Foundations of delimitation of functional transborder areas

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Contents

1. Introduction

Functional areas are a new category of regional and spatial policy in Poland. The term *functional area* was introduced in the National Spatial Management Concept 2030[1] (KPZK 2030) to describe spatially specific territorial complexes distinguished for the purposes of spatial management at the national, regional and local level. Functional areas are characterised by a compact spatial arrangement in the case of functions carried out in a continuous geographical space. In the case of functions carried out in many separated territorial units, due to the studied phenomena, the delimitation of the geographical space is a dispersed set of separate territorial units.

In the development management system in Poland, as in many other European countries, among the concepts of development policy and regional policy, the place-based approach stands out, which is one of the pillars of the new paradigm of development policy. The place-based policy, apart from the targeting of actions taking into account the spatial context, i.e. the geographical determinants, or in other words the endogenous potential, is based on the knowledge of the regional and local authorities, which constitutes an objective value and at the same time an exogenous potential (Reitel, 2006). The combination of conditions and knowledge of individual areas not only within their administrative boundaries but above all within their functional boundaries (geographically defined on the basis of a coherent profile of socio-economic and spatial characteristics) makes it possible to define actions better suited to the specificity of a given place. Moreover, the systematic monitoring of the development of functional areas creates the right conditions for a more

[1] *Koncepcja Przestrzennego Zagospodarowania Kraju 2030*, Ministry of Regional Development, Warsaw 2011, p. 14.

accurate consideration of spatial variations in regional policy and for actions tailored for a given area (Dolzbasz, 2015).

By looking at development issues through the prism of functional links, development policy objectives and instruments can be more differentiated and better adapted to the specificity of individual areas through better use of their potential and more precise identification of barriers to development. Planning and conducting development activities in functional areas must thus be a platform for cooperation between different units and levels of management (Dołzbłasz S., Raczyk A., 2010). The cooperation of different partners operating in functional areas is necessary for comprehensive, coherent, more coordinated and focused pro-development activities and conflict resolution.

The boundaries of the functional area should correspond to the system of functional links. The binding feature of all functional areas is the coherence of development objectives. The mosaic of multiple overlapping functional areas in different parts of the region allows for accurate and efficient targeting of relevant activities and financial tools to support the development of the region (Gerber, Lara, de la Parra, 2010).

In this context, it has become necessary to create the substantive basis for the designation of functional areas (development of criteria for the designation of borders), and then also the formal basis for the cooperation of various administrative entities in the formulation of development objectives and activities (including the determination of the principles of financing from EU funds) for functional areas. It also became important to develop the basis for monitoring the phenomena occurring in these areas and the effectiveness of the development policy conducted for them (Komornicki, Wiśniewski, Miszczuk, 2019).

The aim of this paper is to present methodological approaches to the delimitation of functional areas under conditions of different determinants of regional development, based on various data sources. Under the conditions of an open market economy, economic gravity generated by the economic, administrative or demographic centres of a region is a particularly important factor. It provides a basis for the analysis of causes and effects of social, economic and political polarisation of regional development, facilitates the explanation of causes of polarisation processes, simulation and forecasting of their course, identification of short-, medium- and long-term effects.

It was pointed out that in the modern economy, in conditions of deep institutional in-interventionism, the factors determining the spatial scope of individual functional areas and their concatenation leading to the formation of multifunctional areas include legal regulations and approaches to their application in practice by governmental and self-governmental bodies and international organisations.

A new aspect, which is necessary for the delimitation of functional areas under conditions of economic and political integration and an open market economy, is the cross-border spatial extent of many social and economic processes and systems. The delimitation of cross-border functional areas is particularly important in Europe, especially in the European Union. In the case of countries with small or medium-sized territories, the delimitation of cross-border economies as specific functional areas is an indispensable basis for the policies of state authorities, the activities of their governmental and local administrations and social and economic actors. Methodological problems of spatial delimitation of cross-border economies and cross-border functional areas as well as exemplification of the practical application of selected approaches are addressed in Chapters 4 and 5.

Therefore, when defining cross-border functional areas, it is necessary to take into account the differences between the legal systems of the countries and the impact of these differences on the formation of cross-border functional areas. Differences in the information describing social and economic processes and in the availability of data in different countries must also be taken into account.

2. Methodological basis for the delimitation of functional areas

2.1. The concept of functional area as a categorical concept

The concept of *functional area* used in scientific research, in the practice of political, social, economic activity and in the press and in everyday language is classified as a categorical concept. A *categorical concept* is understood to be a general concept that is used in various use situations. For each type of use situation, it is defined in detail for selected scientific fields or practical activities.

Definitions of a categorical *concept* for different domains and types of use situations may differ. The definition of a categorical *concept* for a domain shall distinguish those characteristics of an object, process or event that are relevant to the domain. However, the definition of *a categorical concept* formulated within each domain or for different types of use situations shall not contradict the general definition of that concept.

Categorical concepts may be defined differently for a specific country, region, social group, legal system. The user of a categorical concept should know for which domain, for which political, social or economic entity, for which geographical area a more detailed definition of the concept has been formulated, and for which domains and objects this more detailed definition does not apply. For example, general concepts such as *unemployment, employment, poverty, innovation, education, environmental disaster area* can be defined in different ways as economic, legal, political, social, statistical categories.

When using categorical concepts appearing in various studies, journalistic texts or public speeches, it is necessary to take into account the differences that occur between the definition of categorical concepts in various scientific fields, in legal regulations, in professional practical activity, and the interpretation of these concepts themselves in colloquial language. The content of categorical concepts interpreted according to the semantics and pragmatics of colloquial language may differ significantly from the content of these concepts in the languages of scientific disciplines and in professional languages used in practical activities.

When using information containing categorical concepts in specific usage situations, we should know within which field of science or practical activity each concept is defined. In particular, we should check whether the concept is interpreted within the framework of colloquial language.

In socially widespread information systems, terms that are lexically analogous to terms representing scientific or professional categories are often assigned different meanings by the end users of the information, often far from scientific and professional ones. This situation often leads to misunderstandings and misinterpretations. This is particularly true for semantically complex concepts, such as the categorical concept *functional area* used by many stakeholders with different interests and information needs. The concept is defined as a category in various scientific, technical and practical fields. It is also used in colloquial language and in journalism willingly operating with the vague semantic rules of colloquial languages.

The term *functional area* is interpreted differently in everyday language than in the scientific and professional languages of fields such as law, social sciences or economics. In scientific and professional languages, the term *functional area* is a single semantically indivisible term, the content of

which is not necessarily related to the content of the uniterms of which it is composed. The reason for the difference between the content of this category in colloquial language and in scientific and professional languages is that in colloquial language the content of the category consists of the colloquial understanding of the individual uniterms - *area* and *function,* which make up this the category. It is about the word *functional*, which in colloquial language is understood differently than in professional terminology. The distinguishing features of a functional *area* are not its *functions* in the economy, society or state. A geographical *area* does not actively perform any *function*, while the various actors in the area often perform specific social, political, economic or ecological functions.

The distinguishing factors of *a functional area* are not its *functions* but the *important characteristics* for the social or economic actors *operating* in the geographical *area* concerned, in particular for the authorities and the public administration, social and political organisations, economic actors needing to know about the political, social, economic or environmental specificities of a particular territory, and researchers and experts assisting those actors.

A functional area does not exercise *functions* in relation to the political, social or economic actors associated with a territory, but is a geographical space whose specific characteristics create conditions for the activities of those actors within a given scope.

For example, a *functional area of ecological risk* resulting from the impact of an opencast lignite mine on the conditions of agricultural activity, on the water balance, air quality, the local labour market, the needs for development of communication infrastructure and housing related to the mine does

not fulfil the *function of ecological risk*, but it has certain features which testify to the quality of the environment considered as attributes of *ecological risk*, distinguishing this area from its geographical surroundings.

A functional area is defined in selected fields of science or practical activity and delimited in a specific geographical space from the point of view of specific information, decision-making and management needs of state bodies, economic entities and for scientific research.

Functional areas are defined by categories from at least three fields of science and practice:

- rights,
- economics,
- statistics.

Depending on the field to which the categories with which we define *functional areas* belong, we see these areas as economic systems, legal systems, social systems, natural systems.

For the needs of specific stakeholders in their specific application situations, categories from other fields of science and practice such as sociology, political science, urban planning, various specific technical and social sciences may also be used to define and delimit functional areas. On this basis we can distinguish functional areas perceived by stakeholders as social, political, sanitary-epidemiological, urban, industrial, ecological and other systems.

Within the same or similar *geographical area*, different stakeholders may delimit several different *functional areas* by defining them as systems using categories drawn from different domains.

For example, an economist studying the labour market and a local authority responsible for managing the labour market in a given area may be interested in defining a functional area of the *local labour market* as a socio-economic system using sociological, economic, legal, political and statistical categories from relevant fields of science and practice. In the same geographical area, it may be necessary to delimit a functional area *settlement network*, whose main delimitation criterion is the permanent or temporary distribution and residence of the population.

For a scientist-environmentalist (not to be confused with the so-called activists of organisations calling themselves ecological, in reality militants paid by sponsors hiding their identity), the functional area of the *Białowieża Forest* will be delimited using categories from several fields as an ecological system, an economic system, a social system and a complex system from the point of view of legal categories regulating such objects as national parks, landscape parks, management in forest areas, water management, agricultural management and construction.

Defining and delimiting a number of functional areas in a single territory gives more complete, multifaceted information to the public institutions responsible for the safety and development of the area in question and to the economic and social actors operating in that area.

Functional area as an economic system

The functional area as **an economic system** was defined using ***economic categories*** from the field of economic policy and spatial management of the country in the document the *Concept of the Spatial Management of the*

Country 2030[2] (KPZK2030). The definition of functional area formulated in this document is referred to in a number of legal acts regulating spatial management and specifying the competences of government and local government administration bodies. As a result, the term *functional area* began to replace the term *problem area,* which was previously used in scientific and professional literature.

In the KPZK2030, *functional area* is a category of economic policy. It is a *compact spatial system consisting of functionally connected areas, characterised by common conditions and predicted, uniform development goals*. This definition is also used in scientific research.

The functional area as a legal system

The functional ***area as a legal system*** in Poland is defined in the *Act of 27 March 2003 on spatial planning and development*, (Dz.U.2020.0.293). According to this document, *a functional area* is an *area of a particular spatial phenomenon or co-occurrence of spatial conflicts* indicated in the voivodship spatial development plans or specified in the studies of conditions and directions for spatial development of communes.

The aforementioned definition of functional area is formulated in such a way that in each specific application situation it needs to be clarified which *specific phenomena* or *conflicts* under the current legal system should be taken into account when defining and delimiting a specific functional area.

For the purposes of spatial management and the performance of public administration bodies and other institutions carrying out public tasks, the

[2] *Concept of National Spatial Development 2030*, Study of the Committee for Spatial Development of the Polish Academy of Sciences, Warsaw 2011

use of legal categories for defining and delimiting functional areas is of little use in practice.

Functional area in the light of statistical categories

A functional area in the light of **statistical categories** is a geographical area which in statistical research is a statistical unit, i.e. an object of statistical observation with social, economic or ecological characteristics described by statistical categories and measured by a defined set of statistical indicators. These indicators are used as identification and delimitation criteria separating this area from its geographical surroundings.

For example, the functional area of the *local labour market* as a statistical category can be delimited by statistical indicators which can be used to delimit the area of commuting from workers' homes to the places of work. In the case of remote working, this area needs to be redefined. The *local labour market* can be described by a set of statistical indicators used to measure employment, unemployment, commuting conditions, compensation of employees, labour costs incurred by employers and employees for commuting.

An *ecological risk* functional area as a statistical category can be delimited by indicators of pollutant emissions and immissions, the level of environmental pollution, exceeding applicable ecological standards and the use of natural resources, in particular non-renewable resources in a specific area. The area may be described by means of statistical indicators measuring the existing ecological resources, the use of these resources, permanent, cyclic or short-term pollution of the environment and by means of indicators describing the social or economic entities located in this area which are affected by environmental pollutants, e.g. the number and structure of the population, the

quantity and quality of water resources, forest resources, agricultural resources and activities and others.

Statistical categories are essential for the delimitation of functional areas as social, economic, environmental, legal and other systems. The precision of the delimitation of functional areas and the body of knowledge about these areas depend on statistical information about the phenomena, processes and resources of a given area.

2.2. Thematic and problematic functional areas

As said above, the *functional area* is distinguished in order to provide information support to the authorities and administrations and other entities operating in the area, using the methods and scientific and expert knowledge available in various scientific, technical and verified practical knowledge.

Depending on whether the main purpose of defining and delimiting a functional area is research or cognitive in a specific scientific or technical field, or whether the purpose is to help solve specific problems and support decision-making by public institutions or business entities, we can distinguish:

- domain-specific functional areas,
- problematic functional areas.

Each specific *functional area* is described with information about its related resources and processes. This includes in particular human, financial, technical, infrastructural resources as well as legal regulations and related institutions. Information about these resources, regulations and institutions as

well as knowledge about the information needs of stakeholders, i.e. the entities operating in the area, is essential for the delimitation of functional areas adapted to the needs of specific user groups.

