable development

Received: 27 July 2022; accepted: 24 September 2022

[1] University of Warmia and Mazury in Olsztyn, Faculty of Geoengineering, Institute of Spatial Management and Geography, Department of Land Management and Geographic Information Systems, Olsztyn, Poland, email: marek.ogryzek@uwm.edu.pl,
https://orcid.org/0000-0002-7493-5488

1. Introduction

A paradigm is a pattern or model of behaviour, where it is maintained that a paradigm is a solution to a certain problem approved of by the scientific community [1]. Paradigms in the social sciences may gain or lose popularity, but they will never be considered true or false and, in addition, the concept of sustainable development can be understood in two contexts. On the one hand, it is a set of tools leading to the attainment of the most desirable socio-economic development; on the other hand, with a much broader meaning, sustainable development is seen as a concept of the relationship between humans and the environment, which must be shaped in compliance with new principles [2]. The concept of sustainable development has won many adherents in the world of science, and is mostly evaluated positively, although there are critical views in the literature expressed from the philosophical and ethical viewpoints, which refer to the idea of sustainable development, the methods of its implementation and even the goals achieved [3]. Moreover, a paradigm can periodically undergo fundamental transformations, leading to profound changes in science. In addition, the very definition of a paradigm can be understood more specifically, i.e. as a way of reasoning that provides guidance to teams of researchers on how to analyse and solve problems (it indicates a model solution to a problem in a particular scientific field) [4]. The concept of sustainable development is thought to have originated from the idea of eco-development, but the prototype of this notion should be sought in the foundations of eco-philosophy. From the pre-Socratic philosophers of nature in ancient Greece (from the 6th to the end of the 5th century BC), and then Socrates, Plato and Aristotle, to representatives of this trend in philosophy from all epochs until contemporary representatives of eco-philosophy.

The best-known approaches to eco-philosophy have been proposed by:

- Arne Naess – deep ecology movement,
- Murray Bookchin – social ecology,
- Thomas Berry – the new story for the Earth,
- Françoise d'Eaubonne – eco-feminism,
- Henryk Skolimowski – eco-philosophy.

2. Historical Outline

The term was coined at the United Nations Conference on the Human Environment in Stockholm in 1972. The idea arose in response to the public's growing awareness of emerging threats under conditions of systematic economic growth and limited natural resources [5]. The concept of sustainability began to take shape relatively early, as the first mentions can be traced back to the 1960s. The concept itself was already being implemented on terraced farmland in China [6], or in the use of spatial data presented as layers (overlays) in the management of environmental

resources according to the design with nature concept [7]. The study showed that international achievements in the field of sustainable development are the result of the implementation of the recommendations of the World Commission on Environment and Development. In 1987, the Commission issued a report with a vision of sustainable development, which took into account the human population as well as the animal and plant world, ecosystems, the Earth's natural resources (water, air, energy resources), and – in an integrated manner – addressed the major challenges facing the world, such as the fight against poverty, gender equality, human rights and safety, education for all, health, intercultural dialogue. In 1968, the first UNESCO Intergovernmental Conference of Scientific Experts on the Interrelationship of Environment and Development was convened, resulting in the establishment of the international interdisciplinary programme Man and the Biosphere – MAB. In 1987, the UN World Commission on Environment and Development, chaired by the Norwegian politician Gro Harlem Brundtland, issued a report entitled *Our Common Future*, which defined sustainable development as development that ensures that the needs of the present generation are met without compromising the ability of future generations to meet their own needs [8]. The report highlights the three pillars of sustainable development: environmental protection, economic growth, and social justice. Scientific definitions of sustainable development have been developed since then, describing it as a process to meet the development aspirations of the present generation in a way that enables the same aspirations to be pursued by future generations [9]. In 1992, the Earth Summit in Rio de Janeiro produced one of the most important documents related to sustainable development, *Agenda 21*, a comprehensive action plan for the 21st century for the United Nations, governments and social groups in every area where humans have an impact on the environment. In 2000, the United Nations (UN) Millennium Summit defined the Millennium Development Goals, while in 2002, the World Earth Summit in Johannesburg provided an opportunity to establish new forms of partnership involving civil society rather than government institutions in the implementation of sustainable development, as has been the case until then. In 2002, the UN General Assembly proclaimed the years 2005–2014 to be the Decade of Education for Sustainable Development, known as the Decade of Change. Its mandate is to promote sustainable behaviour, inspiring critical and creative thinking to find solutions to problems that prevent sustainable development. UNESCO was entrusted with the role of coordinating activities. At the same time, three pillars were set out on which development should rest, i.e. economy, society and the environment [10]. Economic growth, social progress and environmental governance are therefore treated as interdependent phenomena, which means the problems need to addressed holistically [11]. In 2012, representatives from over a hundred countries met at the next Earth Summit in Rio de Janeiro, held under the name "Rio +20". This summit was concluded by passing the declaration *The Future We Want*, recognising poverty as the most important challenge facing humanity today and as the most significant obstacle to sustainable development.

