CARTOGRAPHIC IMAGING OF THE DEVELOPMENT POTENTIAL OF NOWY TARG

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Summary

Development potential, studied on the example of the city of Nowy Targ, is defined by the authors as a set of factors contributing to social, economic, and environmental development. Development potential is also understood as a positive change. Properly examined, it provides an opportunity to maintain good practices, such as the protection of ecologically valuable areas or the preservation of traditions directly derived from the region's characteristics. The methodology used in this study, based on the point bonitation method, has already been applied in the context of ecological and natural assessments of selected territorial units. This publication demonstrates the application of this method to the selection of variables, allowing us to determine the development potential using Nowy Targ as an example. The authors place several indicators in three research sectors: the city's economy, natural environment, and social development. For the purpose of this study, the city area was divided into 245 squares (PPO) with sides of 500 m × 500 m. The size of the PPOs was chosen with regard to the purpose of the research and adapted to the city's area. 15 diagnostic variables were adopted in the examination of Nowy Targ's development potential. The conducted research resulted in a cartographic visualisation of the data using GIS tools. This research provides an opportunity to deepen the analysis of the appropriate choice of development directions when working on municipal development documents. An important advantage of the employed method is its flexibility. A weakness of this method lies in the subjective selection of variables by the researchers and the thematic scope of the chosen research problem. The resulting cartograms allow for a quick assessment of the areas influencing the city's development or degradation.

Keywords

development potential of cities • choropleth map • point bonitation method

1. Introduction

The development of modern cities can be seen as a multi-dimensional process involving entities representing various fields of research. Cities are units that have a unique impact on regional development. They draw together different potentials and activities that determine the course of developmental processes. The pace and character of urban development are similarly influenced by the ability to function in different collabora-

tive networks and the capability to use unconventionally the city's potential to achieve breakthrough results [Wrana 2010]. Urban development is a phenomenon that is difficult to assess definitively and objectively, particularly at the local level, due to limited access to data [Ziemiańczyk 2010]. The complexity of the issue is such that a single effective method for measuring development potential that is universally applicable to all types of cities or regions, has not yet been established. Therefore, this study is in line with the next stage of efforts to determine a method and a selection of diagnostic variables that will help to clarify the challenges of designing future urban development strategies. In Poland, researchers such as Kowalska [2012], Koźma [2015], Giełdas-Pinas [2012], Galiński et al. [2013], Cegielska et al. [2017] are working on the issues addressed in this paper.

Urban development potential is therefore a widely discussed topic in both Polish and international literature. The literature on the subject does not define the concept of 'development potential' conclusively. However, it contains many different terms that basically mean the same thing. Urban development issues have been addressed in Polish and foreign planning literature for many years. These include works by Kudłacz [1999], Markowski [1999], and Marciszewska [2010], among others. They cover a broad range of problems related to local and regional development. The main determinant of development is the identification of opportunities and obstacles that influence the degree of progress in various sectors. Development is the result of positive changes, which include both quantitative growth and qualitative progress [Gałązka 2017]. Studies conducted in various fields of research contribute to a deeper understanding of urban development and methods of determining it [Jha et al. 2007]. Recognition of this issue brings with it several positive developments that contribute to advancing the scientific understanding of the effectiveness of development policies by the public sector, including local governments. This applies to implemented revitalisation programmes and urban development strategies [Małopolskie obserwatorium polityki rozwoju, 2010 – Małopolskie Development Policy Observatory 2010].