The precise delimitation of *functional areas* is important for the creation of *relevant* knowledge resources and for providing specific stakeholders with knowledge that is perpetually *relevant* to their use situations, non-redundant and tailored to their specific needs. In particular, the purpose of defining and delimiting *thematic functional areas* is to provide authorities, administrations and social and economic organisations operating in these areas with the information necessary to make decisions with relatively permanent effects for localities, regions, countries and cross-border regions. It is about decisions concerning the use of non-renewable and limited social, economic and environmental resources of a specific area of a country or region and the creation or modification of existing facilities and infrastructure systems.

Functional areas are defined from two points of view. Firstly, from the point of view of the accumulation of comprehensive knowledge about the characteristics of a given region within a specific field of social, economic, technical and ecological sciences. Secondly, from the point of view of the potential information needs of state bodies, social and economic organisations operating in the region and scientific research in a particular field of science or practice.

Information about a functional area should be comprehensive from both points of view in the sense that it should reflect as far as possible all relevant aspects of the area, social phenomena and processes, economic areas, ecological phenomena and processes, and resources, and at the same time it should be relevant to the information needs of entities institutionally or economically interested in reliable information about the area.

In a specific geographical space, many different domain-specific functional areas can be defined. For example, in an urbanised area with metropolitan features, functional areas can be defined such as a *metropolitan labour market*, a functional area of *ecological risk* concerning the quality of air, soil, water, noise, a metropolitan functional area of *health care*, a metropolitan functional *area of education*, *functional area of transport in the metropolis* or *functional area of water and sewage management* if this area of municipal economy requires special attention of the metropolis' administration or functional area of *municipal infrastructure in the metropolis*, including transport, energy, water and sewage infrastructure, housing and industrial infrastructure.

Delimitation of detailed, specialised *functional areas* is helpful in determining the regionalisation of public administration services, education, health care, other social services and the organisation of infrastructure for social and environmental safety. Delimitation of specialised functional areas provides a good information basis for the formation and development of the metropolitan area's municipal infrastructure and other infrastructural systems serving economic activity.

Decisions concerning the infrastructure and the creation and exploitation of resources of one functional area may have an impact on other functional areas defined in the area. These decisions can create positive synergies but can also generate conflict situations. For example, a decision to improve road transport in a metropolitan area by building a transit express road which cuts through the central city districts of the area may, by making it easier to commute to work and to secondary and higher education institutions located in the centre of the agglomeration, enlarge the functional area of the metropolitan labour market or the metropolitan functional area of education, but at the same time it may worsen the living conditions of part of the population

living in the vicinity of that route, lead to degradation of the environment in part of the metropolitan area or reduce the market value of real estate.

The spatial delimitation of functional areas should take into account the existence of several different functional areas in the same area. Accurate delimitation of different functional areas in the same area makes it possible to analyse the impact of these areas on each other and the effects of this impact on the society and economy of the region.

It is important for the state and other bodies actively influencing the development of the region to identify synergetic interactions between different functional areas. These include both positive synergies, which increase the region's potential in various fields and improve the functioning of households, businesses and institutions providing social services, and negative synergetic effects arising from conflicts between overlapping functional areas whose development is steered by different decision-making bodies.

The identification and precise delimitation of *functional areas* provides a basis for the creation and enrichment of knowledge about a given area within the thematic scope of a specific field of science or technology. This knowledge may be necessary for making political, social, economic and ecological decisions by the authorities and administration of various levels as well as by the entities conducting social or economic activity, which concern the entities and processes occurring in a specific geographical space. In a contemporary legal state, whose characteristic feature is deep institutional interventionism, under conditions of dispersion of competences defined in legal acts among various authorities and public administration bodies as well as social and economic entities, knowledge generated and systematised within functional domain areas is potentially useful for many users and in various use situations.

A *problem functional area* is an economic, social, political or environmental system separated from its geographical environment from the point of view of a specific problem or series of problems faced by the institutions or entities operating in that area. The definition and delimitation of a problem functional area is primarily of interest to those actors who are responsible for solving these problems or those who need or would like to adapt their activities to situations generated by specific phenomena, events or processes. The aim is to optimise behaviour or action under the conditions of the phenomena or processes defined as a problem. Usually these are phenomena with negative consequences for the society or economy of a given area, but they can also be phenomena creating more favourable conditions for development and functioning.

Problematic functional areas are usually defined and delimited only for a certain period of time, when phenomena appear which constitute a specific economic, social or environmental problem requiring specific actions. Problem functional areas may be one-off, cyclical or permanent.

For example, the problem functional area is an environmental disaster area that emerged in Poland in 2019 as a result of the start of discharge of municipal and industrial wastewater into the Vistula River due to the failure of the wastewater flow installation to the main treatment plant in the city. The area includes the Vistula River and coastal areas from Warsaw to the Gulf of Gdansk. It also includes areas where towns and farmers use water from the Vistula or use the river as a recreational area. At present (year 2020) it is not known whether this problem area will be a one-off area and the problem of sewage treatment plant failures in Warsaw will be effectively solved, or whether it will turn out to be cyclical and failures will occur from time to time, or whether it will be a permanent problem. Delimitation of such an area

should include all areas affected by the polluted waters of the Vistula and all the consequences of this pollution - ecological, economic and social.

Problem functional areas should be defined and delimited for possible environmental disasters and catastrophes. For example, *functional problem areas* should be defined and delimited for seismic areas, areas at risk of tsunamis, floods or droughts, and other environmental, economic or social disasters of difficult-to-predict frequency and duration. Such a delimitation of a problematic functional area is needed to prepare information systems and resources that can be activated immediately and make perpetual information available to all stakeholders in the event of phenomena indicating the existence of a problem requiring a response from authorities and other actors.

Problem functional areas should be defined and delimited especially in case of extreme events occurring cyclically, with predictable frequency, on a known scale, in a known place and at a known time. Specification of possible situations and delimitation of such problematic functional areas is an important basis for spatial management and policy of ensuring safety and development of areas which can be affected by extreme events.

With the models of such functional problem areas it is possible to prepare the information base and methodical support and action scenarios which would be activated in case of occurrence of problem situations. In justified situations on the basis of such models, especially simulation models of functional problem areas, it is possible to determine the undertakings which should be implemented to minimise the negative effects of extreme events or processes and to use optimally the positive effects of extreme events.

As mentioned above, many different both domain-specific and issue-specific functional areas can be delimited in a single geographical area. Each can be defined on the basis of legal, economic, social, environmental and

other categories if functional areas are specified according to specific subject criteria or specific information needs of stakeholders: area of social or economic life, environmental aspects, economic branches and others.

For example, in a geographical border territory, it is possible to define a geographical functional area of a *border region* according to the objective criterion of proximity to a national border, using several different categorical criteria. A border region can thus be defined by:

- *legal categories* - a functional border area with special regulations, restrictions and obligations on movement, residence, requirement for documents and others,
- *economic categories* - a functional border area where the economy is affected by the border with another country,
- *social categories* - a functional border area where social processes are influenced by the proximity of the border to another country, including phenomena such as a diverse ethnic structure of the population, cooperation between institutions of different legal systems, specific security problems,
- *ecological category* - a functional border area whose environment is affected by pollution emitted by establishments located in the neighbouring country close to the border or by watercourses having their source across the border,
- *statistical categories* - a border area in which selected statistical indicators characteristic of the social or economic processes of the area close to another country take specific values, e.g. the number and turnover of enterprises serving cross-border traffic, the number of people working across the border, the number of inhabitants of the

neighbouring region across the border using services or working in the border area.

Each of the *functional border areas* defined according to different categorical criteria may cover a territory different from the functional area defined according to the criteria of another category. A functional border area defined according to legal categories in terms of regulations governing residence and economic activities will have a different territorial scope, a functional area defined in terms of its subject matter as a cross-border labour market will have a different territorial scope, and an ecological functional area will have a different territorial scope, e.g. an area of ecological risk related to water management or air pollution or a separate border zone protected due to its natural values.

2.3. Stability and dynamics of functional areas

From the point of view of stability and sustainability, the following types of functional areas can be distinguished:

A) stable functional areas,

B) situational functional areas,

C) incidental functional areas.

Ad A. Stable functional areas

By *stable functional areas* we mean social, economic, ecological systems that are delimited in a given area as *functional areas*, which in the short to medium term do not change their characteristics, functions and objectives relevant to stakeholders' information, decision-making and management needs. While these characteristics, functions or objectives may change over the long term, in the short to medium term these changes are irrelevant from

a stakeholder perspective. Stable functional areas are related to the region's sustainable ecological conditions, settlement network and technical or social infrastructure.

Stable functional areas are urban agglomerations, industrial regions within these agglomerations, local labour markets, areas around sea ports, airports, areas constituting the recreational base of urban agglomerations, forest areas, national and landscape parks, areas affected by environmental disasters, the rehabilitation of which is technically or economically impossible or requires a long period of time.

Ad B. Situational functional areas

Situational functional areas are social, economic, ecological and other systems that are delimited in a given area under the conditions of specific political, social, economic or ecological situations or events. Situational functional area models are applicable in practice only in time and to the extent that specific situations occur.

For example, a situational functional area is the *floodplain* of a river or other body of water which, under particular hydro-meteorological conditions, is flooded or inundated for a certain period of time. Situational functional areas may include areas where extreme environmental phenomena occur from time to time (e.g. regions of tornadoes, hurricanes, typhoons or tropical storms, extreme droughts or precipitation events). Functional areas defined for tourist areas, in which tourist traffic is strongly dependent on unstable weather changes, have the character of situational areas.

As situational functional areas one can distinguish between areas in which the conditions for economic or social activity are or may be changed by political decisions. For example, the opening of a cross-border LBT region

or the closure of this region as a result of a change in the political situation (e.g. the LBT region near Kaliningrad, Elbląg and the Tricity). These include: the opening of a cross-border local border traffic region or the closure of this region as a result of a change in the political situation (e.g. the region of a small border group near the Kaliningrad region, Elbląg and Tricity), regions of the so-called state-owned farming villages after 1990 in Poland after the political decisions had made it impossible for these farms to operate, industrial regions where activities were limited or liquidated as a result of political decisions made by the central or local government (e.g. regions where the only industrial plants constituting the economic basis of smaller towns and whole districts were closed down after 1989 in Poland as a result of the so-called "shock therapy").

Ad C. Incidental functional areas

Incidental functional areas are areas where extreme events may occur with an unspecified probability and at an unspecified time, but which have the characteristics of an ecological, economic or social disaster. The definition and delimitation of such areas is necessary so that the region can be prepared to minimise the negative effects of such extreme events or to take advantage of possible benefits arising from them.

Examples of incidental functional areas are seismic areas, where earthquakes of such magnitude as to cause a structural or ecological disaster may occur very rarely, but when they do, their effects on unprepared areas are dramatic for society and the economy. Similar is the nature of areas threatened by tsunamis, industrial and environmental disasters such as locusts, political disturbances and threats to the internal security of the region.

Specific incidental functional areas are regions in which extreme events or processes that are difficult to predict create significantly more favourable living and economic conditions for the society and economy of these regions, provided that the society and economy are prepared to make use of the unforeseen opportunities. These are phenomena such as regional "harvest disasters" in agriculture, or in tourism, local weather conditions which are exceptionally favourable from time to time and enable the tourist season to be extended.

Situational and incidental functional areas are dynamic systems in three aspects:

- real social, economic or environmental processes,
- the information needs of the entities operating in the areas at the time and place of occurrence of unforeseen or extreme phenomena,
- new statistical categories, measures and indicators that are necessary to map the characteristics of functional areas under specific situational or incidental conditions.

Variability of functional area characteristics

Functional areas existing within political, social, economic and ecological systems are characterised by the variability of the features used to define and delimit them. They are thus dynamic subsystems of specific political, social, economic and ecological systems, changing over time and in geographical space.

The dynamics of a functional area in time and geographical space depend on:

a) changes in the characteristics of the territory in which the functional area is delimited, in particular changes in the characteristics of the systems of which the functional area is a subsystem,

b) changes to the content of the categories (concepts and their definitions) forming the conceptual basis for defining the functional area,

c) changes in the information needs of stakeholders who are interested in knowledge about the functional area.

Ad (a) *Variability of the characteristics of the territory* in which the functional area is delimited.

The characteristics of the area in which a functional area is delimited are subject to change. These changes may relate to social, economic or environmental phenomena and processes occurring in the area or affecting other site characteristics. Such changes affect the spatial extent of the functional area and other terrain features without changing the geographical area.

For example, during the construction of an express road or a motorway in a specific area, a functional area of the local labour market connected to this investment can be separated. When the express road or motorway is completed and put into use, the labour market connected with the construction of this investment disappears in the area, but the labour market is spatially expanded to include localities located along new transport routes thanks to greater opportunities for faster and cheaper commuting to more distant places and thanks to the appearance of new jobs in logistics companies building their bases near the express road or motorway. The functional area of the *local*

labour market of the express road construction is transformed into a spatially similar functional area of the *local labour market of the towns located by the express road*.

For example, the commissioning of a hydrological project to ensure flood safety to the surrounding areas and improve their water balance (construction of a dam, lagoon, water stage), thanks to the creation of a new water reservoir, creates a new functional area - a recreational area for the population of nearby towns and a qualitatively new local labour market related to tourist services.