It was decided to define a set of universal Sustainable Development Goals (SDGs) beyond 2015, closely linked to the status of the Millennium Development Goals. In 2016, the UN adopted 17 goals in this regard. Sustainable development is achievable when the following are pursued harmoniously: growth, social inclusion, and environmental protection.

Sustainable development is often seen as a separate field in sciences because of the rapid growth in the number of books and articles dedicated to this issue which we have witnessed over the past 20 years [12–14]. It is described as an effort to attain an equilibrium between economic, social and environmental factors, referred to in the literature as:

- three pillars [15, 16],
- three aspects [17, 18],
- three perspectives [19, 20].

It is visually presented in the form of:

- a Venn diagram – three overlapping circles (societies, environment and economy), with sustainable development located at their intersection,
- nested concentric circles,
- three pillars on which sustainable development rests,
- four circles taking into account the needs of society, environment, economy and space.

3. Sustainable Development

The term sustainable development also appears in legislative acts, e.g. according to the Environmental Protection Law of 2012, sustainable development is a social and economic process that results in the integration of political, economic and social activities, while maintaining the natural balance and sustainability of basic natural processes in order to guarantee the possibility of satisfying the basic needs of particular communities or citizens of both the present and future generations. However, Rakoczy believes that the term should not be defined by the legislator, as it is not possible to describe sustainable development accurately and comprehensively in legal language [21]. According to Wilkin, the issue of sustainable development, due to its interdisciplinary nature and the need to link many areas of life, should be considered from a sectoral perspective [22].

Critical assessment of the concept of sustainable development appears in works in the field of economics, as economic freedom and freedom of decision-making in different spheres of life are at odds with the possibility of simultaneous social development and economic growth. Another significant challenge is how to satisfy the development aspirations of the current generation in a way that will enable the next generation to satisfy the same aspirations, since it is unknown what needs and

desires future generations will have. Yet another aspect is the globalisation of goals, which vary depending on the degree of economic development, for example, populations in developed countries are ageing due to the demographic decline while migration from culturally distant countries causes social conflicts; in underdeveloped countries, there is a pressure of young people to develop economically [23]. Another aspect consists of measures of the economic, social or environmental development. On the one hand, there is the conviction that non-renewable resources should be conserved; on the other hand, according to Bartkowski's theory, when geological time periods are taken into account, it can be concluded that most resources are renewable, but with the decreasing time of renewability an increasing number of environmental resources can be classified as non-renewable [24]. In addition, we are limiting the extraction of resources, thereby increasing the cost of alternative raw materials, which may or may not be wanted or needed by future generations. The current political situation in the world has led to an energy crisis with a resulting economic crisis, and even though countries have deposits of natural resources, due to restrictions they cannot exploit them fully because they are afraid of penalties. Critics of the idea of sustainable development also point to attempts made to implement it by encouraging inhabitants of poorer regions of the world to avoid the errors of industrialised countries, and to use environmentally friendly technologies; at the same time, dynamically developing countries are reprimanded for not respecting the idea of sustainable development, whereas it is mainly the developed countries that have contributed to the current environmental crisis [25]. A similar situation arises due to restrictions on the construction of transit roads, where areas of particular ecological value are excluded; however, transit roads in developed countries had been built before appropriate changes in legislation acknowledged the principle of sustainable transport.