Potential includes all the assets of a territorial unit that contribute to its development in a specific scientific field. The aim of identifying the potential is to draw up a roadmap for the unit in question in order to accelerate positive change. Directing the development trajectory of a given territory, or setting a trend, is a complex process involving numerous multi-dimensional criteria. The emergence of a particular development trend is caused by a constant, systematic, and long-lasting influence of factors. The concept of potential takes into account all social, economic, and environmental processes. The development of a city is conditioned by numerous correlated factors, mainly demographic, cultural, economic, and historical [Obrębalski 2006]. The phenomenon of development potential is predicted over a longer period and generally represents unidirectional actions to maximise the use of available resources. Thus, development potential indicates the possibility of optimal use of different characteristics of a given area to achieve constant and sustainable development. Defining development potential allows a city to be competitive in many different areas [Sulmicka 2012]. GIS tools can be helpful in its determination [Żyszkowska 2003]. Discussions in previ-

ous studies on the development potential of urban areas have covered a wide range of topics. Markowski and Marszał [2006] define development as a component of a directional evolutionary process, i.e. fundamental and visible processes of positive change in an urban area. According to McCann and Shefer [2005], urban development is related to the city's internal benefits, and the factors that influence development to varying degrees include the diversity of the socio-economic structure, as well as the concentration of activities and built-up areas [Gałązka 2017]. This presents the discussed concept as a positive change in both quantitative and qualitative growth.

An important element of modern development policy is integrated networks between the city centres and their surrounding areas. Such practices are connected to spatial planning and relate to the concept of urban functional regions. Difficulties in determining the city's impact stem from the multifaceted city-environment relationships. These relationships occur at sectoral, material, temporal and spatial levels [Serafin 2018]. As early as the 1970s, the issue of determining measures of regional development was addressed in the literature [Opałło 1972]. There are numerous scientific works discussing the scope of the application of spatial concentration indicators [Sudra 2016]. Some researchers also carry out studies to determine which methods illustrate the impact of human activity on the environment [Cegielska 2020].

The development potential of regions presents a set of individual factors involved in the development of specific administrative units of a country. According to Nazarczuk [2013], the main determinants of development include: the economic structure, level of entrepreneurship, opportunities for innovation creation, human capital, quality of the natural environment, economic activity, and technical infrastructure. The resources and potential of a given unit determine its development opportunities. The influence of external factors is weaker than that of internal factors. They cannot replace the resources accumulated by a given region. External elements should only support the accumulated potential. The author asserts that even with significant external forces, the regions with weaker potential have limited chances of catching up with the more prosperous areas of the country in a short period.

2. Spatial scope of research

The decision to select the research subject was preceded by an in-depth analysis of the results of the studies conducted by the Małopolska Institute of Development on the potential and development trends of cities in the Małopolska Voivodeship. Based on this information, it can be concluded that demographic processes, especially those related to the age structure of the population, play a significant role in the development of urban areas today. Demography is one of the most important factors considered when assessing the development potential of a chosen settlement unit. Unfavourable trends, such as an ageing society and a low birth rate, hold particular importance. Socio-economic development contributes to demographic changes that ultimately influence development potential. Migration trends provide a good source of information on the socio-economic needs of urban complexes. However, the economic conditions are not always the reason

for leaving a place of residence. The driving force behind this phenomenon is the grow-ing affluence of the Polish population and the changing mentality influenced by patterns from developed countries [Małopolskie obserwatorium polityki rozwoju 2010]. Taking into account individual conditions, urban areas have experienced and continue to experi-ence long-term and gradual or sudden depopulation. This process applies to all types of cities regardless of their size [Kantor-Pietraga et al. 2019]. The spatial scope of the research covered the city of Nowy Targ, located in the Małopolska Voivodeship, in the Nowy Targ county. This city is situated near the border with Slovakia, in the Orawa-Nowy Targ basin, at the foothills of the Gorce Mountains. The Dunajec River flows through the city, connecting the Biały and Czarny Dunajec rivers. The city area covers 51.07 km². Nowy Targ is the seat of the Nowy Targ county and serves as the main commercial, trans-portation, and industrial centre of the region. It is the oldest town in Podhale. Its cultural assets and ecologically valuable areas attract tourists [Kasprzyk et al. 2021] who value relaxation in silence, away from the heavy tourist traffic. This makes it an excellent start-ing point for exploring the Tatra, Pieniny, and Gorce mountains. It was chosen for the research due to these qualities which, according to residents, should be more appreciated and used in the future for the city's optimal development.