For example, the project carried out in the USSR in the 1930s to irrigate the desert in Uzbekistan by diverting the waters of the Amu Daria and Syr Daria rivers led to an ecological catastrophe of the Aral Sea located about 1200 km from the irrigated areas. To date, the Aral Sea is the world's largest *functional area of hydrological ecological catastrophe*, the direct cause of which is geographically located far beyond its territory.

Ad (b) *Changes to the content of the categories* defining and identifying the functional area.

A functional area defined by legal categories may change its subjective, personal and spatial scope in the event of a change in legal acts.

For example, the spatial scope of a functional area of a *border region* defined by legal categories may be changed by new legal acts or amendments to earlier legal acts that define concepts such as *border area*, *local border traffic area*, regulations on legal and technical conditions (e.g. traffic), border crossing, stay and behaviour in these areas in a new way.

For example, in Poland, in relation to the Covid19 pandemic, since April 2020, the Ministry of Health in Poland has been defining, by means of regulations, categories of virus risk zones (red, yellow, blue) and introducing rigours related to these zones for conducting economic activities and social behaviour. The spatial scope of these zones, which are specific functional areas, is updated on a daily basis by administrative decisions of the statutorily authorised government administration bodies.

Ad (c) *Changes in the information needs of users* of the functional area delimitation.

Entities operating in the areas included in a specific functional area may need different information due to changes in the territory and changes in legal regulations. The development of new delimitations of functional areas may be needed in the event of transferring commissioned tasks between the levels of local government, e.g. between gmina and powiat, gmina or powiat and voivodship. Transfer of new commissioned tasks to local government results in the fact that the local government, in order to perform its new tasks, needs additional information, including information necessary to develop a new, more precise delimitation of the functional area taking into account the new functions of the local government.

For example, in a pandemic situation, the information needs of local administrations and businesses change fundamentally. In order to effectively limit the spread and impact of a pandemic at the municipal level, it is not enough for the local authority to have the number of identified infections and illnesses for the entire province or district, but it is necessary to identify these phenomena at least at the level of

the locality (cadastral boundary), and better still, at the level of the parcel with the characteristics of the facility located on this parcel, where infections and illnesses were found. Only with data at this level of spatial identification can a functional area of epidemic risk be delimited that is useful for local government and higher-level decision-making bodies. This delimitation of the functional area of pandemic control allows correct decisions to be made about the area and type of restrictions that may be optimal for protecting the health of the population and the economic activities and lives of the inhabitants.

For example, the decision to build an opencast lignite mine means changes to the ecosystem of the surrounding area, such as lowering groundwater levels, soil and air pollution. These effects in the long term may mean degradation of tourism and agriculture in the areas surrounding the opencast mine. Local self-governments responsible for the living conditions of the inhabitants and functioning of the economy in the area threatened ecologically by a new investment need a lot of new information and prognostic models of functional areas delimited for the areas of influence of an opencast mine, once they find out about such investment planned in "their" area. It should not be enough for local self-governments to receive information about damages for permanent degradation of communes or localities to be paid to the budgets of the communes, but rather comprehensive data about all consequences of the investment for a precisely delimited functional area of an opencast mine ecological *threat*.

Changes in the decision-making situations of state bodies and economic entities operating in a specific area usually imply a change in the information needs of these entities. These changes should be taken into account

in the functional area models they use. This also means that the spatial delimitation of functional areas needs to be updated after each identified change not only in the decision-makers' awareness but also in the potential information needs.

2.4. Sources of information necessary for the delimitation of functional areas

The possibility and precision of spatial delimitation of functional areas is determined by information about the territory, its resources, objects, processes and phenomena available from various sources. In order to delimit a specific functional area, it is necessary to have a set of information that is *perpetual*, i.e. information verified as reliable, up-to-date and useful for the purposes for which the functional area is delimited. These sets should contain complete and non-redundant information. In accordance with the Ockham razor's principle, from the sets of information relevant from the field the *perpetual* information should be selected, only the information that is necessary for the identification, definition and delimitation of a specific functional area.

Information about objects, processes and phenomena identified in geographical space is generated by various information entities, i.e. such entities whose one of the functions is to generate, collect and make available economic, technical, environmental, administrative and other factual information. These include both the state authorities and public administration, public statistics, scientific institutions, social organisations, enterprises involved in collecting and distributing information in public space, and the mass media.

Thanks to modern information technologies we can have at our disposal extensive collections of information on geographical space, on morphological features, resources, objects, processes and events occurring in a given area. This information is usually created and recorded in electronic form. They are easily and cheaply accessible via the Internet, intranet networks, or obtained through access to specialised information systems managed by public administration, companies generating large collections of transactional information (*big data*) and some information entities (e.g. institutions managing databases and scientific and technical information systems).

For those interested in spatial information and functional area delimitation, the problem is not so much the lack of information relevant to their needs in general, but the lack of information tools for efficient retrieval from a wide range of different systems and sets of perpetual information, verified in terms of quality, necessary and sufficient for defining and delimiting a specific functional area and updating this delimitation in accordance with the dynamics of changes occurring in this area. It is not about a lack of information search tools, because there is no shortage of them on the market. These tools are widely available, also on a non-commercial basis or at a cost which does not constitute an economic barrier for professional users.

Search engines used on the Internet seem to be powerful enough to support even technically demanding users. However, there are no domain-specific information and search languages, no indexing of data sets using these languages, no typical queries that could be used by incidental database users, and especially no methods to verify the quality of information searched in different systems. Information retrieval on the Internet and many other information systems is usually based on the QWIC (*key-words in context*) approach. The terms used as key words for information search are formulated

ad hoc by users while formulating a query. Most often, these are words from languages they know and use to communicate on a daily basis. An example of this approach is searching for information on Google and other popular search engines. The accuracy and completeness of searches using such "key-words" formulated hastily by the user is difficult to verify.

In addition, the relevance and pervasiveness of information searched on the Internet and in many other information systems is affected by the lack of practical possibility to verify the substantive quality of information searched on the Internet and made public by the mass media. The lack of possibility of quality control also applies to information for which the Internet and the mass media are only an intermediary in delivering information to the user.

Therefore, any work requiring verified information, including such a methodologically complex task requiring a wide range of data as functional area delimitation, should use only information sets for which the responsibility of the entities generating the information and of the entities involved in selecting, interpreting and making the information available to the final users is defined by law. The sources of such information should be only information systems for which the responsibility for the quality of the data lies with their managers. This responsibility should be appropriate to all the consequences which could arise if the information made available to users does not meet the required quality criteria. All potential users are concerned. These users may make wrong decisions, incur unnecessary costs or suffer losses as a result of the "poisoning" of their information environment.

It is expected that the information quality requirements set out in scientific and legal standards are met by official information systems supervised and controlled by government and local government bodies and by official

scientific institutions. These systems are created and managed directly by public sector units or are managed by enterprises and other social and economic organisations, but supervised and controlled by official institutions from the point of view of compliance with information standards defined in legal acts. The operators of these systems have a regulatory responsibility for the quality of the information and the quality of the information services provided. Many of these systems belong to the information infrastructure of the state[3] .

Information useful for the delimitation of functional areas is found primarily in those systems that apply detailed spatial identification of the objects, events, transactions described in them, and possibly their accurate identification in time.

For the delimitation of functional areas, identification at the level of the following geographical space units is needed:

- XY geographical coordinates,
- postal address,
- registered (cadastral) parcel,
- cadastral district,
- census circuit,
- statistical region,
- different types of settlement units and land use in rural and urban areas,
- territorial subdivisions of areas outside the settlement network (e.g. forest, inland waterway and marine concessions),

[3] See Oleński J., *Infrastruktura informacyjna państwa w globalnej gospodarce*, Publ. Nowy Dziennik, Warszawa 2006.

- units of administrative division of the country: village, district, municipality, county, voivodship),
- other spatial units defined for specific purposes in specific use situations (e.g. land allocated for national or regional security, communication routes, for power lines and for other infrastructural linear facilities).

Information systems collecting data that may be useful for the delimitation of functional areas are:

- *official statistics*; in particular micro-databases containing information on statistical units which are identified at the level of XY coordinates, parcels or other detailed territorial units (e.g. micro-data from censuses and statistical reporting at technical-local unit level),
- *nationwide administrative registers,* e.g. PESEL, REGON, CEiDG, NIP, registers of payers and insured of ZUS,
- *nationwide registration systems*, in particular the EGiB, NKW, CEPIK, official specialised registers of selected objects, devices, processes, events,
- *national information systems of the public administration*: tax, customs, social security, information systems of the state budget and local government budgets, information systems of government agencies performing coordination and regulatory tasks of the state in sectors requiring such regulation of the economy and social services, such as agriculture, environmental protection, protection of competitiveness and consumers on the internal market, and others,
- *information systems of the National Bank of Poland*,

- *transactional information systems* of enterprises operating in selected domains subject to state supervision due to their significant importance to the economy and the state at the national, regional or local level: e.g. information systems of the National Clearing House, banking, insurance, other financial systems, energy, telecommunications, railway, air, water, road transport (including the VIA TOLL system),
- selected *big data* resources, i.e. transactional databases, monitoring databases in areas relevant for spatial delimitation,
- archival resources containing auxiliary information useful for the spatial delimitation of social, economic and ecological processes and phenomena, including the delimitation of functional areas.

When developing the delimitation of a specific functional area, it would be advisable to review all available sources of information that may be useful for the definition and delimitation and to select those that are necessary to achieve the highest possible level of precision, timeliness and give the opportunity to follow the dynamics of change of a given functional area. We should not be satisfied with aggregated data available in statistical yearbooks or statistical databases containing aggregated data at the level of administrative units of the country division or NTS. Satisfactorily precise delimitation of functional areas often requires identification of data at the level of XY coordinates, cadastral parcels or the smallest settlement units taken into account in administrative registers created at the local level.

The possibilities of functional area delimitation adequate to the needs of institutions and entities interested in defining and separating in the geographical space areas with special characteristics depend on available

sources, scope and quality of information useful for delimitation. The possibilities and precision of delimitation are determined by the quality and scope of available perontinental information.

From the point of view of information bases, we can distinguish the following types of information sources that can be used for the definition, identification and delimitation of functional areas:

- *symptoms* indicative of particular characteristics, functions or processes that distinguish an area from its surroundings (the so-called *traced data*),
- *official registers and records* kept by public administrative authorities and other institutions empowered for that purpose,
- public *administration transactional information systems* (e.g. tax, social security, health, public safety systems),
- *transactional information systems of enterprises* and other economic and social entities, including large network organisations,
- *monitoring systems* - the basic source of information used for the functional area delimitation is the monitoring of objects, phenomena or technical, economic and ecological processes,
- *sensor systems* for ecological and technical phenomena, objects and processes,
- *big data* from other sources,
- official *statistical surveys* and methodologically validated scientific and commercial statistical surveys.

In practice, different sources of information available are used simultaneously for the delimitation of functional areas. Data from different sources

are often incomparable, developed on the basis of different methods and verified in different ways.

Systematization of approaches to functional areas delimitation and development of generative delimitation models depending on specificity of regions, needs of functional areas models users and on available and used information sources, especially cross-border areas, border areas and areas with extreme social, economic and ecological phenomena and processes is a subject of research works in the State School of Technology and Economics in Jarosław and in Centre for Transborder Research of Statistical Office in Rzeszów. It is planned to present the results of these works in the next publications of this PWSTE publishing series.

3. Economic gravity as a basis for the delimitation of functional areas

In a knowledge-based open market economy, with political systems defined as democratic legal states, local and regional development is significantly influenced by the *economic gravity* generated by urbanised areas and industrialised areas and by infrastructural development policies pursued on a meso and macroeconomic scale by state institutions and other social and economic entities involved in the creation, development and management of infrastructural systems. This includes all types of infrastructures: social, political, economic, technical and environmental.

The practical conclusion from the above hypothesis for central state bodies influencing regional development and for local governments and local administration is the need to take into account the phenomenon of *economic gravity* and its social and economic effects when making specific decisions affecting systems of an infrastructural nature and in their actions affecting sustainable social and economic development on a local, regional and national scale.

The processes of economic gravity, their causes, course and consequences for society and the economy depend on the specifics of the political, social and economic systems in which they occur. In particular, the following features inherent in contemporary political systems often referred to as *democratic legal states* and social and economic systems referred to as *market economies*:

- *profound institutional interventionism* determined by law and carried out by the organs of the so-called *democratic legal state*,
- *a knowledge-based market economy*, *open* on a regional, national, cross-border and global scale,

- *social and economic development based on infrastructure systems* on a regional, national, cross-border or international scale covering all areas of social and economic life,
- *dependence* of the functioning of state bodies, business entities, the social services sector and the society *on modern information and communication technologies,*
- *"self-governance" of state bodies, especially at local and regional levels,* generating tendencies towards autonomisation of administrative units of the territorial division of the country; in a democratic state governed by the rule of law, where institutions of judicial power gain predominance over institutions of executive and legislative power, there may be a *denationalisation of* territorial self-government,
- *development of cross-border processes and economies*, which are not only of regional but also of macroeconomic importance for small and medium-sized countries.

These above-mentioned factors should be taken into account when defining and delimiting functional areas for which development programmes and projects in various fields are drawn up and implemented.