Spatial scientists, on the other hand, understand the concept of sustainable development as an opportunity to reach a compromise between environmental, social and economic aspects [26]. Sustainable development is seen as a balance between social development, economic development, and environmental protection. It is a type of socio-economic development, so it is man-made and takes place in the technosphere, which must be considered as part of the natural environment [27]. Optimal and rational land use (land use – function of the area) is a key to achieving sustainable development and supporting the global Millennium Development Goals agenda.

The best-known definition of optimal land use is the one that states it is such use which, of all the legal and physically possible uses that are "consistent with its intended use", generates the highest value land [28]. Sustainable development is the optimal use of an area in which the area is used rationally in terms of natural, economic and anthropogenic benefits and disadvantages (optimal land use is that which provides a balance between the criteria for assessing natural value, economic value and anthropogenic value according to the postulates of rational and

optimal land use) [29]. In the field of land management, the concept of optimisation is used in the verification of the best (optimal) land use as the relationship between the natural/economic and social/ecological value of space [30]. The optimisation method is also called the "land valorisation method" and its prototype in Poland is the "Warsaw optimisation method" [31]. The method was developed between 1961 and 1963 and its aim was to rationally locate investments. The method was used in the preparation of spatial development plans in 1961–1978 for the cities of Warsaw, Gdańsk, Krakow, Łódź, Poznań and Skopje [32]. Bajerowski determines the natural value using the feature matrix and the post-transformation economic value for the current and optimal area function derived from the feature matrix [33]. Ogryzek supplemented the method with a matrix of anthropogenic features to determine the natural value and determined the economic value for different states of land use using an algorithm with elements of game theory of the transaction price index obtained from a computer simulation of the sale of property by tender [34]. Jędrzejewska and Biłozor, on the other hand, developed a nature-anthropogenic matrix by which they determined the nature-economic value and used a public survey method as to the optimal use of the land [35]. The most commonly used methods for valuing and assessing natural areas are: basic assessment fields, Bogdanowski's method, Wejchert's impression curve, Sohngen's method, Bajerowski's method, Kowalczyk's method or the photographic method [36].

The most popular methods for determining public expectations are the feature matrix method and surveys, while the economic value can be determined by classic property valuation methods or by alternative methods using statistical models [37].

Spatial management is the process of the transformation and formation of the actual state of space into a desired state that meets the society's needs, in accordance with the maintenance of spatial order. The main objective of spatial management is to protect the value of space, and to shape the space rationally and consciously [38]. The allocation of land to different social and economic functions and decisions on how to manage and develop these areas lead to the planned distribution of residents, housing and social, technical and economic infrastructure in the area for its rational management, operation and use, taking into account the protection of the environment and living standards [39]. The task of spatial management is to define the principles and methods of spatial management in order to ensure spatial order and achieve sustainable development. Conservation activities involve efforts to maintain a balance between the natural elements of the environment and the products of human activity. Space shaping, on the other hand, is a transformative activity related to new directions of socio-economic development. Sustainable development harmonises the fulfilment of all economic, social, and ecological, as well as cultural and spatial functions by rural areas. In terms of novelty, this type of development represents the highest level in both scientific and practical achievements. An important aspect in this approach is space, which is a limited resource and as such it cannot be enlarged. This situation contributes to an increase in the number of conflicts

between different actors as well as between different economic functions in relation to the demand for space. Therefore, it is necessary to take measures for the rational use of resources in the economy. Meeting the objectives of spatial management requires spatial data. Having such data is essential for sustainable agriculture, which can ensure sufficient food production and prevent famine. An important tool for the implementation of sustainable development is the use of spatial information systems. Research into the implementation of international GIS development concepts has shown that, over the past twenty-five years, many initiatives emphasising the relevance and importance of pursuing a global policy of sustainable economic, social and environmental development by means of continuously developing GIS systems have been stimulated by decisions made during the summits. An important role of UNESCO, engaged in consultations with other UN agencies, international organisations, national governments and NGOs, should be pointed out. Digital systems integrated with other information systems, as a basis for effective land management, in addition to fulfilling key functions in the land management paradigm, namely: securing property rights, providing information on property values and land use type, and providing comprehensive information on the state of economic development of selected land areas, will also guarantee universal access to the data collected in them by SDIs and enable their free processing already at the level of sharing. Large-scale digital cadastral maps with the possibility of visualisation in 3D/4D, owing to the integration of spatial and descriptive data, make it possible to obtain information on the type of land use, but also on the rights, obligations and restrictions pertaining to this land [40].