3. Research material

The analysis of the developmental potential of Nowy Targ was carried out using digital data from the National Geoportal, and up-to-date and available for free geospatial data. These include the vector Base of Topographic Objects Database (BDOT10k), which contains the spatial location of topographic objects together with their basic descrip-tions. The content and detail of the BDOT10k database are generally equivalent to a traditional topographic map at a scale of 1:10,000. All analyses were performed using the QGIS 3.18 software.

4. Research methodology

The study adopted the point bonitation method, which allows a synthetic evaluation of the chosen (defined) spatial unit. This method involves assigning a certain number of points to selected diagnostic variables according to a scale established by the author. Points are assigned based on varying values across the research area. The research results are then divided into classes and ranges of the intensity of a given phenomenon. Both the selection of the classes and the decision on the number of classes (and their range) are subjective aspects that depend on the analyst. For this reason, it was crucial at this stage of research to seek expert opinions from regional specialists who live in the region and care for its further development. This was essential because assigning points to phenomena is a challenging task that impacts the final research outcome.

In the point bonitation method, scores (points) are assigned to arbitrary basic assess-ment areas (PPO). For this study, the city area was divided into 245 squares with sides of 500 m × 500 m. The size of these basic evaluation areas was chosen considering the

research's objectives and adapted to the city's area. To analyse the development potential of Nowy Targ, 15 diagnostic variables were adopted. These variables were grouped into three sectors covering social, economic, and natural environment conditions. The diagnostic variables were further divided into stimulators and destimulators. For stimulators, points were assigned in ascending order as their values increased. Destimulators, on the other hand, were indicators that achieved the highest score at the lowest intensity of the phenomenon. Table 1 indicates the diagnostic variables, placed by sector.

Table 1. The diagnostic variables

Sector I – social indicators	
X_1	population density [persons per km^2]
X_2	cultural facilities – cinemas, libraries, museums, community centres and clubs [amount]
X_3	schools and research institutions [amount]
X_4	sports facilities [%]
X_5	area of hospital buildings and medical care facilities in relation to the assessment area [%]
Sector II – economic indicators	
X_1	industrial buildings [amount]
X_2	commercial and service buildings [liczba]
X_3	tourist accommodation buildings [liczba]
X_4	development density in relation to the assessment area [%]
X_5	length of road network in the assessment area [km]
Sector III – environmental indicators	
X_1	forest area in relation to the assessment area [%]
X_2	area of legally protected land in relation to the assessment area [%]
X_3	water surface in relation to the assessment area [%]
X_4	area of industrial storage areas in relation to the assessment area [%]
X_5	area of wetlands and rushes in relation to the assessment area [%]

Source: Authors' own study

Sector I – addresses aspects of the city's social life. Its content is a set of indicators that can be used to assess the possibilities shaping the quality of life of residents. It includes factors influencing the satisfaction of needs for education, self-realization, and safety. Sector II – relates to the city's economic and logistical aspects. The analysed factors in this sector broaden the scope of analysis to include employment opportunities, housing, and transportation. Sector III – concerns indicators of the natural environmental conditions, the proportion of natural land cover, and its diversity.

In its administrative division, the analysed city of Nowy Targ has no district boundaries. However, their locations are given general names. The authors of this study have used identification points of these locations to generate simplified research areas known as 'districts.' The Voronoi diagram was employed for this purpose using QGIS 3.18 software. This type of diagram is constructed from a set of points distributed over a defined area. The Voronoi diagram divides the studied areas into parts (cells) in such a way that each point located within a given cell of the diagram is closer to the node located in that cell than to any other network node [Brassel and Reif 1979].

The previously entered spatial data were then analysed in detail in the assigned areas of the basic assessment. These data were appropriately classified and assigned to the selected research sectors. The organisation of the data into chosen categories, including buildings with specific purposes or land cover types within a selected unit, was carried out using SQL language expressions. The research work was complemented by field inspections to verify the current use of buildings in the city.

