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SPATIAL DIMENSION OF COHESION AND THE METHODS OF ITS ASSESSMENT

Abstract: The article refers to the concept of territorial cohesion. It focuses on its terminological complexity and close relations with the ideas of social and economic cohesion. The second part of the paper is aimed at presenting and discussing the usability of the chosen methods of measuring territorial cohesion. The attempts to assess spatial dimension of cohesion relate to international, regional and sub-regional levels. In the first case they are strongly influenced by the EU development policy and ESPON achievements, whereas in the second one, the objectives of the presented research projects respond rather to regional and national needs. Discussing the concept and methodology of measuring territorial cohesion is preceded by presenting a wide range of exemplary variables used in illustrating the analyzed phenomena.

Key words: Methods of assessment, territorial cohesion.

Introduction

In the everyday life cohesion means that various elements create one whole; that something has been bound, united or somehow connected. In social sciences and spatial planning it refers mostly to the society and economy, thus terms such as social cohesion and economic cohesion have recently entered scientific language. Social cohesion is explained as the ability of the society to secure its prosperity, minimize the disparities and avoid polarization, whereas economic cohesion appears when the differences in the levels of socio-economic development are insignificant, the whole economy is effective and the potential of its particular elements is utilized properly [Churski 2009]. The state of social cohesion means that citizens act for the common good and any negative social phenomena is marginal rather than usual. This may happen when such elements as common values, public spirit and culture, social order and social control are combined together. What also matters is social solidarity, avoiding social polarization, social capital as well as the identity and attachment to particular territory [Kearns, Forrest 2000]. On the other hand, economic cohesion is seen as

a state of effective co-operation of various elements in the economic system, which appears together with the lowered transactional costs. This state requires harmonious relations with the institutional surrounding [Gorzela 2008]. Although both those terms refer to different phenomena, there is one element which evidently connects them – they should be considered in reference to the territory.

1. Cohesion in spatial context

Territorial cohesion became popular due to the common policy of the European Union, although at the beginning only its social and economic aspects were taken under deep consideration. In foreign literature, territorial cohesion, also referred as ‘territoriale Kohäsion’, ‘territorialer Zusammenhalt’ [Scholich 2005, Schön 2006] and ‘cohésion territoriale’ [Grasland, Hamez 2005], is explained as the possibility for the population living in a territory (without making the divisions such as men/women, young/elderly, employed/unemployed, *etc.*) to access services of general economic interest (*e.g.* transport, energy and communication services). In this context access means overcoming various obstacles and barriers – physical (natural *e.g.* landlockness, architectural, infrastructural), social (impediments for women, disabled, elderly, immigrants) and economic (poverty, high tariffs, *etc.*) [Farrugia, Gallina 2008].

In discussion about this phenomenon, a question arises, why this term contains ‘territorial’ instead of ‘spatial’ element. The answer is that ‘territorial’ in this particular case means a subcategory of space, which is a definitely less abstract concept than space itself. The territory refers directly to the governance, co-operation and the society and therefore becomes more useful in formulating and implementing development policies. However, it must be explained that in terms of EU objectives, territorial cohesion becomes only an element of spatial development policy, which again should be perceived as considerably wider category [Schön 2005].

Researchers like Douvodi [2005], Doucet [2006], David [2007], Schön [2005], or Stein [2010], many times referred to this topics in their publications, but the achievements of Faludi [2004a, 2004b, 2006, 2007] should be particularly appreciated among the mentioned group. Faludi made numerous attempts to solve terminological ambiguities referring to the analyzed phenomena; he also presented and discussed methods used in cohesion policy implementation.

Research on territorial cohesion was undertaken also by Polish scientists – especially by planners and geographers. For example. Churski *et al.* [2009] in their analyses bound territorial cohesion with the concept of the network region. In their approach, the analyzed term is associated with an optimal organization of the system, which enables rational, effective performance of the economy and the society. As a consequence, it is related to both – economic and social cohesion, and depends heavily on the linkages that stimulate economic and social relations.

Territorial cohesion might as well be understood as a tool and an effect of pursuit for social and economic cohesion through the development of the settlement system and communication infrastructure. Such belief was presented by Konecka-Szydłowska [2009], who sees in such activities a way for optimal shaping the socio-economic structure and establishing local networks in peripheral regions. In this approach spatial linkages are of great importance, since they enable balancing the existing spatial inequalities.