4. Tools for Sustainable Development

Geographical information is essential to achieving sustainable development and environmental sustainability. In addition, it is important for the performance of such public tasks as traffic and transport, water management, economic development and spatial planning, and in fields like climate and environment, education and healthcare, security and emergency planning [41]. Sources of geographical knowledge can be divided into direct (observations, measurements, monitoring, interviews, questionnaires, surveys) and indirect ones (maps, books, magazines, Global Positioning System, Geographic Information Systems, statistical databases as well as drawings, photographs, films, and other materials in the scope of geography). Additionally, there are many decision-making support systems for collecting and processing data, such as GIS, Earth Survey, Earth Management Systems, Real Estate Cadastre, etc [42]. Collecting comprehensive spatial information on a given region is time-consuming, while comparing these data between different EU countries is almost impossible, as they were not harmonised. To change this situation, in 2007, the European Commission adopted the INSPIRE Directive (Directive 2007/2/EC of

the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community), whose main task is to facilitate and accelerate access to data and to increase the possibility of exchanging them within the EU countries [43]. The data reliability of the information provided by the national geoportals is not only the most solid foundation of the Spatial Information Infrastructure, but especially of the property administration systems, which affects the efficiency of decision-making in real estate markets [44]. One of the biggest challenges in achieving the shared vision of the Sustainable Development Agenda is to have high quality, timely, comparable, and accessible data to measure and report progress towards the Sustainable Development Goals (SDGs). Hence, in many countries, geospatial information (including Earth observations) and algorithms implemented in cloud computing platforms have become important tools for monitoring SDG indicators owing to their wide availability and global reach [45]. Using the latest technology, GIS systems should provide the private and public sectors with comprehensive information on land rights and constraints, i.e. such rights that would support the sustainable development of space [46]. GIS is an instrument supporting the management and administration of land resources because the GIS software is a platform for the acquisition, management, and analysis of spatial data.

The European Commission's Joint Research Centre (JRC) has set up the INSPIRE geoportal, which is intended to be the central node of the European infrastructure for spatial information, as part of an extensive outreach. The global idea of establishing national geographic information systems (geoportals) arose from the need to establish single infrastructure for the implementation of spatial policy, supporting the strategic management of real estate in order to achieve sustainable use of space. The integrated geographic information systems of each country are the infrastructure created to implement its spatial policy, fulfilling the tasks and objectives of sustainable development. In addition, the main aspects of spatial modelling have been distinguished, i.e. legal (it is to operate on the basis of legal articles), economic (it is to provide a choice of economically best solutions), technical (it is to strive towards development, including the development of information technology) and social (it is to serve society). In addition, one of the designated tasks is to provide extensive support to land administration and management so as to ensure the sustainability of these processes.

Another important tool-related aspect in the sustainable development of space is the transport system, as it should ensure that all people have access to the economic and social opportunities necessary for dignified life [47]. When considering the issue of sustainable development, attention should be paid to the determinants of development, among which the improvement of regional accessibility can be highlighted. An underdeveloped transport network means fewer opportunities for dynamic urban or regional development. In addition, accessibility has become the most important factor in landscape change, as urbanisation processes can even be

observed in remote rural areas [48]. Communities living in various regions are striving to develop sustainable transport systems, especially road networks, which will enable them to achieve an appropriate level of growth in the economic, social, and environmental spheres. However, it must be acknowledged that the environmental aspect and the associated need to overcome natural barriers are one of the biggest challenges we face in developing the transport network [49]. Good road accessibility tends to be associated with a developed highway network, with a focus on motorways, interregional transport corridors, and an international transport network. The impact of the transport network on the economy of societies with underdeveloped road networks has been thoroughly researched [50] because, as has been confirmed in studies, this situation influences urban land use [51, 52]. Location models show cities as economic models or models of the potential for urban attractiveness (gravity models). In this vein, a number of research breakthroughs are worth noting, such as the introduction of the concept of two-dimensional continuous space [53], the introduction of computer simulations [53], and a model with a spatial vector field characteristic [55].