In order to calculate the population density within a sector, the estimated European standard of residential area per person was adopted. The current European housing standard is 39.6 km^2 per person. In the case of the social sector, for sports facilities, the surface area was taken for the assessment, taking into account, in particular, the dimensions, which vary for the areas and sports facilities concerned. The same applies to hospitals and medical care facilities, where it was assumed that their area would better represent the development of the phenomenon in the basic assessment area than the number of their elements. The surface area of buildings was used to calculate the density of development, and thus their share in the given basic assessment area.

Spatial analyses, including investigations into the intensity and area of land cover with the given dataset, the number of objects, or the percentage share of selected diagnostic variables, were conducted using geoprocessing tools. An additional tool, the GroupStats plugin, was applied. Data grouping using this tool was based on the ID identifier, which represents the selected area of the basic assessment. The results obtained using the GroupStats plugin were stored in CSV files, which were exported and appropriately transformed before being incorporated into the chosen vector layer. The prepared data was visualised and unique display styles were developed. The results of the analysis were then divided into interval classes. Scores were assigned to the corresponding phenomena within the selected research sectors. The final step was to aggregate the final results, which included the assessment points from each of the 5 indicator sectors in each surveyed grid cell. This process yielded three result maps showing the level of development potential in three different sectors.

The distribution of values was determined based on the intensity of a given phenomenon within the surveyed area of a city. The number of classes in the point bonitation method is subjectively chosen by the author. In this case, an analysis of the results was conducted, and the classes were selected based on the minimum and maximum value differences, as well as the objects present in different basic assessment areas. As a result, each class is better than the previous one but inferior to the following one. The number of intervals identified corresponds to the maximum number of points achiev-

able for a single diagnostic variable. It is important to note that each indicator can have different score ranges. For the assessment of each sector, a different maximum number of points was set. For economic indicators, it was 25 points, for social indicators, 24 points, and for environmental indicators, 29 points.

5. Results

As a result of the conducted analyses using the point bonitation method with the QGIS 3.18 software, result maps (Fig. 1, Fig. 2, and Fig. 3) were generated, illustrating the classification of values for selected development indicators. Each indicator was divided into individual value intervals based on the intensity of the phenomenon within the basic assessment area. The divisions were made according to the minimum and maximum value differences as well as the number of objects. The results were presented in the form of simple cartograms. Due to these cartograms, it is possible to compare the results within the same reference area layout. The assessment areas in this study are of the same shape and size, thus making it easy to compare the saturation of a given indicator. These maps are a typical example of an analytical presentation format for phenomena. It is worth noting that either similar or different scoring scales were adopted for the indicators. This was dictated by the intensity of each indicator within the respective basic assessment area.

For the analysis of the development potential of Nowy Targ, 15 indicators were used, and divided into sets of 5 for each sector: social, economic, and environmental. Each sector was elaborated individually to avoid thematic conflicts, ensuring that the results do not mutually exclude one another. Each sector plays a different role in the development of the city. It was assumed that the unit with the highest number of points has the highest development potential. The cumulative number of points obtained through the analysis of individual indicators allowed for the distribution of points into specific numerical intervals, subsequently assigning them a level of development potential. A development structure was formulated in the form of result maps based on the acquired point intervals. Table 2 illustrates the value intervals of point bonitation classification and the degree of development.

Table 2. Final values of the point bonitation

Social sector	
Amount of point	Development potential
0–1	Low
2–4	Average
5–8	Medium
9–14	Good
15–18	High

Table 2. cont.