3.1. Economic gravity

In a knowledge-based market economy, open on a regional, national, cross-border and global scale, there is a phenomenon of concentration of social and economic potential determining the development of regions and countries in a limited number of localities. These are most often cities which are the seats of central and regional authorities and state administration, and

areas of intensive economic activity, in particular industrialised areas. Cities and industrialised areas base their development not only on their own demographic, institutional, infrastructural, industrial and natural resources, but above all use the resources of the surrounding regions.

In the medium and long term, the development opportunities of a given area are determined by human capital and social capital, which in turn depend on the demographic potential of the region and the country. In the conditions of an open market economy and modern technologies, the importance of *economies of scale,* which determine the effectiveness of economic and social activity in many areas, is growing. For *economies of scale* to emerge in a region, human capital, social capital, institutional capital, economic capital and various types of technical capital should exceed a certain size. Cities and industrialised areas are often unable to create new or increase existing capital necessary for development on the basis of their own demographic, technical and economic potential. The condition for their development is the use of external resources, located in the surrounding geographical space, in the field of their economic gravity.

Cities and industrialised areas, due to the concentration of institutional, social, economic and technical potentials that are greater than those in neighbouring areas, create around themselves *socio-economic gravity fields* (in short, *economic gravity fields*). Due to the difference in social and economic potentials, cities and industrialised areas "suck out" human, institutional, industrial and natural resources from the surrounding localities, non-urbanised areas and rural areas which are within the range of their *economic gravity fields*. In the first place, the most valuable resources are "sucked out", which are necessary for the effective functioning of the economy, authorities and administration, institutions providing social services, enterprises and other organisational units located in the surroundings of cities.

Cities and industrialised areas also benefit from the immobile infrastructural and industrial resources of their geographical surroundings. First of all, this concerns natural resources, transport infrastructure and infrastructure supplying cities with energy, water. "In return" they try to use the neighbouring geographical environment as sites for municipal and industrial waste.

The use of resources extracted from the geographical environment by urbanised or industrialised centres is often sub-optimal or even predatory. Resources which could be used more effectively in small towns, in rural areas, are "sucked out" of these areas by cities and industrialised areas which are centres of economic gravity for the region or the country. In these centres they are often used less effectively than if they remained in small towns or rural areas. The process of depriving the surroundings of the centres of economic gravity of the most valuable resources causes a permanent widening of disproportions and development opportunities between larger cities or industrialised areas generating economic gravity and the remaining localities in the region affected by this gravity.

The *economic gravity* generated by social and economic centres (cities, industrial districts, centres of political institutions) may be reinforced by infrastructural projects, including those intended to foster the sustainable development of regions. The social and economic effects of such infrastructure projects for regions or parts of regions may turn out to be quite different from what was expected. Instead of balanced development of the whole region, they may cause an increase in disparities, polarisation and even destabilisation of the region's economy.

For example, an express road, motorway or high-speed railway shortening the travel time from small towns to urban centres is usually seen as an opportunity for the development of these "transport-excluded" localities, an

inflow of development capital. In practice, such transport investments may turn out to be routes for an even faster outflow of valuable human capital and other resources from small towns and villages to centres of economic gravity, thus limiting even further the development possibilities of smaller localities.

Although the construction of an express road or motorway and ring roads in medium and small towns brings about an improvement in the living conditions of the inhabitants by "moving" car transit traffic out of the city, it usually results in a decrease in demand for services that local small businesses would provide to travellers passing through towns, especially for freight traffic. Reducing the commuting time from a town to a big city more often than not strengthens the gravitational influence of the big city on smaller towns, in particular accelerating the outflow of valuable human capital to centres of economic gravity.

Therefore, decisions on supra-regional, national or international infrastructure projects affecting the extent and strength of the economic gravity of cities, agglomerations and urbanised areas should take into account their impact on *economic gravity* fields and the social and economic effects on areas with weaker gravitational force in the long term.

The policy of sustainable development should take into account limiting the negative influence of changes in economic gravity fields under the influence of infrastructural investments. For example, before taking a decision on the course of new traffic routes it is necessary to determine how many petrol stations, garages, motels or restaurants, and therefore local jobs, located in nearby towns will disappear or significantly reduce their activity after the ring road or an express road is put into use. These effects should be foreseen in advance and the projects should include investments accompany-

ing such infrastructure, compensating for economic losses and limiting peripheralisation of villages or towns, which after completion of the infrastructure investment will suddenly find themselves next to main transport routes.

For example, when deciding on large scale linear investment projects such as the *Via Baltica* and *Via Carpatia* ("*from Tallinn to Thessaloniki*") it would be advisable as part of the study to develop delimitation of the economic gravity fields of these investments and simulation models of their impact on neighbouring areas. It is worth paying attention to possible changes in directions, forces and ranges of influence of *economic gravity* between centres of economic gravity and other localities. The consequence of such investments may be an increased transfer of resources between localities within the area of influence of the investment, accelerated sucking of resources from smaller centres to larger ones or, conversely, the creation of conditions for the transfer of resources to areas from which there had previously been an outflow of resources to the centres of economic gravity.

New delimitations of economic and social sub-regions (e.g. maps of future local labour markets to be created once the new infrastructure is in place) and simulation models of the impact of an intensified transfer of resources on the development of the areas which will fall within the economic gravity field of the *Via Baltica* and *Via Carpatia* should also be developed on the basis of economic gravity models. Such information could be used for decisions by the central state authorities and by the local governments whose regions would be influenced by this new transport infrastructure, on accompanying investments and other measures to make better use of the new infrastructure for local development.

Forecasting and simulation economic gravity models would facilitate decision-making on investments accompanying major infrastructure projects.

Thanks to these accompanying investments there would be a positive synergy effect compensating for losses and giving additional, greater benefits from the new transport infrastructure for small towns and rural areas[4] .

National or international network infrastructure systems, such as energy, road and railway infrastructure, air transport, water transport, telecommunications infrastructure, are primarily oriented towards serving and connecting those cities and agglomerations which are areas of concentration and accumulation of other types of infrastructure, such as social infrastructure covering areas such as education, health care, culture, public services provided by the state apparatus, economic sectors of an infrastructural nature such as banking, insurance, the mass media. The information entities forming the information infrastructure of the country and regions are also concentrated in cities which are centres of economic gravity.

In the conditions of contemporary technologies, any meso or macroeconomic or social decision concerning a particular geographical space should take into account its impact on *economic gravity* processes and their consequences for regional development.

Deep institutional interventionism is an attribute of modern economy. Therefore, in order to ensure a *balanced regional development*, to prevent socially and economically harmful developmental disproportions between different units of the settlement network of the region resulting in a sub-optimal use of resources on the scale of the whole region and to use the country's resources in an optimum way at the regional level, it is necessary for the state

[4] An interesting and practically important research problem would be the development of a simulation-based, prognostic *economic gravity* model for the planned Central Railway Port, which could help in comprehensive planning of investments accompanying this undertaking on a local and supra-regional scale.

to pursue an active, centrally programmed policy of harmonised, balanced regional development. The basis for centrally implemented regional policy undertakings is the programming, planning, implementation and development of infrastructure: institutional, social, technical, environmental and information, based on the delimitation of various functional areas whose spatial extent is determined by economic gravity.

Under conditions of deep institutional interventionism, regional development cannot be left to the so-called *market*. The *market* is a good regulator only when we are dealing with processes and phenomena with short-term and local effects, like the setting of prices in a bazaar by hagglers. The market is a bad regulator of any process where social goals and effects and long-term economic goals and effects have to be taken into account. The market is also a very bad regulator of any infrastructure system.

The infrastructural development of regions should be the central task of the state. It cannot be left to gmina or powiat authorities, let alone to the market, especially the market which operates like the proverbial oriental bazaar, let alone a housing estate bazaar. Decisions on location, construction, nor operation or management of any infrastructural segment or facility affecting local or regional economic gravity processes cannot be delegated to commercial entities, but should be strictly regulated by *good law* and supervised by the relevant central state authorities, including their field delegations. On the other hand, local governments and other social and economic actors in the regions should be obliged to actively participate in infrastructure programming, planning, implementation, operation and development.

The region's infrastructure potential is concentrated in settlement units of different sizes, with different social, economic and political functions. The greatest concentration of this potential is in cities, especially in

large cities. There is a significant qualitative difference between urban centres and smaller settlements, mainly concerning institutional capital. In small towns, institutional capital (offices, political and social organisations) is rarely strong enough to have an effective impact on the development of other economic and social resources. It is in cities, and not in villages or towns, that the organisational units constituting the institutional infrastructure of the state are located. These are the executive and judicial branches of government, public administration, institutions implementing the state's duties to enforce the obligations of citizens and enterprises defined by law, such as taxes, sanitary, technical, ecological standards, institutions of social welfare and health care, education, science, most institutions responsible for the security of citizens and the state, infrastructural mass media.

Observing the activities of local self-government bodies, it can be concluded that those who lead them understand well that a certain potential of institutional capital is a necessary condition for the development of other resources and for limiting the outflow of mobile resources. It is from this perspective that one should assess the efforts of local activists to locate certain offices in "their" locality, for a village to gain urban status, and for a municipality or several municipalities to gain the status of a new county. Institutional capital is a factor generating strong economic gravity in the modern economy.

Under conditions of increasing economic gravity on regional development, the following theses on regional development in an open market economy are justified:

1. The development of cities and industrialised areas at the expense of exploiting the resources of the regions surrounding them is a process

that accompanies the development of state institutions and the economy. Cities being the centres of authorities at various levels have always generated *fields of economic and social gravity* around them. With the industrial revolution, areas of intense economic activity emerged that are not centres of power. These areas generate around themselves fields of economic gravity which "suck" from the surroundings the resources useful for the economic activities carried out in them.

2. In the conditions of modern transport and ICT technologies, the development of various types of national and regional infrastructures takes place under the influence of economic gravity fields. This causes that cities and urbanised areas develop not only and not so much on the basis of their own human, social, ecological, technical capital, but on the basis of the resources of the surrounding settlements of the region useful for the centres of economic gravity.

3. Technological development - as a result of the pursuit of economies of scale - leads to an increasing concentration of objects and infrastructural systems in a decreasing number of urban units. An effect of this regularity is the metropolisation of development, i.e. the concentration of factors that condition and determine social and economic development in ever larger metropolises and the peripherisation of areas located outside of metropolises. Peripheralisation means that the areas outside the metropolises affected by the fields of economic gravity of the metropolis lose the possibility of independent development. Their situation depends on the development of the metropolis and the policies pursued by institutions located in the metropolis.

4. The concentration of the region's social and economic potential in an increasingly smaller number of cities or urbanised areas, the transformation of urban centres into metropolises and urbanised mega-agglomerations, is facilitated by the development of regional and supra-regional network infrastructures, primarily transport, telecommunications, energy, environmental and social network infrastructures such as education, health, culture, internal security and information infrastructure.

5. The development of transport and telecommunications networks results in the concentration of political, social and economic institutional infrastructure in fewer and fewer localities on a regional, national and, in some areas, international scale. People and entrepreneurs are forced to use services generated by institutional and social infrastructure units located in cities increasingly distant from their places of residence and places of business. "Digitisation" of administrative services based on national or global ICT networks and systems strongly influences the concentration of seats of authorities, administration, business decision-making centres and other institutions in a decreasing number of cities and metropolises.

6. In the contemporary open market economy, the *infrastructuralisation of development*, i.e. the dependence of development in all fields on the state of basic political, social, economic and technical infrastructures, leads to the spatial enlargement of economic gravity fields generated by cities, agglomerations and urbanised areas and to the increase of their gravitational force. As a result, there is an accelerated transfer of resources from increasingly larger areas covered by economic gravity fields to urban and industrial centres. The localities located in these areas become the periphery of the centres of gravity.

A further consequence is the permanent polarisation of regional development on a national and international scale.

7. As a result of the increase in the strength and space of the impact of *economic gravity* generated by cities and urbanised areas, *mega-agglomerations* are emerging, i.e. vast metropolitan areas covering even entire medium-sized national economies and cross-border areas of neighbouring countries. *Mega-agglomerations* in spatially large countries often fulfil the function of economic centres for entire national economies. In these countries, the remaining cities and urbanised areas undergo processes of *peripheralisation*.

Impact of gravitational transfer of mobile social and economic resources on regional development

The institutional, social, economic and natural *mobile resources* "sucked" by cities that are *centres of economic gravity* are primarily:

a) *institutional capital* (state bodies, offices),

b) intellectual capital (educated people, especially with valuable work experience and skills),

c) social capital (people with leadership qualities, social and political organisations, cultural institutions),

d) *managerial capital* (decision-making centres of enterprises and other organisations operating nationally or internationally),

e) *technological capital* (mobile technological processes, especially in innovative industries).

The concentration of capital, infrastructure and resources in a relatively small area, most often in large cities, the interpenetration of institutional, social and economic infrastructures in one area create - sometimes seemingly - better security and development conditions for people and socio-economic entities than outside large cities.

The subjective attractiveness of cities in relation to non-urbanised areas for many inhabitants causes people and organisational units, which are the *mobile resources* of the region, to move from rural areas and small towns to nearby cities and from these cities to larger centres.