According to Pearce [56], sustainable development involves maximising the benefits of economic development, but also comprehensively improving other aspects of society. Culture, as the basis of social life, is considered one of the four pillars of sustainable development. Cultural heritage is one of the main elements of such a described culture and is understood much more broadly than just in the context of historic preservation, it also consists of local traditions and customs, cultural affiliations, or sources of intangible values. Cultural heritage is often considered a non-economic factor in spatial development. However, treated as a resource, it can be transformed into an asset that can play an important role in sustainable development strategies, both at local and national levels.

Another important aspect of modelling space in the context of sustainable development is the impact on the environment. How to use space in harmony with nature while achieving the goal of agricultural production and agricultural development are important aspects of implementing sustainable development in rural areas. Sustainable development requires the monitoring of agricultural development.

5. Summary

The development of the concept of sustainability has given rise to a multitude of approaches to the interpretation of this concept, which is associated with ecodevelopment or, more broadly, with integrated spatial order on a local and global scale. Spatial governance is the socio-economic development in which political, economic and social activities are integrated in harmony with the environment and the natural processes taking place within it. It aims to guarantee the fundamental needs of society, both of the present generation and of future generations [57]. The

concept of sustainable development therefore sets out directions for improving the quality of life of society while respecting the principles of environmental protection. Thus, socio-economic development requires a compromise with nature, even though social development and economic development will proceed more slowly under such conditions. It appears that sustainable development (despite the criticism) can ensure balance and protect the world, because achieving economic growth at all costs violates the balance of ecosystems and ecological security. It is therefore important to manage resources in such a way that development is as harmless to the environment as possible. The optimal use of land does not equate to its rational use because a disadvantage of indicator methods is the subjective choice of criteria in addition to the quality of input data. Hence, the results are not objective and do not account for specific situations, for example when one of the determinants of sustainable development of a given area should be devoted to the protection of nature or social needs. A hybrid method can solve this problem as it allows the user, at least in specific cases, to deviate from the rule of optimal land use in favour of rational land use. Hence, it is crucial to define the principles of optimal and rational land management.

Postulate 1. Principle of selection of optimal land use:

A given area can be transformed to an optimal function when the sum of the natural, anthropogenic and economic values is greater than the values assigned to other functions of the site.

Postulate 2. Principle of the selection of rational land use:

A given site can be transformed to a rational function in order to preserve spatial order when there are rational ecological, economic premises (criteria) or social needs. In this case, the natural value or the anthropogenic or economic value for the function must be greater than the natural value or the anthropogenic or economic value for the optimal land use, depending on the criterion for derogation from the principle of selecting optimal land use.

References

[1] Kuhn T.S.: *The Structure of Scientific Revolutions*. University of Chicago Press, Chicago 1962.

[2] Trzepacz P. (red.): *Zrównoważony rozwój – wyzwania globalne: podręcznik dla uczestników studiów doktoranckich*. Instytut Geografii i Gospodarki Przestrzennej UJ, Kraków 2012.

[3] Poczta-Wajda A., Sapa A.: *Paradygmat rozwoju zrównoważonego – ujęcie krytyczne*. Progress in Economic Sciences, vol. 4, 2017, pp. 131–142. https://doi.org/10.14595/PES/04/009.