In the official standpoint of the Polish government [Baucz *et al.* 2009] territorial cohesion is explained from two perspectives – as a state and a process. In the first case it means the desired development of the particular territory, which is the result of effective flows and exchange in the society and economy, allowing for proper allocation of resources. On the other hand, territorial cohesion was defined as a process of shaping European space, aimed at providing the best possible conditions for the development of the unique potential of particular territories. In this context the role of European institutions is emphasized, because they make macro scale integrated development management possible.

Territorial cohesion in the described context doesn't mean a standardization of static conditions, but achieving a certain minimal level of development – different territorial units don't have to, and even shouldn't, be uniformed. The key problem in this case is creating conditions for effective co-operation between various elements through dynamic development of functional relations [Kozłowski, Marszał 2010].

Contrary to already presented opinions, Markowski [2009] suggests that territorial cohesion should be considered as a subjective category. In this approach cohesion is defined by the degree to which users of space are satisfied with the location and the accessibility of various values (referring to resources, demand as well as the values influencing living conditions). This viewpoint is certainly very innovative, however, its subjectiveness becomes a serious obstacle when its utilization in empirical studies is taken under consideration. The reason for this is the variety of factors that determine different social groups' satisfaction with the mentioned values. It causes serious methodological problems with the assessment of territorial cohesion, especially with making comparisons between different territories.

No matter of the dissonance between various interpretations of what territorial cohesion is, also arguments against using this term appear. Some researchers claim that adding another dimension for cohesion policy (apart from social and economic spheres) is doubtful, because the majority of socio-economic processes happen in space, have their spatial impact and are analyzed in reference to some kind of territory. In reference to this viewpoint, Śleszyński [2009] suggests introducing the term of geographic cohesion, which would integrate all mentioned cohesion subcategories. In his opinion geographic cohesion means a property of the system (natural, social and economic), which allows for generating various crucial spatial bonds and relations, providing its integration. Contrary to the mainstream explanations, cohesion

is not an effect, but a wide range of conditions for the system, including technical infrastructure, social capital, polycentric settlement system, specific features of the natural environment, *etc.*

Śleszyński's opinion is evidently geographically oriented, and that point of view is also close to the author's, who is a geographer herself. However, it may be feared that introducing another category to cohesion analyses together with removing former findings, would complicate even now complex situation. Therefore the author of this article understands cohesion of space in a rather 'traditional' way – as a state of effective functioning of connections between various socio-economic elements of geographic space, which balance spatial inequalities [Pielesiak 2012]. In this approach connections of different types – social (commuting to schools, institutional co-operation), economic (connections between enterprises, employment flows, satisfying the external demand for various goods and services) and infrastructural (road and railway networks, communication, energy and water supply, collective waste and sewage management), are the key factors that integrate territories. Choosing this approach as a reference point was of course motivated by the spatial scale of the research, which so far has been conducted on the sub-regional level.

In the discussion about territorial cohesion of the EU it was announced that there is even more suitable concept, which successfully combines the ideas of cohesion in its social, economic and spatial contexts. The solution is seen in applying the concept of polycentric development, which is seen as a useful tool in implementing European common policy, instead of nowadays forced incompatible policies of competitiveness and cohesion. Polycentric development refers to various aspects (from climate to population ageing problems) and indicates the need to manage them according to the differences in impact they have on particular territories. It is explained as "a strategy that considers the possibility of spill-over effects of investments or projects in all areas of the territory, without automatically assuming that the positive effects in the central areas will spill over into the peripheral areas" [Farrugia, Gallina 2008, pp. 8-9].

Although the scope of territorial cohesion is still a subject matter of dispute, in almost each standpoint the role of technical infrastructure is appreciated. Infrastructural development is a main factor influencing territorial cohesion, because it strongly correlates with social, economic, environmental and spatial processes. The positive impact on the mentioned fields could be seen in making the area more attractive for people (improved living conditions and the quality of the natural environment *e.g.* as a result of effective waste management) and in its economic stimulation (intensification of people, goods, services, capital and information flows) [Pielesiak 2012]. Infrastructure reduces spatial resistance – enhanced mobility allows for increased accessibility of resources and markets, which generally leads to regional economic convergence [Paez 2004], gaining competitive advantages and avoiding the threat of marginalization in the global world [Stawasz 2005]. Moreover, various technical net-

works, becoming the axes of settlement and economic expansion, influence the shape of spatial structures, and as one of spatial planning tools, enable their stabilization.