Of particular importance for the gravitational force of cities and other centres is the concentration of institutional and social capital. For many centuries, the main town-forming factors were public authorities, primarily central, but also regional and local, and the defence infrastructure of the country or region. An exception to this rule were cities established on trade routes. The gravitational force of these cities was determined by economic factors.

As a result of the industrial revolution, in Europe until the first half of the twentieth century, industry became the urban factor. Today, under the conditions of modern technologies and knowledge-based economy and services, industrial production develops not so much within city limits, but mainly in areas well connected with political and managerial centres located in cities, creating common areas of economic gravity. In larger urban centres, thanks to the concentration of human capital, centres of political institutions, public administration bodies, financial institutions, management centres of economic and social organisations, commercial centres, as well as enterprises providing specialised services to institutions and industry are created.

In cities accumulating human and social capital, scientific centres, higher education institutions, cultural institutions, highly specialised health care have better chances for development.

The transfer of mobile resources under the influence of economic gravity generated by urban centres results in the polarisation of regional localities. In some countries, in order to prevent the permanent polarisation of regions, the political authorities try to control the processes of economic gravity, especially to actively influence those factors that the authorities have influence on through legal regulations and administrative decisions. This primarily concerns the location of institutional capital (government offices and other institutions) and centres for the creation and use of human and social capital (schools, universities, research institutes, institutions providing advanced social services such as specialised medical care, cultural and arts centres).

Authorities with an interest in the sustainable development of all regions, aiming at the optimal use of resources throughout the country, pursue an active policy to limit uncontrolled mobile resource transfer processes occurring under the influence of economic gravity generated by urban centres and agglomerations. Authorities aiming at the sustainable development of a country or a region strive to eliminate or at least limit unnecessary or forced by regional disparities transfers of resources to urban centres from social and economic settlement units located in the field of economic and social gravity of cities. Such transfers strengthen the economic gravitational force of centres.

Unfortunately, few countries have had any real success in curbing the inefficient transfer of mobile resources "from the countryside to the city", i.e.

from smaller towns to urban centres of economic gravity. The proverbial "village" loses incomparably more on this transfer than the "city" absorbing these resources gains. There are many regions in Europe where the process of sucking out mobile resources by a few centres of economic gravity can be considered completed in the sense that the settlement network practically disappears outside the centres, and with it any social and economic activity.

In the post-industrial economy, based on modern technologies, the social and economic development of the country and regions is determined by the *infrastructuralisation of* basic areas of political, social and economic life. Sectors of the economy become more efficient and competitive if the economic entities operating in them form networks of an infrastructural nature. For example, in the field of research, these are the so-called networks of excellence; in manufacturing, services and trade in goods, these are regional or cross-border industrial and commercial clusters.

Infrastructure networks are often international in scope, e.g. in trade, transport, banking and finance, the purchase, processing and distribution of agricultural products, scientific research, telecommunications or the mass media. Infrastructure networks take the form of clusters or business cartels. Under conditions of deep institutional interventionism, the political and institutional infrastructure of the state becomes particularly important. This infrastructure generates a strong economic gravity with a wide spatial range, affecting many sectors of the economy and social life.

In democratic legal states, political and institutional infrastructures can influence the economic gravity of other infrastructures through legal norms. For example, legal regulation of environmental standards, technical standards, national spatial planning, regionalisation of access to social infrastructure (education, health, internal security, etc.) and natural resources, can

effectively limit or direct the economic gravity of certain urban centres or industrialised areas.

The *infrastructuralisation of* social and economic *development* strengthens the economic gravitational force of urban centres, as it is in or around cities that most resources organised in the form of infrastructural networks are concentrated. The concentration of infrastructural resources in cities leads to increasing regional polarisation by permanently depriving the units of the settlement network located outside cities - centres of economic gravity - of their basic resources. This especially concerns the most mobile resources - human capital and institutional capital. As a result of the processes of "sucking out" of resources by urban centres with a greater infrastructural potential, and thus with a greater gravitational force, smaller towns and villages may lose their ability to further develop even when new technical, economic or environmental conditions, which are objectively favourable for development, appear in them. For example, a region, which could develop thanks to its tourist or natural advantages, more easily accessible for tourists from distant metropolises through the construction of express roads and motorways, will not use its chance if before the construction of these express roads and fast railways, entrepreneurial and educated people will emigrate from this region, previously "sucked in" by these distant metropolises. A barrier to "greenfield" investments in small towns outside large agglomerations is sometimes the lack of a local cadre of skilled workers, who after the collapse of small and medium-sized enterprises operating there for many years in traditional industries, left "for bread" to distant cities, where they could find work, although often below their qualifications. And often they emigrated to other countries.

In the 21st century, it has become a "fashionable" and effective way of interventionism to use the institution of judicial security to block economic, social and environmental initiatives. This institution can play a positive role in creating conditions for sustainable development. More often, however, we observe situations in which the justice system in a democratic state under the rule of law, which has the exclusive right to apply the institution of judicial safeguards, has the characteristics of a denationalised business cartel of legal corporations and is used by interest groups to achieve their own political or economically conflicting goals.

The economic gravitational force of urbanised and industrialised centres in the conditions of *infrastructural development* is increased by technological progress, especially in such fields as transport, telecommunications, the mass media and computerisation of production processes, management and public administration. It is reasonable to hypothesise that in recent decades technological progress in these very fields has accelerated the *polarisation* of economic development of localities and regions.

The effect of the influence of the economic gravity fields of cities and urbanised areas in the region, in the economy of the whole country, as well as internationally, is the *peripheralisation* of areas outside the centres of gravity. As a result of the economic gravity fields, a social and economic polarisation of the settlement network takes place. The polarisation manifests itself in the fact that smaller settlements take on the characteristics of *peripheries* in relation to larger urban centres. The influence of centres of economic gravity transforms towns, settlement units and local labour markets located outside them into *peripheries* in the economic, social and political sense. *Peripheralisation* means that localities lose their ability to function independently as political, administrative, social or economic units. Peripheral localities and

areas become dependent on other localities where institutional, administrative, social, managerial capital for the whole region or country is concentrated.

In the case of small or relatively less developed national economies, peripheralisation may affect entire economies. They become peripheries of other, usually neighbouring, national economies. Economically and technologically stronger countries use profound institutional interventionism to shape the fields of economic gravity on an international scale in such a way that the neighbouring countries become peripheries providing cheaply the missing resources, such as valuable labour, raw materials, natural resources, or scarce services. In the European Union, such a policy of shaping fields of economic gravity by means of institutional influence on the development of infrastructure within the EU has been consistently pursued by Germany, to the benefit of its economy. EU member states that do not want to accept the status of periphery of the German economy are confronted with the actions of European institutions (the European Parliament, the European Commission, the Court of Justice of the European Union and others), which make it difficult for these countries to shape the fields of economic gravity in accordance with social and economic interests, by means of infrastructural development. Examples of such actions are the many years of blocking of the equalisation of direct payments to farmers of Central European countries, regulations on the so-called "posted workers" in the EU or the delay and limitation of spending on international infrastructure investments in Central European countries (*Tri-City - Via Baltica and Via Carpathia,* international energy infrastructure).

The processes of *peripheralisation* of regions and smaller countries cannot be stopped or their effects mitigated without an appropriate active regional development policy pursued by the states. What is important in this

policy is the creation, maintenance and continuous development of institutional and social capital of appropriate quality and scale as well as the construction and maintenance of infrastructural networks, facilities and economic processes of supra-local importance, also on an international scale, in places outside the centres of economic gravity (transport, energy, telecommunications, safety of natural resources, environmental investments).

Particularly in border regions and in countries with a small area, these networks, infrastructural facilities and processes and the institutions associated with them should be strong enough so that the economic gravity fields they generate can counterbalance the impact of the economic gravity fields generated by foreign political and economic centres. The point is that the economy of a country or cross-border area should not become a peripheral appendage to foreign urban agglomerations and foreign political and social centres.

The countries whose social and economic policies are oriented towards the *peripheralisation* of the economies and societies of neighbouring countries have promoted the economic doctrine of the so-called liberalism, according to which the free market and private ownership of industrial capital are the optimal regulators of resource transfer processes. This doctrine is applied eagerly by European Commission officials representing the interests of the countries that seek to take up the position of decision-making centres in the European Union, degrading the other countries to the role of their political, economic and social periphery. Today, after years of painful experience in the countries of Central Europe, the acceptance by economists of the doctrine of the market as the optimum regulator of economic development, and in particular of balanced regional development, is a methodological error, and by politicians a harmful naivety.

The policy of sustainable regional development under conditions of increasingly strong influence of *economic gravity* should be based not on the doctrine of free market as a regulator of development, representing political interests of some countries, but on a good theory explaining the mechanisms of regional development under conditions of deep institutional interventionism and knowledge-based open market economy and modern technologies. For this we need a system of scientific concepts that will create a theoretical - but not doctrinal - basis for identifying and mapping the processes of influence of economic gravity centres on the geographical, economic and social environment of gravity centres under conditions of infrastructuralisation of development and deep institutional interventionism, explaining the cause-effect relations between infrastructural and institutional factors and resource use and development, and the causes and effects of polarisation of regional development. It requires defining, redefining or completing definitions of such concepts as *socio-economic gravity* (economic gravity), *economic gravity field*, *institutional, human, social, economic capital*, *capital potential differences*, socio-economic *asymmetry, economic black hole*.

Economic gravity in the modern economy is of strategic importance for spatial economy and regional development. The effects of its influence on the centres of gravity and on the surrounding areas are multifaceted and long-lasting and concern all areas of social, economic, political and environmental life. Therefore, *economic gravity* should be taken into account in the analyses of all regional development processes, especially social, economic and ecological polarisation processes, in explaining the causes of these processes, forecasting their course, identifying medium and long-term effects, especially permanent consequences of the spatial transfer of renewable and non-renewable resources and their exploitation.

Attention should be paid to all possible social, economic and environmental effects that the development of economic gravity centres at the expense of the resources of the region regional polarisation causes for the optimal, sustainable use of the resources of the entire region and country. By analysing and forecasting these effects it is possible to formulate scientific methodological foundations for the regional development policy and practical conclusions for actions that should be taken to ensure sustainable optimum development of these areas when developing various types of infrastructure on a national, regional or local scale.

Empirical basis for modelling economic gravity

Economic gravity consists in the fact that political, social and economic potential concentrated in urban centres, in urbanised areas or in industrialised areas, greater than the potential of the areas surrounding these centres, creates relatively better, objectively or subjectively, conditions for the development of mobile potential and mobile resources located in localities outside the centres. The differences in conditions between the centres of economic gravity and the localities located outside them result in two-way processes of resource transfer:

a) the movement in geographical space of mobile resources (especially institutional, human, social and mobile technological capital) from non-central locations, mainly larger cities, to centres of economic gravity,

(b) the integration of immobile or difficult-to-mobile resources located outside centres of economic gravity into the social and economic processes and systems controlled from those centres, without these resources being physically moved in geographical space.

For example: the development of shopping centres on the outskirts of large cities creates a local labour market for people living in villages and towns located even quite far from these shopping centres, but well connected to them (vide the Janki shopping centre near Warsaw). Another example: construction of a lagoon or artificial lake and recreational centres providing recreational facilities for residents of nearby agglomerations (vide Zegrzyński Reservoir providing recreational facilities for residents of Warsaw and jobs for residents of surrounding villages).

In such situations the localities located around the agglomeration become *peripheries* dependent on that agglomeration. *Peripheralisation* may affect not only small localities located in the economic gravity field of a city or an urban agglomeration, but entire regions or even countries.

For example, economic integration within the European Union has turned the Mediterranean islands of Greece, Spain and countries such as Cyprus and Malta into the *periphery* of the industrialised countries of the EU, their geographically distant but economically connected recreational and tourist hinterland. Peripheral status has given these Mediterranean regions and islands an impetus for economic development, but at the same time made their development dependent on the current economic conjuncture and political situation in the countries that are centres of economic gravity. Even small disturbances in these countries can cause serious economic and social perturbations.

Every development-oriented social, economic or political entity strives to increase those of its resources which constitute the economic, social and political potential at its disposal, giving it a competitive advantage over other entities or stabilising its position on the political scene, in the market or

in various fields of social life. The process of increasing the potentials necessary for stabilisation and social and economic development is carried out by investing the qualitative and quantitative development of its own resources or by acquiring resources from outside. The social and economic entities choose a development strategy based on increasing their own resources or on acquiring resources from outside following economic criteria.

Independent, safe and sustainable development of countries, regions, localities, enterprises, social or political organisations is possible if they have resources exceeding a certain critical level. Only after exceeding this level is stable functioning and further development possible. Maintaining one's own resources above the critical level necessary for stability and development is one of the basic functions of any political, social and economic entity. This can be achieved by developing resources in-house or by acquiring them from outside, from other actors, regions or countries.

For example, a company can build on its human resource potential by investing in the training of its employees or by hiring school and university graduates to train them in what is needed in a particular field and location within the company. But it can also increase its human resources by attracting trained and experienced workers from other companies and localities by promising them more attractive working conditions.

For example, a higher education institution may create its scientific-research and teaching potential by creating opportunities for its own employees' scientific development and professional advancement. A university may create this potential by not investing in the scientific development of young employees, but by acquiring lecturers with scientific achievements from other universities, offering them better financial conditions or additional employment under civil law contracts. These universities give up on developing

scientific research, limiting themselves to offering paid teaching services. So they do not create new human capital, but use the capital developed by other research and teaching centres.