[4] Muszyński Z.: *Siedem cech głównych szkoły naukowej*. Filozofia Nauki, R. 3, nr 1–2(9–10), 1995, pp. 63–67.
[5] Fiedor B., Kociszewski K. (red.): *Ekonomia rozwoju*. Wydawnictwo Uniwersytetu Ekonomicznego, Wrocław 2010.
[6] Płachciak A.: *Geneza idei rozwoju zrównoważonego*. *Ekonomia – Economics*, nr 5(17), 2011, pp. 231–248.
[7] McHarg I.L.: *Design with Nature*. Wiley, New York 1969.
[8] World Commission on Environment and Development: *Our Common Future*. Oxford University Press, Oxford 1987.
[9] Greene D.L., Wegener M.: *Sustainable transport*. Journal of Transport Geography, vol. 5(3), 1997, pp. 177–190. https://doi.org/10.1016/s0966-6923(97)00013-6.
[10] Bąkiewicz A., Żuławska U.: *Od teorii wzrostu do ekonomii rozwoju*. [in:] Bąkiewicz A., Żuławska U. (red. nauk.), *Rozwój w dobie globalizacji*, Polskie Wydawnictwo Ekonomiczne, Warszawa 2010, pp. 64–88.
[11] Matuszczak A.: *Zróżnicowanie rozwoju rolnictwa w regionach Unii Europejskiej w aspekcie jego zrównoważenia*. Wydawnictwo Naukowe PWN, Warszawa 2013.
[12] Kates R.W., Clark W.C., Corell R., Hall J.M., Jaeger C.C., Lowe I., McCarthy J.J. et al.: *Sustainability science*. Science, vol. 292(5517), 2001, pp. 641–642. https://doi.org/10.1126/science.1059386.
[13] Komiyama H., Takeuchi K.: *Sustainability science: Building a new discipline*. Sustainability Science, vol. 1, 2006, pp. 1–6. https://doi.org/10.1007/S11625-006-0007-4.
[14] Schoolman E., Guest J., Bush K.F., Bell A.R.: *How interdisciplinary is sustainability research? Analyzing the structure of an emerging scientific field*. Sustainability Science, vol. 7, 2012, pp. 67–80. https://doi.org/10.1007/s11625-011-0139-z.
[15] Basiago A.D.: *Economic, social, and environmental sustainability in development theory and urban planning practice*. Environmentalist, vol. 19(2), 1998, pp. 145–161. https://doi.org/10.1023/A:1006697118620.
[16] Boyer R.H.W., Peterson N., Poonam A., Caldwell K.: *Five approaches to social sustainability and an integrated way forward*. Sustainability, vol. 8(9), 878. https://doi.org/10.3390/su8090878.
[17] Goodland R.: *The concept of environmental sustainability*. Annual Review of Ecology and Systematics, vol. 26, 1995, pp. 1–24. https://www.jstor.org/stable/2097196 [access: 5.09.2022].
[18] Tanguay G.A., Rajaonson J., Lefebvre J.-F., Lanoie P.: *Measuring the sustainability of cities: An analysis of the use of local indicators*. Ecological Indicators, vol. 10(2), 2010, pp. 407–418. https://doi.org/10.1016/j.ecolind.2009.07.013.
[19] Brown B.J., Hanson M.E., Liverman D.M., Merideth R.W. Jr.: *Global sustainability: Toward definition*. Environmental Management, vol. 11(6), 1987, pp. 713–719. https://doi.org/10.1007/BF01867238.