On the other hand, underinvestment and inappropriate maintenance of infrastructural systems reduce the effectiveness of transportation, which has negative implications for the society, as well as for the economic development. There is also a threat that, in certain circumstances, well developed infrastructural networks could bring unwanted results. Such phenomena was described in various economic theories referring to polarization processes. Apart from that, rapid and spontaneous expansion in this field may lead to problems in other spheres, negatively influencing territorial cohesion. The development of technical infrastructure may disturb natural environment (due to pollution, disconnecting green corridors, *etc.*) and even cause negative phenomena for local communities (*e.g.* in residential areas isolated from the main urban tissue by railroads). That is why, in order to avoid problems with ineffective land development, well thought over spatial planning is always required.

2. Approaches to measuring territorial cohesion

The disagreement in defining territorial cohesion is reflected in the lack of commonly accepted methodology of assessing this phenomena. As a result, the whole concept becomes blurred and creating cohesion policy is no longer clear, being deprived of the solid empirical basis. So far many varied and sometimes incomparable indices have been used to measure the level of territorial cohesion, the majority of which is used within the scalar approach (Table 1). The mentioned indicators are the most popular ones, however, much more examples of indices and coefficients may be found in the INTERCO Final Report (2010) and its annexes (2011).

There are two approaches towards assessing territorial cohesion – a scalar approach and a vector approach. In the first one, which is definitely the most commonly used, measures illustrating the level of cohesion within the borders of territorial units (mostly on national and regional levels) are subjected to analysis. The individual indices are in this case often aggregated in a synthetic measures of cohesion. The less are the differences between measured values in the whole area, the stronger its territorial cohesion is. Compared to this approach, the vector analysis is not so popular. In this kind of studies spatial relations between territorial units are taken under consideration. The scalar approach is used in macro scale research, whereas the other one is more suitable for the research on a local and sub-regional level. The difference in popularity of those two research approaches results from the difficulties in obtaining reliable and detailed data about relations between territories – it is always easier to gather information related to separate territories, than measure what happens between them. Nowadays cohesion is analyzed generally in the macro scale. Considering the fact that in Europe international flows of people, goods and capital are almost unlimited,

choosing complex vector approach would certainly give valuable, interesting and useful results, but it would require enormous load of work and huge funding.

Another problem concerns answering the questions: how the data should be processed, and is it possible to construct universal, easy for interpretation and at the same time complex measure? Efforts aimed at solving this problem in a macro scale were initiated by ESPON and were supposed to European Spatial Cohesion Index (ECTI). This aggregate measure was designed in reference to Human Development Index (HDI). It concerned information about competitiveness, social cohesion and sustainable development. Unfortunately it appeared that the initial requirements (scientific correctness, relative low level of complication, ability to be used in practice) were very difficult to meet, especially due to the fact that ECTI seemed to be liable to manipulation. The difficulties in obtaining the reliable statistical data, particularly for the regional level, proved to be another serious obstacle [*Spatial Scenarios...* 2004-2006].

In spite of the multiplying difficulties, research on measuring territorial cohesion was continued and resulted in the STeMA model (Sustainable Territorial environmental Management Approach) supported by GIS tools. STeMA was designed for different scales (from sub-regional to national) and provided two approaches:

- towards innovative and scientific activity, global and local interactions (in economy and transportation), quality (climate, natural resources, poverty) and the utilization of funding;

- integrating three general criteria (society, economy and natural environment) [*Territorial Dimension...* 2006].