For example, in a parliamentary democracy, a political party can increase its political potential - the number of supporters of that party ready to vote for it in subsequent elections, i.e. the *electorate* - by developing economic and social programmes that are attractive to that electorate and by building trust in society based on the fulfilment of promises made in election campaigns.

A political party can also build political potential through negative propaganda disseminated in the mass media. This method of building political potential in the conditions of modern information and communication technologies is cheap and effective, provided it dominates in the mass media with a wide reach. Such a party seeks to gain an advantage over competing political groupings by reducing the number of potential supporters of other parties. A party using negative political marketing increases its political potential through aggressive propaganda depreciating its competitors, using methods of psychological warfare such as information provocation, lies, slander euphemistically called "fake-news", or reaching for the "brotherly help" of hostile to a given country foreign centres of power and foreign mass media. In the conditions of modern information and communication technologies such methods of depriving political competitors of their supporters turn out to be effective and cheap.

Another way for political parties in systems defined as democratic legal states to increase their resources is to attract individuals who have gained popularity in various fields through frequent appearances in the mass media,

especially on television and tabloids (sports, mass entertainment, film, political activities in other parties, television and online journalism), by appearing in the public space through scandalous behaviour or by participating in events publicised by the mass media.

Effective methods of negative political marketing are *information provocations*, i.e. dissemination of information about events that never happened, edited in the form of images and sound with the help of information technologies. In the conditions of modern information and communication technologies, it is easy and cheap to control the behaviour of large numbers of people using *information provocations*.

The above examples illustrate the possibility of generating and directing the forces of social and economic gravity through information disseminated by means of contemporary ICTs. A city, a region, a company or a political party can generate social or economic gravity favourable to itself by "investing in image" through the mass media. In the same way, the gravity fields of other actors, cities, regions or social or political organisations can be influenced.

An industrial agglomeration or a central regional city can develop its human and economic potential by creating favourable living conditions for its residents and favourable conditions for the development of companies that have been operating in the city for many years. But it can also increase its human and social potential by attracting educated, skilled and talented people even from distant cities and towns. Thanks to the disparities in living conditions and social and economic activities between urban centres that fulfil the role of regional centres and those considered to be peripheral in the region, the transfer of mobile resources from the periphery to the centres involves almost no costs.

Administrative and economic decisions taken by authorities and entrepreneurs should take into account the effects on resource creation and economic gravity. Agglomeration authorities may also create preferential conditions for the so-called 'foreign investors', more favourable than for enterprises operating for years in the local market. They hope - illusively - that these 'investors' will increase the potential and resources of the region or industry. Such a policy of preferences for "foreign investors" was pursued on a large scale in the early 1990s in Warsaw and several other cities. At that time, under the guise of "privatisation", Warsaw thermal power plants were sold off for next to nothing to foreign state-owned entities, and in a number of Polish cities, in exchange for never fulfilled promises of alleged modernisation investments and mythical know-how, enterprises managing municipal infrastructure of agglomerations (water, sewage, heating, waste management) were handed over to foreign public entities or other foreign enterprises. Unfortunately, the transfer of ownership of infrastructure networks to "private foreign investors" (e.g. state or municipal German, French or Swedish companies) did not resulted in the transfer of resources from the investor's country to Poland. Instead of modernisation and development, these cities witnessed the degradation of municipal infrastructure, including ecological disasters. The expected effect of economic gravity did not materialise. On the contrary, the priority of the "investors" was, and still is, the transfer of (financial) resources from the region to the foreign headquarters of these "investors".

A factor favouring the transfer of resources under the influence of real economic gravity is the disproportion in opportunities for effective use of human capital of high value in small localities. For example, after graduation from university in a large urban centre, a person with higher specialist education coming from a village or small town is unlikely to find an attractive job in his/her hometown, compatible with his/her education and intellectual

potential. On the contrary, the high qualifications of such a specialist may become an obstacle in obtaining employment in a small town. Even if there is a demand for people with such a profile and level of education in the locality, such specialists will rather be treated as competition for other people with a similar professional profile already functioning in the locality. Discouraged by the lack of professional opportunities, they will probably find a job in a nearby agglomeration, although their "added value" as human capital in the labour market of this agglomeration will be much lower than it would be in a smaller town.

On the other hand, large agglomerations absorb human capital from outside quite differently than small towns. The larger the city, the greater the demand for educated persons from enterprises and public institutions already existing there. Admittedly, some professional groups organised in corporations block access of new employees, e.g. legal professions, some technical professions, some medical specialisations. However, also in these situations, a lawyer may find employment outside the strictly legal professions, in public administration or in enterprises, while in his home town he will not find any job in his profession and at a level corresponding to his level of education and experience.

For example, a vocational university in a small town fulfilling a useful function of educating young people creates human capital - graduates of this local university. Unfortunately these graduates are sometimes forced to look for further development opportunities outside the region. Human capital and social capital - educated people with social competences and leadership qualities and human teams - created in these local universities are not so much "sucked out" by larger urban centres, including universities offering further studies at master's and doctoral level, but "pushed out" from smaller towns by the local labour market outside the region. Graduates of these studies are

absorbed by the labour market of large cities. The same applies to graduates of universities in agglomerations, coming from small towns and rural areas, where they obtained their master's or doctoral degrees as students. They rarely return to their hometowns as they do not find there any opportunities for professional development and for work using their knowledge, qualifications and personal predispositions. They migrate to closer or further agglomerations, even though their value as human and social capital for their home town or county would be much higher than in a large agglomeration.

The policy of mobile resources management implemented in practice by local authorities and self-governments in localities with low economic and social potential, and thus all the more valuable, is rarely oriented towards maintaining and developing their own resources. The self-government administration of municipalities and districts pays too little attention to the fact that their young inhabitants obtaining education and professional experience in other cities are motivated to return and serve their human capital to the local community. Often, on the contrary, the local "establishment" is reluctant to accept university graduates and experienced specialists representing high intellectual potential and professional status, who intend to return to their localities, especially newcomers from outside. It treats them more as competitors than as enrichment of the human and social capital of a small locality. This attitude applies especially to professions organised in corporations. On the other hand, larger cities, including university centres, and large enterprises, are willing to employ outstanding graduates from outside these cities, people with foreign experience and proven professional achievements in other regions or countries.

The above examples show that, with regard to mobile resources, economic gravity is strengthened, on the one hand, by the *attraction* of these resources from smaller centres (localities, enterprises, social environments)

to larger ones, and, on the other hand, by the *pushing out* of mobile resources by smaller environments to the centres of economic gravity. These two-way processes of *attracting* and *pushing* mobile resources accelerate the polarisation of localities, enterprises and industries.

3.2. Asymmetry of potentials - a stimulator of resource transfer in economic gravity fields

The asymmetry between potential opportunities for the development of people, enterprises, and institutions in large agglomerations and in small settlement units is the main force generating the attraction of mobile resources by larger urban centres.

The greater the *asymmetry of potential opportunities for the development* and use of mobile resources between localities of different sizes, the stronger the *economic gravity,* mainly of large cities and industrialised centres, the greater the spatial range of economic gravity fields, the greater the subjective range (human, managerial, organisational capital) and object range (natural resources, industrial capital) of resources that are transferred from localities with weak economic gravity or exploited by centres forming strong *economic gravity* fields.

The processes of transfer, accumulation and concentration of the use of mobile resources or useful non-mobile resources in a small number of urban centres of the region under the influence of the forces of economic gravity generated by urbanised or industrialised areas proceed in different ways and have different scope for different types of resources. The most important from the point of view of the polarisation of regional development are the transfer processes of the following resources:

A) Human capital.

B) Social capital.

C) Institutional capital.

D) Cultural resources.

E) Industrial resources.

F) Ecological resources.

A) Human capital

Human capital is the most mobile type of resource. In the information society and knowledge-based economy, along with the technical progress in the fields of transport and communication, the transfer of human capital under the influence of economic gravity over ever greater distances is becoming a common phenomenon. For enterprises and institutions benefiting from the effects of acquired *human capital,* the cost of this transfer is low, negligible. Besides, the transfer costs are often borne by the people themselves who constitute and create that *human capital*.

Four factors influence the spatial movement of human capital:

(1) *Complementarity of human capital* in different places of the settlement network of the region, the country and internationally. Human capital that is not useful or not fully used in small towns turns out to be complementary to human capital in centres of economic gravity. People whose knowledge, qualifications and experience are not available for use and development in small centres can prove to be a valuable complement to human capital in larger administrative, social and economic centres. In other words, human capital redundant in one

economic or social environment turns out to be complementary to human capital in another environment, generally in large agglomerations where there are already human capital resources and resources of other capitals e.g. social, institutional, cultural, industrial or ecological, which generate demand for human capital.

The *complementarity of human capital* generates economic gravity the stronger the asymmetry between opportunities for professional and intellectual development of people between smaller centres and metropolitan localities. This is most often the case of the asymmetry between the opportunities for the use and development of people representing human capital (intellectual, qualifications, skills, leadership qualities) in a village or town and the opportunities offered on the labour market of the nearby large urban agglomeration.

For example, if a graduate of a local university teaching economics, management or law and administration, also at MBA level, can count on employment opportunities in his hometown - and this at the level of connections - at most as a trainee assistant to the chief accountant in the local authority, without any chances for further professional development and promotion in the structures of the authority, until the "boss" retires, he will make every effort to take any job in a larger urban agglomeration, hoping to find better opportunities for professional development and economic position in the near future. And if he graduates from a university in a large agglomeration, he will resign from returning to his native village or town and will seek, already during his studies, the opportunity to realise his ambitions and needs on the labour market of that agglomeration. In a small

town, a law graduate, even from a renowned university, without family connections to the local "palestra" has no chance of working in his profession. Already during his studies he knows that he should quickly leave for a nearby regional metropolis or even further. The so-called "closed systems" in small local communities strengthen the impact of the economic gravity of larger cities on those places, they even force the transfer of human capital and the related institutional capital from small towns to large cities and metropolises.

The complementarity and substitution of mobile human capital between different centres generates, besides the *attraction* of human capital by centres of gravity, and the *pushing out* of human capital that is not in demand in smaller centres, the phenomenon of *repulsion* of human capital that could enrich the resources of the local social, economic or institutional environment.

(2) *Information* on the need for a specific type of human capital disseminated in the economic gravity fields of regional and national centres. The spread of *internet* access has increased the social reach of economic gravity fields and the strength of their impact on human capital. The extent of information about potential human capital demand in specific places and areas has also increased with the introduction in the public sector, and in some other sectors, of compulsory public advertising of recruitment for specific positions. This practice is also followed by many companies.

Local governments and economic entities operating in small towns with a weak economic gravity field should take into account the "sucking out" of valuable human capital even by geographically distant centres.

Counteracting the loss of human capital requires an active policy, first of all providing conditions for professional and intellectual development for one's own inhabitants and acquiring valuable capital from outside without fear that it will compete with the local community. An active policy in the field of human capital development is conditioned by the state and development of local social capital, especially institutional capital, which is discussed below under (B)-social capital and (C)-institutional capital.

(3) The *costs of the movement of human capital* from small towns to centres of economic gravity and its absorption in agglomerations and vice versa, from large urban centres to small towns. These are:

(a) communication costs between peripheral localities and regional or national metropolises in the phase prior to the decision to move to a metropolis or other centres generating demand for human capital,

(b) the costs of moving to the metropolis and staying there (mainly housing) or commuting to work,

(c) costs of adaptation to functioning in the social, economic and institutional environment of the metropolis or other centres.

In Poland, these costs are not borne by centres of economic gravity. These costs are almost entirely borne by potential employees who decide to change their place of work and residence. Employers are involved in the transfer of human capital only in exceptional cases and participate in the transfer costs to a small extent. This is sometimes the case with employer subsidies for commuting to work or organising transport for employees and the so-called "business transfers" of

people in certain positions. Unfortunately, this does not always have a positive effect on the human capital of localities[5].

The costs of communication and transfer of human capital in open labour market conditions depend on information and communication infrastructure. The construction of a express road or motorway connecting small towns with the metropolis may not so much influence the economic and social development of small towns, but on the contrary - accelerate the sucking out of human capital from them to the metropolis or include the towns into the labour market and commuting to the metropolis, turning it into the metropolis' "bedroom" and a reservoir of cheaper labour force.

For example, after the completion of the section of the expressway from Radom to Warsaw there was a decrease in the number of unemployed people and the unemployment rate in the Radom region. However, there was no increase in the number of jobs in Radom. Thanks to the shortened access from Radom to the southern periphery of Warsaw (the suburban shopping centre in Janki and its logistic facilities), many Radom residents found a job in this part of the Warsaw agglomeration. The time and cost of daily commuting from Radom to Warsaw by the expressway is smaller than the commuting of inhabitants from the central districts of Warsaw, especially those located on the right side of the Vistula River. The express road increased the economic gravity field of Warsaw agglomeration in the southern direction and strengthened its influence in the direction of Radom.

[5] For example, it is difficult to see the strengthening of human capital in the judiciary in Białystok by the transfer of a 'judge on call' from Gdańsk, or the judiciary in Rzeszów by the transfer there from the District Court in Warsaw of a judge accused of bribery.