[20] Arushanyan Y., Ekener E., Moberg Å.: *Sustainability assessment framework for scenarios – SAFS*. Environmental Impact Assessment Review, vol. 63, 2017, pp. 23–34. https://doi.org/10.1016/j.eiar.2016.11.001.
[21] Rakoczy B.: *Zasada zrównoważonego rozwoju w Konstytucji Rzeczypospolitej Polskiej*. [in:] Poskrobko B. (red. nauk.), *Wpływ idei zrównoważonego rozwoju na politykę państwa i regionów: monografia naukowa. T. 1, Problemy ogólnopaństwowe i sektorowe*, Wydawnictwo Wyższej Szkoły Ekonomicznej w Białymstoku, Białystok 2009, pp. 29–35.
[22] Wilkin J.: *Podstawy strategii zintegrowanego rozwoju rolnictwa i obszarów wiejskich w Polsce*. Wydawnictwo Uniwersytetu Warszawskiego, Warszawa 2003.
[23] Kosiek T.: *Zrównoważony rozwój – rozwiązanie czy ideologia?* Zeszyty Naukowe. Organizacja i Zarządzanie – Politechnika Śląska, nr 1943(85), 2015, pp. 233–244.
[24] Bartkowski T.: *Kształtowanie i ochrona środowiska*. Państwowe Wydawnictwo Naukowe, Warszawa 1981.
[25] Fernando J.L.: *The power of unsustainable development: What is to be done?* The Annals of the American Academy of Political and Social Science, vol. 590(1), 2016, pp. 6–34. https://doi.org/10.1177/0002716203258283.
[26] Manashinghe M.: *Environmental Economics and Sustainable Development*. World Bank, Washington D.C. 1993.
[27] Pawłowska B.: *W kierunku zrównoważonego rozwoju – przegląd efektów działań w Polsce*. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, nr 401, 2015, pp. 362–372. https://doi.org/10.15611/pn.2015.401.33.
[28] Kinzy S.: *Dwelling attribute forecasts based on land residual maximization*. Land Economics, vol. 68(4), 1992, pp. 380–396. https://doi.org/10.2307/3146695.
[29] Ogryzek M.: *Simulator of Sustainable Urban Development – a tool for selecting the optimal use of land*. [in:] Cygas D., Tollazzi T. (eds.), *9th ICEE: 9th International Conference on Environmental Engineering, May 22–23, 2014, Vilnius, Lithuania: selected papers*, Vilnius Gediminas Technical University Press Technika, Vilnius 2014, pp. 1–8. https://doi.org/10.3846/enviro.2014.127.
[30] Bajerowski T. (red.): *Podstawy teoretyczne gospodarki przestrzennej i zarządzania przestrzenią*. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego, Olsztyn 2003.
[31] Leśniak J.: *Planowanie przestrzenne*. Państwowe Wydawnictwo Naukowe, Warszawa 1985.
[32] Broniewski S., Suchorzewski W.: *Metoda optymalizacji warszawskiej*. [in:] Kulikowski R., Makowski M. (oprac. nauk.), *Zastosowanie analizy systemowej w modelowaniu rozwoju regionalnego: Jabłonna 11–16 września 1978. 1*, Państwowe Wydawnictwo Naukowe, Warszawa – Łódź 1979, pp. 91–102.
[33] Bajerowski T.: *Metodyka wyboru optymalnego użytkowania ziemi na obszarach wiejskich*. Acta Academiae Agriculturae ac Technicae Olstenensis, 535, Geodaesia et Ruris Regulatio, 26, suppl. B, Wydawnictwo ART, Olsztyn 1996.

[34] Ogryzek M.P.: *Weryfikacja metodyki wyboru optymalnego użytkowania ziemi wg Bajerowskiego dla potrzeb zarządzania przestrzenią planistyczną*. Acta Scientiarum Polonorum. Administratio Locorum, t. 6(2), 2007, pp. 19–34.
[35] Jędrzejewska K., Biłozor A.: *Optymalizacja przestrzeni miejskiej – studium na przykładzie miasta Olsztyn*. Studia i Materiały Towarzystwa Naukowego Nieruchomości, vol. 20(2), 2012, pp. 155–166.
[36] Senetra A., Cieślak I.: *Kartograficzne aspekty oceny i waloryzacji przestrzeni*. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego, Olsztyn 2004.
[37] Kucharska-Stasiak E.: *Tradycyjne czy alternatywne metody wyceny*. Świat Nieruchomości, nr 1(103), 2018, pp. 7–12.
[38] Kielesińska A.: *Aspekty i uwarunkowania prawne gospodarki przestrzennej*. Zeszyty Naukowe Politechniki Częstochowskiej. Zarządzanie, nr 8, 2012, pp. 92–105. https://sbc.org.pl/dlibra/docmetadata?showContent=true&id=362656 [access: 13.07.2022].
[39] Cymerman R. (red.): *Planowanie i zagospodarowanie przestrzenne w gospodarce nieruchomościami: (wycena, zarządzanie i pośrednictwo w obrocie)*. Materiały Edukacyjne. Seria Nieruchomości, nr 9, Educaterra, Olsztyn 2001.
[40] Enemark S.: *From cadastre to land governance: The role of land professionals and FIG*. [in:] *Annual World Bank Conference on Land Policy and Administration, Washington D.C., 26–27 April 2010*, pp. 1–23.
[41] Sladić D., Radulović A., Govedarica M., Jovanović D., Pržulj Đ.: *The use of ontologies in cadastral systems*. Computer Science and Information Systems, vol. 12(3), 2015, pp. 1033–1053. https://doi.org/10.2298/CSIS141031009S.
[42] Dowman I., Reuter H.I.: *Global geospatial data from Earth observation: status and issues*. International Journal of Digital Earth, vol. 10(4), 2017, pp. 328–341. https://doi.org/10.1080/17538947.2016.1227379.
[43] Dawidowicz A., Sońta M.: *Analiza porównawcza wybranych geoportali europejskich*. Acta Scientiarum Polonorum. Administratio Locorum, t.13(2), 2014, pp. 59–76.
[44] Dawidowicz A., Źróbek R.: *The evolving role of the cadastre in the land administration system in Poland*. [in:] *FIG/FAO International Seminar: State Land Management in Transitional Countries: Issues and Ways Forward, September 20–21, 2012, Budapest, Hungary*. https://www.fig.net/resources/proceedings/2012/Hungary_2012_comm7/3.3_paper_dawidowcz_et_al.pdf [access: 23.07.2020].
[45] Merodio Gómez P., Ramírez Santiago A., Juárez Carrillo O.J., Jiménez Nava F.J.: *The potential contribution of Earth observation data cubes for the production of information for sustainable development in emerging countries*. Geomatics and Environmental Engineering, vol. 16(3), 2022, pp. 131–155. https://doi.org/10.7494/geom.2022.16.3.131.
[46] Oliveira E.: *Land ownership and land use development: The integration of past, present, and future in spatial planning and land management policies*. Landscape Journal, vol. 36, 2017, pp. 119–121. https://doi.org/10.3368/lj.36.2.119.