The introduction of STeMA model was followed by the advancement made by Farrugia and Gallina [2008]. Their analyses referred to the concept of polycentric development and resulted in creating the aggregate measure of territorial cohesion, combining information about seven aspects (transportation, communication, energy consumption, education, access to health services another crucial services *e.g.* municipal infrastructure, as well as data illustrating spatial inequalities of different types *e.g.* urban-rural, gender, income) in a Territorial Cohesion Index (TCI). Each aspect was represented by a few variables (4 maximum), which were normalized for each country with the respect to their ascending or descending character. The aggregation of these variables included equal weighing of the main components and was done by taking their average. TCI appeared to positively correspond to HDI, GDP *per capita* (PPP) and negatively to the country size. Although the method of measuring cohesion presented by Farrugia and Galina is very clear and covers wide range of indicators, it seems that choosing indices for the aggregate measure wasn't faultless since in a few cases the composite indices appeared to be strongly correlated to one another (the authors notice that but there is no further investigation in this matter). The result is that the reader doesn't know whether the choice was made fully consciously (and all correlations were checked at the beginning of the analysis) or without the knowledge that correlated component indices unnecessarily increase the value of the aggregate index.

Table 1

The examples of territorial cohesion indicators in scalar and vector approaches

Cohesion aspect	Scalar approach	Vector approach
Transport, communication and ICT	<ul style="list-style-type: none"> – road and rail network accessibility (e.g. road density according to road categories), – congestion index/cost, – number of international traffic passengers in airports per inhabitant, – volume of freight transport relative to GDP, – ICT accessibility (eg. broadband access per one hundred inhabitants, Internet users per 10 thousands inhabitants), – new enterprises in ICT sector, – gross domestic expenditure on research and development, – ICT accessibility and utilization by the elderly 	<ul style="list-style-type: none"> – road (network linkages, traffic flows etc.), railway, air transport and water transport connections, – co-operation between universities and other institutions
Economic disparities	<ul style="list-style-type: none"> – GDP (PPP) <i>per capita</i>, – consumption <i>per capita</i>, – comparative price levels, – unemployment level, – employment flow index (number of arriving employees related to the number of departing employees), – price index for consumption goods and services, – demographic dependency ratio, – share of people employed in the service sector, – average salary (gross) in relation to the national average, – capital expenditures in enterprises according to location, – gross fixed capital formation/GDP, – local government income, – public sector debt relative to GDP 	<ul style="list-style-type: none"> – redistribution of regional income, – employment flows
Socio-demographic inequality and living conditions	<ul style="list-style-type: none"> – infant mortality index, – life expectancy at birth, – welfare and health services accessibility and quality (e.g. hospital beds accessibility, pharmacies' accessibility), – access to education (e.g. primary schools per 10 thousands inhabitants, share of primary school / higher education graduates in total population), – employment rate of older workers, – at-risk-of-poverty rate after social transfers, – access to culture (e.g. population per library, museum objects per 10 thousands inhabitants, UNESCO objects per 10 million people, cultural capitals of Europe – candidates and nominations per 10 million people), – average floor area (total/ per inhabitant), – access to water distribution network, sewage system and electricity 	<ul style="list-style-type: none"> – migration flows (total/due to natural disasters, military conflicts, extreme poverty etc.)

Participation, social justice and solidarity	<ul style="list-style-type: none"> – trust for European Commission, Parliament <i>etc.</i>, – participation in decisive processes on European, national, regional and local levels, – active participation of women /migrants /disabled in associations and unions of chosen types, – difference between female and male employment rates, – women entrepreneurship and employment, – barriers for the disabled and the elderly (<i>e.g.</i> in cities, country, mountain areas) and their overcoming, – educational and professional integration of people representing different age groups/ the disabled, – share of population reporting crime, violence or vandalism by the degree of urbanization 	-
Settlement system	<ul style="list-style-type: none"> – urbanization index, – polycentricity of the settlement network (<i>e.g.</i> share of biggest agglomeration population in total population, share of people living in cities according to their size), – area per one city over 100 thousand inhabitants, – cities in METREX network per 10 million inhabitants 	<ul style="list-style-type: none"> – co-operation between local authorities (<i>e.g.</i> formal associations, joint investments)
Natural environment	<ul style="list-style-type: none"> – sustainable use of natural resources, – communal and hazardous waste production, – waste reduction and recycling, – greenhouse gases production, – water consumption, conservation and public management, – conservation of energy and new energy sources, – share of areas under conservation in total area, – area of green space per inhabitant, – enterprises in sustainable tourism sector (<i>eg.</i> hotels accessibility) 	<ul style="list-style-type: none"> – transfer of energy, – water, sewage and waste flows between territorial units – green corridors connecting territorial units

Source: Author's elaboration based on Churski 2009, pp. 53–54; Dutkowski 2009, pp. 272–294; Farrugia, Gallina 2008, p. 37; INTERCO 2013, pp. 1-19; Prezioso 2008, pp. 17–19; *Territorial Dimension...* 2006, p. 33.