The increase in the area and strength of the economic gravity of regional and local centres is influenced by the reduction of commuting times and transport costs. It increases the fields of economic gravity by affecting the transfer of human capital leading to the peripheralisation of areas outside the centres of gravity.

The phenomenon of peripherisation as a result of relocation of human capital under the influence of economic gravity is of significant importance for the strategy of sustainable regional development. The condition for sustainable development of the whole country and regions is the development of transport infrastructure in such a way that it does not drain human capital from metropolitan areas, deepen development disproportions and cause permanent *peripheralisation* of localities located outside centres, but within the influence of economic gravity fields. These fields of gravity are expanding due to infrastructural investments, which were usually intended by decision makers to favour the development of these localities.

As mentioned above, a problem deserving investigation is the simulation and projection of the impact of major infrastructure investments on the economic gravity fields around these investments. Such investments include *Via Baltica* and *Via Carpathia* and the respective railway lines. In Poland these investments are gradually changing the economic gravity fields from Suwałki to the Slovak border. The changes affect the economic gravity fields of regional metropolises such as Bialystok, Lublin, Rzeszów, the medium sized cities along the route and the flow of human capital between the towns located in the area of these fields. These investments may also affect the cross-border economic gravity fields in the areas around Grodno and Brest.

The study of changes in economic gravity fields is worth adopting as a requirement for the analysis of the effects of infrastructure investments on regional development. It would be interesting to study the impact of the Warsaw-Bialystok expressway put into operation in 2018 on the mutual interaction of the economic gravity fields of these agglomerations. And also the impact of the economic gravity of the Berlin agglomeration on the border areas of Lubuskie Voivodship, the impact of the gravity generated by the A4 motorway on the sections Wrocław, Opole, Śląsk, Kraków, Rzeszów, Przemyśl and other network investments that are being implemented or planned. For the development strategy of the Elbląg region it would be useful to forecast economic gravity caused by the diversion of the Vistula Spit and opening of the port of Elbląg for trade and tourism. Knowledge of the impact of infrastructure investments on changes in economic gravity is essential to determine which investments should accompany infrastructure projects in order to ensure balanced development of regions and optimal use of human capital.

(4) The *capacity of agglomerations to create and absorb human capital*. This capacity depends on the size and structure of the agglomeration's economy and its demographic potential. In practice, even large agglomerations are not able to generate the human capital necessary for the institutions and enterprises operating in that agglomeration. Conversely, in certain areas there may be a kind of 'overproduction' of a particular type of human capital.

For example, there may be a shortage of in-house qualified staff at universities, in public administration bodies or in the mass media in regional metropolitan areas. These regional metropolises often do not invest in human resources development on their own. On the other

hand, there may be an excess of certain types of human capital in other metropolitan centres which have the potential to educate specialised human resources at the right level and on such a scale that the local labour market is not able to absorb them. In such situations there may occur processes of interference between the economic gravity fields of two or more agglomerations generating multidirectional transfer of human capital between them. For example, academics and professionals educated in a large agglomeration take up jobs in universities and enterprises in smaller towns. Thus there is a diffusion of economic gravity fields of large agglomerations and small towns. This results in a two-way flow of human capital from small towns to agglomerations and vice versa, from agglomerations to smaller towns.

The diffusion of economic gravity fields is another important research problem and aspect that should be taken into account by policy makers talking about a sustainable regional development strategy.

B) Social capital

Social capital is the ability of people to work together in groups and organisations to achieve their own goals or interests[6]. *Social capital* is formed by human teams organised formally or informally to achieve specific goals. The strength and scope of influence of economic gravity in geographical space and other spaces (e.g. political, economic, cultural) generated by teams of people constituting social capital is determined by the human capital of each member of such teams.

[6] Fukuyama F., *Zaufanie - kapitał społeczny a droga do dobrobytu*, wyd. PWN, Warszawa 1997.

It is only such human capital that can be organised and activated as social capital through integration with other individuals constituting individual human capital.

For individual *human capital* to be activated in the form of *social capital*, at least two conditions must occur:

- first, *a critical mass of human capital*, i.e. a sufficient number of people with specific knowledge, qualifications and motivation to act together, and who are ready to participate jointly in social, political or economic activities, should be achieved,

- second - *institutions* organising people representing appropriate human capital into teams carrying out specific activities. In small towns, this is usually the local parish, school, voluntary fire brigade, circles and associations organising cultural, political or economic cooperation, and in agglomerations, political, economic or social organisations representing institutional capital.

In the information society, the mass media, social networking sites are increasingly important in organising and activating human capital into various forms of social capital. These means create opportunities for even small initiative groups to organise much more numerous social capital. Thanks to the mass media and the internet it is possible to organise social capital easily and cheaply both on a local scale and to create regional, national or global social network structures. The organisation and activation of social capital with the help of ICT is now widely used by political parties and groups, associations activating local social capital oriented towards the realisation of cultural goals, economic cooperation or the development and improvement of security and living conditions in localities.

The mass media can "from non-existence" create a political party (e.g. in Poland 2018 parties: *N.*, *Razem*, formerly *PO*), or a political movement or an association of unknown employers (e.g. *KOD, "Lewiatan"*), which in favourable circumstances, with financial and media support, become significant actors on the local, regional or national political, social or economic scene, mobilising around alleged politicians, social activists large groups of people unaware that they are manipulated by a couple of TV programme directors or editors working on internet portals. The real objectives of these 'parties', 'social movements' and 'business organisations' are determined by the hidden owners, often foreign, of media corporations, Internet portals and television or radio stations.

Such entities artificially created by the mass media, allegedly representing "bottom-up" social needs organising social capital in terms of form, do not differ from entities organising real social capital not around a Polish-language TV station with foreign capital, but around important social, religious, political or economic goals. These entities create chaos in the social information environment and hinder the organisation of social capital serving the public good and the real needs of society at local, regional or national level. In Poland, examples of such actors include the so-called organised groups of 'activists' representing alleged environmental interests, defending 'minorities' against alleged repression, fighting for the 'rule of law' and 'respect for the constitution'.

In the information society, it is important to distinguish between social capital representing the real needs and interests of society and social capital organised by narrow interest groups, which is used by these groups to cheaply achieve their political or economic goals.

Social capital directed towards the achievement of objectives serving the public good of local communities is the basis of a genuine civil society and a democratic state. An important role in the creation of social capital is played by professional circles, especially those that organise themselves in the form of corporations or associations, clubs and associations that integrate people with common scientific, social or political interests. Centres stimulating the creation and activation of social capital in cities are universities, cultural and educational centres, sports clubs, etc.

The bigger the city, the more social capital centres there are. The potential of social capital in big cities is in turn a factor attracting human capital from other, smaller localities, which consequently lose - generally irretrievably - their small human and social capital. Drainage by social capital in centres of economic gravity concerns especially people with unique skills and qualifications. A talented actor in a theatre in a small town, a TV presenter of a local internet television, an announcer of a local radio, a mayor of a small commune or a creative entrepreneur sooner or later supply the social capital of bigger cities or the proverbial "capital" of the region or the country. Small towns deprived of valuable and rare for them human and social capital lose their possibilities not only to develop, but even to maintain the previously achieved social and economic status.

Sustainable regional development requires the creation of centrally coordinated network structures of social capital in the country's settlement units regardless of their size. Good examples of such network solutions are the Friends of Radio Maryja or the Gazeta Polska Clubs, voluntary fire brigades. These entities, initiated and coordinated centrally, organise local social capital around important social and political goals, both local and national, and at the same time they do not generate processes of human and social capital flow from villages and small towns to big cities. Conversely,

people involved in the activities of such network social capital organisations as Friends of Radio Maryja, Gazeta Polska Clubs, youth organisations or OSP become more closely linked with local communities. State institutions can and should foster the development of regional, nationwide, cross-border or international networks of this kind, thanks to which individual human capital at the level of micro and small towns as well as communes and powiats is transformed into social capital.

C) Institutional capital

The factor most strongly affecting the transfer of mobile resources, especially human and social capital, is *institutional capital*. The direction of this transfer is determined by the location of institutions. Most often it is a transfer of these capitals from dispersed localities of the region to metropolitan areas, where the management centres of institutions are located. It can be the other way round - to smaller towns, if regional or central offices or other regional or central institutions are located there.

Management centres of nationwide or regional political parties and associations, business associations, scientific organisations, professional associations and corporations, cultural associations, authorities and administration, and management centres of nationwide and international enterprises, organisations and social associations are usually located in national metropolises or regional centres. These centres need a special kind of human and social capital, people with high specialist qualifications, experience and personality predispositions. Usually there is too little such capital even in large metropolises, or - even if such capital exists there - it remains unidentified in the mass society of the metropolis. An important function of institutional capital

is the identification of existing valuable human and social capital and the creation of organisational and economic conditions for the more effective use of these capitals.

Institutional capital generates a particularly strong field of economic gravity "sucking out" human capital and social capital sometimes from quite distant areas. It is primarily the most mobile capital - educated people with work experience, organisational skills and leadership qualities, or people willing to move in order to "make a career".

Of particular importance in the creation of economic gravity fields is the institutional capital, which is constituted by the organs of state power and administration and organisational units implementing the tasks of the state in the field of security, institutions conducting activities in such fields as education, health care, culture, scientific research.

The location of organisational units of the state apparatus and other entities performing public tasks, universities, research institutes, cultural centres, conference centres, large health care facilities in specific, also small, localities not only creates stable workplaces there, but also generates gravity fields shaping local labour markets. The activities of administrative units and entities carrying out public tasks usually cover a geographical space much larger than a given locality - the area of the commune, county, voivodship or a cross-border area.

State or state-organised institutional capital fosters the creation, maintenance and development of other resources at the local level. Therefore, the economically, or rather bureaucratically, rational liquidation of an organisational unit constituting local institutional capital in a small locality or its relocation to a larger city means that the development opportunities of that

smaller locality in a number of areas are threatened. For example, the liquidation of a higher vocational school in a county town and its relocation to a nearby bigger city, which has become easily accessible thanks to the opening of a express road or a motorway, will mean for the smaller town that it will enter the strong economic gravity field of the bigger agglomeration and "suck out" from it mobile social resources such as graduates and qualified employees living there. Such a smaller city quickly takes on the characteristics of a periphery of a nearby agglomeration.

In states defined as democratic legal states, *institutional capital* created by the so-called *non-governmental organisations (NGOs)* is increasingly important. These are organisations carrying out activities in which state bodies or other institutions are interested, but which for various reasons do not carry out these activities themselves. NGOs carry out their activities as a kind of outsourcing of tasks deemed necessary by state authorities or other organisations carrying out public tasks. Because they are most often financed from the budgets of state institutions or by international organisations, the boards of NGOs are often located in localities where the state bodies that finance them and the national delegations or offices representing these international institutions are based.

The location of organisational units constituting institutional capital in small localities with a low economic potential and natural resources is an effective way of creating conditions for sustainable regional development and weakening the negative impact of the economic gravity of larger cities and metropolises on the resources of smaller localities. Creation and maintenance of institutional capital enabling active shaping of economic gravity fields of particular settlement network units is the basis of the policy of sustainable regional development.

Efforts to balance the fields of economic gravity in the regions by locating units that constitute institutional capital in specific localities are observed in many regions of Poland. For example, in the reform of the administrative division of the country in several voivodships (Lubuskie, Kujawsko-Pomorskie) the offices of voivodes and the offices of voivodship marshals were located in different places (Zielona Góra and Gorzów Wielkopolski, Toruń and Bydgoszcz). As part of the same reform, starosties were given the status of territorial self-governments. Many more powiats were created than would result from an optimal management system at this level. As a result, institutional capital important for local communities and the economy emerged in many localities.

The importance of institutional capital for sustainable regional development is generally well understood and appreciated by people representing local social capital. This may explain the efforts of local social activists to change the status of their village from a village to a city, the efforts to locate some central or regional office in "their" town, or the fervent protests against changing the status of district courts in small towns and transforming them into field branches of district courts located in nearby larger cities. For local communities it is - perhaps intuitively - obvious that the condition for the development of their small town is the status of a "powiat starosty", having an independent university on their territory, the seat of an independent district court or the location of another regional or national office or a representative office of an international organisation.

The location of institutional capital is, in the hands of government, a powerful tool for influencing sustainable regional development by affecting the fields of economic gravity in the regions and nationally. Institutional capital is the most mobile capital. Its location depends solely on the political decision of state authorities or managers of other organisations or enterprises.

At the same time, institutional capital itself creates strong economic gravity field influencing other mobile resources in a wide spatial and domain-branch range.

D) Cultural resources

The cultural resources of countries and their regions are currently concentrated mainly in cities. The creation of cultural resources is related to the activities of cultural, scientific and educational institutions, and these are mainly located in larger urban centres. Although some cultural heritage sites are located outside cities, but again they are administered or managed by institutions located in regional centres.

Direct public participation in culture is much more intensive in cities, especially metropolitan cities, than in small, dispersed towns. In small towns, participation in culture remains via the mass media - television, internet, press. The participation in culture of inhabitants of smaller towns is determined by the owners and publishers of the mass media.