Economic sector	
Amount of point	**Development potential**
0–1	Low
2–4	Average
5–8	Medium
9–14	Good
15–18	High
Environmental sector	
1–3	Low
4–7	Average
8–11	Medium
12–15	Good
16–21	High

Source: Authors' own study
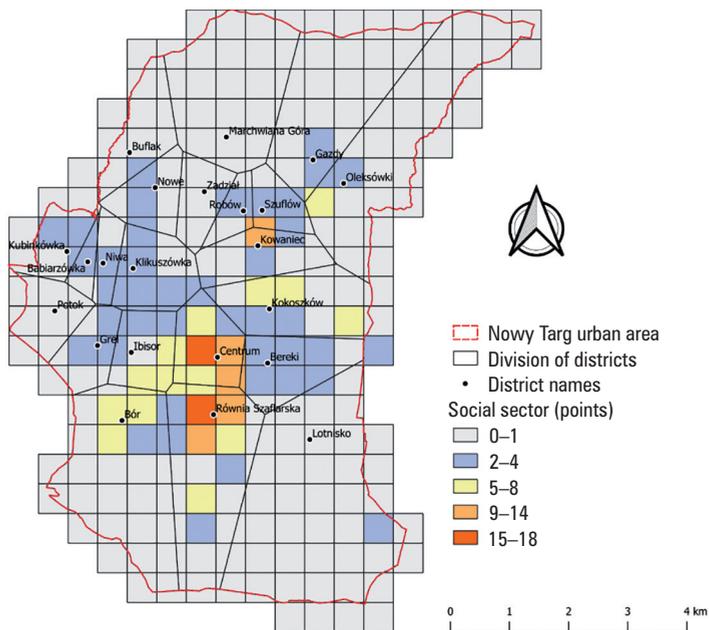
Source: Authors' own study

Fig. 1. Resultant map for the social sector
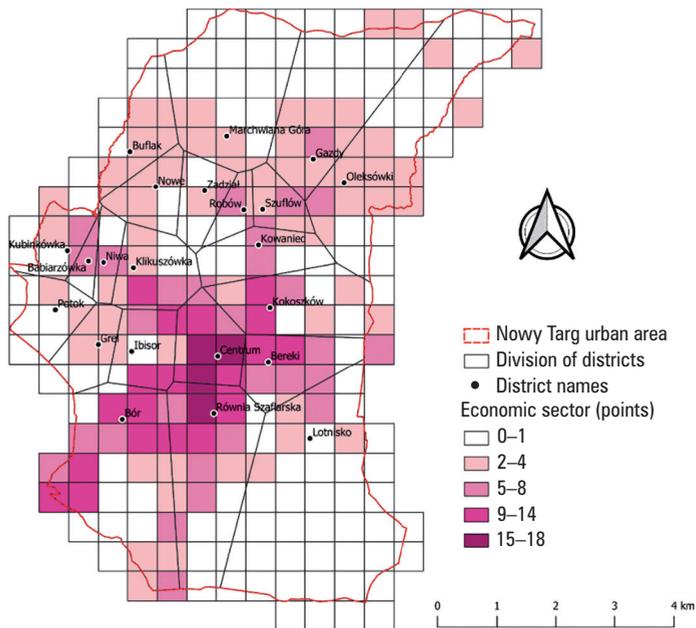
Source: Authors' own study

Fig. 2. Resultant map for the economic sector
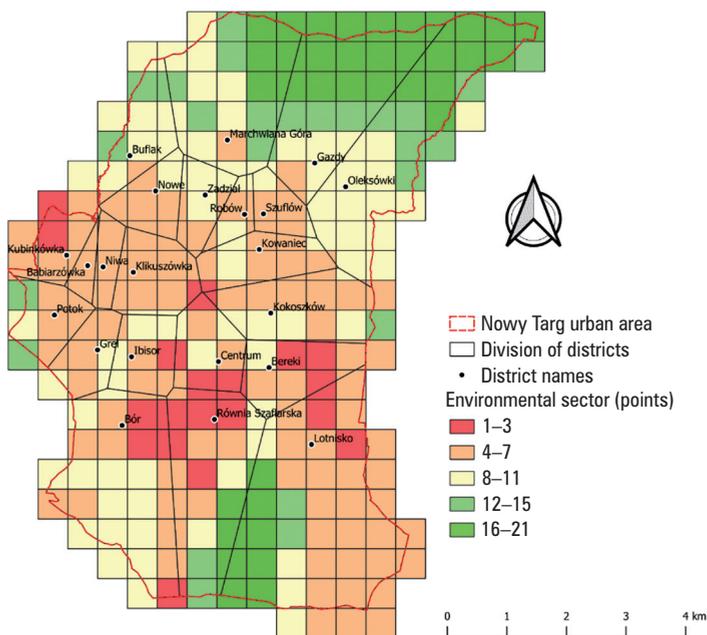
Source: Authors' own study