Recent advancement in the described field refer to a big set of indicators and the involvement of GIS tools in analyzing territorial cohesion. Within the frames of ESPON a special indicator toolset is about to be designed so that it could be able to map individual and composite indices. Afterwards the final set of indicators is supposed to be selected. So far it has been announced that three types of indicators are in the centre of interest. The first group is described as the classical or simple socio-economic indicators, and it covers data like GDP *per capita* or unemployment rate. The second group includes composite indicators designed for thematic issues (such as HDI) or accessibility (*e.g.* to the services of the general interest). Finally, there are so called 'new composite territorial cohesion indicators', which refer to balance, polycentricity, attractiveness of regions considered from various perspectives *etc.* [INTERCO... 2010].

The described concepts of measuring territorial cohesion were developed for the macro scale research (international and regional levels). In local and sub-regional analyses this problem needs completely different approach and the set of data. Such more detailed research has been recently conducted in Poland – in Poznań and in Lodz.

In the first case territorial cohesion of Poznań voivodship (divided into administrative districts) was assessed in reference to urban settlement system, regarding also transport infrastructure and the functional linkages it provided. Among the composite measures there were on one hand – urbanization index, the density of cities and towns in the district, the average employment level in urban areas, and the average employment in services in urban areas. On the other hand, another index was constructed, which included the density of municipal and district roads, the density of railway stations, the share of localities accessed by the passenger transport, the average number of bus connections (per 24 hours) in the district, and finally – total number of bus and railway connections in the district per 1000 inhabitants. The level of cohesion was assessed on the basis of two aggregate indexes (again constructed by taking the average), composing of standardized values. Those synthetic measures, although at first glance referring to different fields, proved to be strongly correlated to one another [Churski *et al.* 2009].

In the second mentioned research project, assessment of the territorial cohesion was done for Metropolitan Area of Lodz – for municipalities that constitute and directly surround it [Bartosiewicz *et al.* 2012]. Apart from the usual factors taken into consideration in similar analyses (transportation, social and economic issues), also recent change in land use, the consistency of municipal spatial policies, as well as cohesion in the ecologic aspect were examined. In the final stage of research, cohesion of local policies wasn't included into the aggregate measure, because it gave completely reverse results to the rest of the analyzed variables. The majority of land use problems occurred in the central part of the metropolitan area (where the land is the most valuable), which at the same time was the most coherent in terms of social and economic factors taken under consideration. To assess the cohesion the authors adapted and extended Farrugia and Galina's procedure. Taking into account the fact that the research was done in the sub-regional level, and what is even more important, it referred to the nodal region (urban agglomeration), spatial connections were exposed as much as possible. First, twelve variables were chosen – referring to socio-economic (commuting flows to work, places of education and cultural institutions), transport (connections in passenger transport, direct connections to Lodz, average time of travel to Lodz via passenger transport) and ecologic linkages (green corridors to other municipalities), as well as reflecting the socio-economic situation of the municipalities (population density, migration balance, unemployment rate, entrepreneurship index and the development of technical infrastructure). Then three methods of measuring cohesion were applied:

- creating four aggregate measures (one for each category, basing on the average formula),
- aggregating four normalized measures into one index (equal weighing and taking the average),
- aggregating all variables into one index (equal weighing and taking the average).

All those approaches gave similar, however, not identical cohesion patterns. In order to precisely indicate the most and the least coherent areas, a cartographic method was applied. Three mentioned types of results were confronted on a map, together with a delimitation of Lodz Metropolitan Area accepted in the regional spatial development plan. This step allowed for evaluating the correctness of the formal extent of the metropolitan area, acknowledged by local and regional authorities.