[47] Richardson B.C.: *Sustainable transport: Analysis frameworks*. Journal of Transport Geography, vol. 13(1), 2005, pp. 29–39. https://doi.org/10.1016/j.jtrangeo.2004.11.005.
[48] Antrop M.: *Landscape change and the urbanization process in Europe*. Landscape and Urban Planning, vol. 67(1–4), 2004, pp. 9–26. https://doi.org/10.1016/S0169-2046(03)00026-4.
[49] Ogryzek M., Adamska-Kmieć D., Klimach A.: *Sustainable transport: An efficient transportation network – case study*. Sustainability, vol. 12(19), 2020, 8274. https://doi.org/10.3390/su12198274.
[50] Owen W.: *Special problems facing underdeveloped countries: Transportation and economic development*. The American Economic Review, vol. 49(2), 1959, pp. 179–187. http://www.jstor.org/stable/1816113.
[51] Lucas R.E., Rossi-Hansberg E.: *On the internal structure of cities*. Econometrica, vol. 70(4), 2002, pp. 1445–1476. https://doi.org/10.1111/1468-0262.00338.
[52] Wheaton W.C.: *Commuting, congestion, and employment dispersal in cities with mixed land use.* Journal of Urban Economics, vol. 55(3), 2004, pp. 417–438. https://doi.org/10.1016/j.jue.2003.12.004.
[53] Beckman M.: *A continuous model of transportation*. Econometrica, vol. 20(4), 1952, pp. 642–660. https://doi.org/10.2307/1907646.
[54] Puu T.: *Mathematical Location and Land Use Theory: An Introduction*. Advances in Spatial Science, Springer, Berlin, Heidelberg 2003. https://doi.org/10.1007/978-3-540-24785-2.
[55] Fujita M.: *Urban Economic Theory: Land Use and City Size*. Cambridge University Press, Cambridge 1989. https://doi.org/10.1017/CBO9780511625862.
[56] Pearce D.W.: *Sustainable development and developing country economies*. [in:] Turner R.K. (ed.), *Sustainable Environmental Economics and Management: Principles and Practice*, Belhaven Press, London – New York 1993, pp. 71–105.
[57] Woźniak M.: *Ład przestrzenny jako paradygmat zrównoważonego gospodarowania przestrzenią*. Białostockie Studia Prawnicze, z. 18(25), 2015, pp. 167–182. https://doi.org/10.15290/bsp.2015.18.13.