Fig. 3. Resultant map for the environmental sector

6. Discussion

Dividing the area and the scope of the research into thematic sectors avoided conflicts and did not distort the results of the deliberations. The conducted analyses could serve as one of the elements of the city's development strategy. The adopted indicators, due to their number, namely 15, could be expanded with data that the author was unable to obtain. Such data could include specialised information, city statistics, the results of questionnaires and background surveys. The results of the research revealed patterns emerging from the interrelationships between the adopted sectors. It was observed that areas rich in natural resources are not developed for industrial and commercial purposes. The analysis of the results of the natural environment against the economic indicators shows a dependency, as highlighted by Nazarczuk [2013]. Specifically, the conditions of the natural environment serve as the basis for developing the potential of tourism, accommodation, and recreational services. As the research shows, accommodation services are predominantly situated in ecologically valuable areas. In the final outcome of the environmental sector analysis, two indicators played an important role: the share of forested areas and the share of legally protected areas. A key step in the analysis was the introduction of destimulants for environmental variables. Industrial storage and warehouse complexes have a particular impact on the natural environment and its surroundings. Basic assessment areas that did not include this indicator gained additional points in the resulting assessment of this sector.

It seems that the most difficult step in the analysis was the accuracy of the parameter selection. Subsequent steps were based on the ability to use the QGIS 3.18 programme, which calculated the loaded geodata using appropriate algorithms.

7. Summary and conclusions

The development potential of cities is a topic that has been studied and further explored by many researchers over the years. The aim of this study was to identify areas with potentially favourable conditions for further development and to determine areas in Nowy Targ with weaker predispositions for development. The study was preceded by field inspection and a background survey conducted to eliminate erroneous data and ensure the correct selection of parameters (geodata).

Based on these analyses, the following conclusions can be formulated:

- the adopted research method allowed the identification of areas with different development potentials within the administrative boundaries of the research area,
- the choice of diagnostic variables determines the results of the study and, to a larger extent, the outcomes of further work on development strategies,
- the division of the city into assessment areas was eventually a positive phenomenon that had an influence on the level of detail of the study,
- a weakness of this method is the fact that the values in the assessment area are averaged,

- the adopted research method and the obtained results can be used in further works on the development of Nowy Targ, highlighting both weak and strong development areas in the selected research sectors,

- an important step in the study of the development potential of each area is the preparation of data for the analysis. Its selection and obtaining of reliable sources.

The chosen research method is mainly used for measurements and analysis of natural areas. Therefore, this work represents a kind of extension of the existing scope of research using the point bonitation method. It seems that in the future, it could constitute an appropriate set of development indicators, which could be used for assessing the entire Podhale region or any localities. It can be used in strategic forecasting, the role of which is aptly defined by Sulmicka, who writes that an entity's development policy is interventionism that aims to increase and improve the quality of the economy's broadly conceived productive potential, intending to ensure its competitiveness, resulting in social well-being. Changes in the development potential require a long-term horizon, so development policy is fundamentally characterised by medium- and long-term measures. Strategic forecasting [Sulmicka 2012] serves as an instrument, or more precisely, as a meta-instrument, for formulating modern development policies.

References

Brassel K., Reif D. 1979. A Procedure to Generate Thiessen Polygons. In: Geographical Analysis.

Cegielska K. 2020. Koncepcja multimetrycznego indeksu antropopresji opracowanego w środowisku GIS. Rozprawa doktorska. Uniwersytet Rolniczy w Krakowie.