Within the frames of scalar approach, researchers may use many other methods leading to typology and classification. Those include simple procedures of graphic presentation in Cartesian co-ordinate system, valorization methods, table of signs *etc.*, as well as more complicated ones like Principal Component Analysis, accompanied by Cluster Analysis [Grasland 2008] or Principal Factor Analysis. Finding the example of assessing territorial cohesion completely within the vector approach is difficult. The author of this article did it in her research [Pielesiak 2012], but she referred only to one aspect of cohesion, which was functional linkages of technical infrastructure (roads, railways, electro energetic system, gas distribution network, water supply and sewerage system). Again the municipalities of Lodz Metropolitan Area were examined, but the procedure was different from the ones described above. The author used the matrices of standardized values (representing particular types of flows), and analyzed the relations in each pair of territorial units (together 378 relations, of which 65 meant direct neighbourhood). The seven components were afterwards aggregated into one synthetic measure of spatial relations, and supplemented with a cartographic illustration of the strongest and the weakest linkages. This method is definitely different than others and offers interesting results, however, it required enormous load of work with collecting data from several dozen institutions of various types, which probably disqualifies it from wider implementation.

Much easier and less laborious (considering the necessary data) are the methods used in gravitation analyses, spatial autocorrelation analyses and, particularly, graph methods. Gravitation analysis, providing that measures of weigh, distance and other parameters in the formula are properly chosen and assessed, could be useful in cases of low accessibility of empirical data. It could therefore become a tool for making initial diagnosis of territorial cohesion. On the other hand, focusing on spatial autocorrelation could offer promising results, because it might give answers to the question: if, and to what extent, there is a tendency for aggregating territorial units in which the similar level of particular phenomena (*e.g.* infrastructural development) is observed. The last of the mentioned group of methods refers to mathematic graph theory and offers 'ready to use' cohesion coefficients, which are definitely uncomplicated in their construction and

easy for interpretation. However, this results in significant losses of information, which could become crucial for cases where not only the strength of connections was a matter of interest, but also their structure and spatial distribution [Pielesiak 2012].

To conclude the discussion about methodology, it is worth mentioning that there is another, completely different way to analyze territorial cohesion. It is certainly suitable for local research projects, but it seems that after some adjustments it could become useful also for bigger scale examinations. This strictly cartographic method, known as the equity mapping, requires the wide use of GIS tools. In visualizing equity various accessibility measures could be chosen and different objects might become a subject of analysis. A project done by Talen [1998] may become a good example for this idea. Talen examined equity in reference to public parks basing on four measures: gravity model (illustrating the force of attraction depending on the size of parks), minimizing travel costs (method adapted from locational optimization models), covering objects (involving critical distance and binary coefficient) and minimum distance (aimed at reducing the journey of consumers). In research on cohesion this method could be successfully applied *e.g.* in the evaluation of spatial distribution and planning new infrastructural objects, which are vital for linking different territories.

Conclusions

Although quite a long time passed since territorial cohesion concept appeared in the EU policy and scientific research, there is no significant success in the specification of its scope, and, as a consequence, no significant advancements in methodology of measuring its level. Apart from terminological disagreements, also the accessibility and the quality of raw information still remain a serious obstacle. It is difficult to construct a relatively simple measure, which would be scientifically correct and wouldn't require enormous effort in gathering data. The problem is even more complicated, because it is expected that the cohesion measure should at the same time have big load of information and remain highly resistant to manipulation, which is important for implementing cohesion policy and possible transferring huge funds for incoherent regions. In case of macro scale research only the scalar approach seems to be a reasonable solution, however, obtaining proper input information (comparable and accessible for all territorial units in the whole area, and at the same time well suited to the objectives of the research) is still complicated. In any case, the most promising achievements may be attributed to ESPON works as well as to wider and wider involvement of GIS tools.

On the other hand, projects realized for smaller territories, especially urban agglomerations, ought to reflect their specificity, resulting usually from their nodal character. That is why spatial linkages ought to be strongly focused on. This approach seems to correspond better with the notion of cohesion at this level of territoriality.

There haven't been many analyses strictly referring to the idea of territorial cohesion so far, but this issue could become an important subject of research especially for geographers, who are always interested in spatial organization, its hidden internal structures and spatial linkages of various kind.

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