Cegielska K., Szylar M., Kukulska A. 2017. Wielokryterialna ocena potencjału rozwojowego wybranych jednostek administracyjnych. Acta Sci. Pol., Administratio Locorum, 16(3), 161–174.

Galiński M., Siwek G., Szuwarski J. 2013. Metoda bonitacji punktowej jako narzędzie waloryzacji zjawisk przestrzennych. Kwartalnik Naukowy Państwowej Wyższej Szkoły Techniczno--Ekonomicznej, 5–17.

Gałązka A. 2017. Teoretyczne podstawy rozwoju regionalnego – wybrane teorie, czynniki i bariery rozwoju regionalnego. Studia BAS, 9–61.

Giełdas-Pinas K. 2012. Waloryzacja przyrodnicza krajobrazu Pojezierza Gnieźnieńskiego. Problemy Ekologii Krajobrazu, XXXIII, 77–85.

Jha M., Chowdhury A., Chowdary V., Peiffer S. 2007. Groundwater management and development by integrated remote sensing and geographic information systems: prospects and constraints. Water Resource Management.

Kantor-Pietraga I., Krzysztofik R., Runge J., Spórna T. 2019. Przemiany demograficzne miast Polski. Wymiar krajowy, regionalny i lokalny. Ed. R. Krzysztofik. Warszawa–Kraków–Katowice.

Kasprzyk H., Mika M., Kotlarz P. 2021. A study on the maintenance of spatial order in the development perspectives of the city of Nowy Targ. Geomatics Landmanagement and Landscape, 4, 87–101.

Koźma J. 2015. Metoda waloryzacji przestrzennej pokrycia terenu i obiektów ochrony przyrody na potrzeby oceny konfliktowości potencjalnej eksploatacji kopalin w obszarach perspektywicznych. Przegląd Geologiczny, 63(9), 581–588.

Kudłacz T. 1999. Programowanie rozwoju regionalnego. Wydawnictwo Naukowe PWN, Warszawa.

Małopolskie obserwatorium polityki rozwoju. 2010. Potencjał i trendy rozwojowe miast w województwie małopolskim. Urząd Marszałkowski Województwa Małopolskiego, Kraków.

Marciszewska B. 2010. Potencjał turystyczny regionu a kreowanie jego wizerunku. Zeszyty Naukowe Uniwersytetu Szczecińskiego. Ekonomiczne Problemy Usług, 13–21.

Markowski T. 1999. Zarządzanie rozwojem miast. PWN, Warszawa.

Markowski T., Marszał T. 2006. Metropolie, obszary metropolitalne, metropolizacja. Problemy i pojęcia podstawowe.

McCann P., Shefer D. 2005. Agglomeration, economic geography and regional growth. Israel Institute of Technology.

Nazarczuk J.M. 2013. Potencjał rozwojowy a aktywność inwestycyjna województw i podregionów Polski. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego, Olsztyn.

Obrębalski M. 2006. Mierniki rozwoju regionalnego. Metody oceny rozwoju regionalnego. Ed. D. Strahl. Uniwersytet Ekonomiczny we Wrocławiu.

Opałło M. 1972. Mierniki rozwoju regionów. Warszawa.

Serafin P. 2018. Zmiany w typologii demograficznej miejskich obszarów funkcjonalnych Polski w latach 2002–2017, 328–343.

Sudra P. 2016. Zastosowanie wskaźników koncentracji przestrzennej. Przegląd Geograficzny, 247–272.

Sulmicka M. 2012. Nowy model programowania polityki rozwoju w Polsce. Prace i Materiały Instytutu Rozwoju Gospodarczego SGH, 255–284.

Wrana K. 2010. Uwarunkowania i procesy rozwoju miast. Śląskie Studia Regionalne.

Ziemiańczyk U. 2010. Ocena poziomu rozwoju społeczno-gospodarczego gmin wiejskich i miejsko-wiejskich w województwie małopolskim. Infrastruktura i Ekologia Terenów Wiejskich, 14, 31–40.

Żyszkowska W. 2003. Analizy przestrzenne w systemach informacji geograficznej.

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