The creation of *cultural resources* is connected with the existence of sufficiently numerous creative environments in a given locality, which constitute the *social capital* of these localities. The creative process is more intensive if it is realised in environments constituting *social capital* with the potential and profile appropriate for a given field of culture and arts. The number of such environments depends on the field of activity, and is different in the case of the opera or philharmonic, in the case of the local chamber of memory or the local ethnographic museum, and in the case of amateur music or folklore ensembles. A writer, poet, composer or painter may seemingly create their works in isolation, but creative inspiration and dissemination of the results of the creative process require activity in an appropriate

culture-creating environment. This environment is co-created by the creators themselves and by cultural institutions. The *cultural capital of* a region or country is - one might say - the result of the concatenation of *creative human capital* and *institutional cultural capital*. This phenomenon is not new. Culture has developed for centuries with the support of patronage occurring in various forms.

The functioning of cultural institutions and the associated creative circles requires stable financing and organisational support to stimulate public participation in culture. At present, mass cultural events are an important form of cultural activity for small localities, whose local governments have managed to make them a distinctive feature of the city, and through the mass media promote the city and the region also in other fields[7].

It should also be noted how valuable a *cultural capital* for many small towns are places of religious worship, monuments of sacral architecture and places of pilgrimage. The value of these monuments should be perceived not only in terms of the economic effects of pilgrimage on the local population, but above all as a permanent, immobile resource of a given locality, around which the whole region can develop in a sustainable way. It is worth drawing on the experience of the Middle Ages, when cultural, social and economic development was concentrated around monasteries, often built in undeveloped areas, outside the seats of rulers and outside trading towns. The medieval monasteries are proof that the concentration of even quantitatively small

[7] A good example of creating conditions and using cyclical events as a form of cultural activity is Mrągowo - a small Masurian town, whose important cultural capital are various festivals organised in the amphitheatre on Lake Czos.

but qualitatively valuable human, social and cultural capital can be a powerful driver of harmonious, balanced regional development[8]. The delimitation and investigation of the impact of social and economic gravity fields generated by pilgrimage centres in modern information societies is becoming an increasingly important research topic of political, economic and social importance.

Culture has the ability to create exceptionally strong fields of economic gravity with relatively little investment in their creation and maintenance. Social capital develops around cultural institutions and creative communities supported by other institutions, in other fields such as scientific research, secondary and higher education, social care and health care. Thanks to the concentration of human capital involved in the creation, maintenance and development of cultural resources in regions saturated with these resources, economic activity develops in many other fields. Supporting these institutions and environments by local administrations is an effective and inexpensive tool for promoting sustainable, balanced regional development.

E) Industrial resources

Industrial resources are technical infrastructure, fixed assets for industrial activity and related human and social capital. These resources are the basis for the creation of the local economic potential and the local labour market only if the market conditions allow their effective productive use of these resources. This potential and the local labour market generate economic

[8] An almost textbook example of cultural development with few human and material resources can be found in medieval Ireland, which, thanks to St Patrick and the monasteries, became a developed, harmoniously developed country. It took many centuries, the Anglican schism and the "industrial revolution" for Northern Ireland to turn into an almost empty country with the local metropolis of Belfast, an artificially maintained Londonderry thanks to the local university and a few tourist resorts on the coast.

gravity fields. Their range and strength of influence depend on the size of the resources and the industry.

In countries which underwent political and economic transformation after 1989, part of the industrial resources in many localities ceased to be used for production purposes. As a result of the absurd so-called "*shock therapy",* the Polish economy suffered great losses in terms of the maintenance of industrial resources and the use of local industrial capital. There was even large-scale physical devastation of the technical infrastructure of industry, devastation of the fixed assets of "privatised" enterprises, and degradation of the existing human capital linked to industry through the so-called "group lay-offs" of skilled workers. Leading to the economically unjustified bankruptcy of many industrial enterprises was particularly acute in small and medium-sized localities, which often had only one industrial plant - the main employer feeding the local commune or city budget. As a result of the bankruptcy of industrial plants, these localities lost their function as local centres of economic gravity, creating the labour market for the population of the surrounding settlement network and the conditions for social and economic development of the subregion. The places of concentration of industrial capital, whose economic gravity field constituted the basis for regional development, ceased to fulfil the role of centres for human, social and partly also institutional capital.

30 years after the *shock therapy* catastrophe, sustainable regional development requires an active state policy aimed at rebuilding local centres of economic gravity at regional level on the basis of reactivated or new industrial capital. The basis of this policy is the reindustrialisation of the economy at the locality level, oriented towards the optimal use of all types of capital and resources of the region. Reindustrialisation should take into account the

creation of such an economic gravity of localities to prevent larger urban centres from "sucking out" the strategic mobile resources of smaller localities. Above all, it is about creating conditions for valuable human and social capital in such a way that people representing this capital are not forced to seek their goals in other centres. It is not enough to rebuild or build industrial plants to replace those destroyed by the *shock therapy*, but to comprehensively create conditions for development in the new conditions of economic gravity in the region.

F) Ecological resources

Ecological resources are mostly immobile resources. Two types of resources should be distinguished in the policy of sustainable regional development using the impact on economic gravity fields at the local level:

(a) ecological production resources,

(b) ecological service resources.

Ecological production resources are natural resources used in the industrial production process (mineral resources, natural resources, investment land, water resources used for production purposes). Ecological service resources are resources that underpin the provision of services such as tourism, recreation, health, education or cultural services.

In practice, there are often conflicts of interest between the exploitation of the same natural resources for production and service purposes. The policy of sustainable regional development should be based on a comprehensive, long-term economic calculation of the profitability of exploiting these resources for different purposes. The idea is that ecological non-renewable or hardly renewable resources should not be permanently devastated by their short-term use for production purposes. The short-term production effect

may, in the long run, turn out to be much smaller than the effect of using these resources for service, tourist, recreational or cultural purposes.

In an information society and a knowledge-based economy, in which different types of natural resources are increasingly important, the use of natural resources for service purposes is usually associated with the generation by regions endowed with those resources of an economic gravity attracting the users of those resources. Regions attractive for tourism generate economic gravity attracting residents of agglomerations (e.g. the Masurian lakes generate strong economic gravity reaching the Warsaw agglomeration and the Tri-City, mountainous regions in the south of the country generate economic gravity affecting the agglomeration of Upper Silesia and Krakow, etc.). The strength of this gravity depends primarily on the income of metropolitan residents and the accessibility of tourist regions in terms of time, cost and travel conditions. An additional factor is the offer (quantity and quality) of tourist services of these regions as well as services in the field of culture, health care.

The regional development strategy should use economic gravity models of these regions. For example, a scientific analysis of the economic gravity fields of Warmia and Mazury could confirm or refute the hypothesis, whether at present it would be more effective to reduce unemployment in the Warmińsko-Mazurskie voivodship than to rebuild industrial plants in that region, but to complete the construction of express roads to Mazury from Tri-City and Warsaw, to help the inhabitants launch a year-round attractive offer of tourist services for middle and lower income families and to implement tourist information systems allowing year-round weekend tourism.

The economic black hole syndrome

As said above, large cities, metropolises and industrialised areas generate strong economic gravity fields "sucking up" the mobile resources of the surrounding regions. With the technological progress and infrastructuralisation of economic development, the gravity fields draining the resources located in the area of these fields become stronger and stronger, and the spatial extent of their impact is ever greater. This drain affects all resources, all types of capital, which can be useful for centres of economic gravity.

The specificity of drainage in the fields of economic gravity of large cities and agglomerations is its robbery character in the sense that resources constituting the development capital of smaller localities and other resources are "sucked out" from the environment by the centres regardless of the value of these resources for the localities and regions from which they are obtained. A resource or capital valuable for a small locality constitutes an insignificant added value for a big city and agglomeration, for enterprises or institutions located in the metropolis. For example, a good, talented budgeting specialist in the local government of a municipality is valuable human capital ensuring proper management of the usually modest public funds of the municipality. The same specialist, attracted by higher pay and a move to a large city to the so-called advisory position, in the local branch of a large bank is of marginal importance to the corporation in which he was employed. Thus, the loss suffered by the municipality or small town as a result of the "sucking out" of this specialist by the gravity field of institutions located in a large city is much, often many times greater than the benefits that, thanks to the employment of this specialist, the economy and administration of that city will gain.

It is often the case that public institutions in metropolitan areas apply a drain on human, social or institutional capital in relation to other public institutions

in small towns in the region, depriving them of unique resources conditioning not only the development, but sometimes the proper functioning of these institutions.

The profound *asymmetry between the region's losses and the metropolis' gains* from draining the region's resources is an important problem not only for research but also for policy. The asymmetry between the losses suffered by small towns as a result of the transfer of valuable mobile resources to the metropolis under the influence of their economic gravity and the benefits gained by the agglomeration and its actors from acquiring these resources points to the need to study the comparative costs and comparative benefits of resource transfers due to economic gravity in the economy.

The deprivation of small towns and cities of valuable mobile resources by centres of economic gravity justifies the description of the impact of large metropolises on their surroundings as an *economic black hole*. The term *economic black hole* can hardly be considered scientific within the framework of economics and statistics. It seems, however, that - referring to common knowledge of astronomy - it reflects well the essence of the impact of metropolises on their surroundings.

Every metropolis, every agglomeration, every large infrastructure investment generates fields of economic gravity around it. All mobile resources of the geographical surroundings which are useful for a metropolis or an infrastructural investment, and which find themselves in the field of its economic gravity, are absorbed by that metropolis. Around the metropolis or the infrastructure investment, in the area of the economic gravity field, an area is created which is deprived of valuable mobile resources which have proven to be useful for the centres of economic gravity. Small towns located in the area

of economic gravity fields, but too far away to become peripheries of agglomerations or industrialised areas, are deprived of qualified and educated human resources in the first place. Inhabitants of these localities, after completing their secondary or higher education in other localities, do not return to them, because "they have nothing to return to". Institutions originally located in smaller towns willingly change their location and move to the metropolis[9].

The fields of economic gravity influence the centres of gravity to cover ever larger geographical spaces. In metropolises enriched with new human, social and institutional capital and relatively mobile industrial capital, economic and social activities develop more and more intensively. Additional space is needed to carry out these activities. The metropolitan city is thus transforming into an agglomeration, and gradually into a mega-agglomeration, absorbing more and more distant neighbouring localities. The size and shape of agglomerations and mega-agglomerations are largely determined by the transport infrastructure delimiting the regional labour markets and industrial zones operating within the agglomeration.

The direction of spatial development of economic gravity fields is influenced by transport infrastructure and the location of useful natural resources around economic gravity centres. For the efficient functioning of agglomerations and mega-agglomerations, an appropriately developed urban and municipal infrastructure is necessary. Maintaining this infrastructure re-

[9] A textbook example of how the Warsaw *black hole* works is the Szydłowiec Construction Stone Works, whose management moved from Szydłowiec to the Warsaw district of Śródmieście in the 1970s, making this Warsaw district the largest producer of building stone in Poland in industrial production statistics.

quires additional human, industrial, energy and environmental resources, additional communication infrastructure. This in turn requires the acquisition of further additional human, economic and technical resources.

Thus an agglomeration and infrastructure investment acts on its surroundings like an astronomical *black hole*. The greater its economic potential is, the more resources it has to acquire for its maintenance and development. Its economic gravitaty field and gravitational force increases, as a result of which towns which are geographically more and more distant are deprived of any valuable resources.

The greater the difference in social and economic potentials between a metropolis and its surroundings, the stronger the economic gravity that sucks up the resources of that environment. The greater the difference in potentials, the spatially larger the fields of economic gravity of the metropolis become.

A metropolis, infrastructure investment and industrialised area can generate several different economic gravity fields, each of which is oriented towards the acquisition of different types of resources from the environment and has a different spatial scope. For example, the field of economic gravity oriented towards the acquisition of human capital from the surroundings has a different scope and shape than the field of economic gravity oriented towards creating recreational facilities for the agglomeration's inhabitants. The economic gravity field will have a specific spatial scope.

Once a metropolis exceeds a certain amount of demographic potential, social capital, institutional capital and urban resources, it becomes *an economic black hole* for its surroundings. Therefore, the study of the processes of obtaining by national and regional metropolises the features of *an*

economic black hole detrimental to the region as a whole is essential for determining the strategy of sustainable regional development and development at the local level of villages and small towns.

Centres of economic gravity, which affect their surroundings like *an economic black hole*, affect the development of the whole region and limit the effectiveness of the policy of sustainable development of the whole territory. For example, it is highly probable that an institution of higher education, a social institution or a production plant located in a smaller town in a strong gravity field of a metropolis with the characteristics of *an economic black hole* will soon be closed down or their activities will be significantly reduced or transferred to the metropolis. And in the case of immobile resources - their use in a small location will be limited by the outflow of mobile resources, especially human, social and institutional capital to the metropolis. In Poland such phenomena can be observed in Podkarpacie after the A-4 motorway between Kraków and Rzeszów and Przemyśl was opened. Similar effects can be expected after the commissioning of the Podkarpackie section of the *Via Carpathia*.

The *economic black hole* syndrome consists of the following processes:

– The metropolis generates such a strong field of economic gravity that the localities which find themselves within its sphere of influence do not have the economic and technical capacity to counteract the transfer of all useful mobile resources, especially intellectual, social and institutional resources. From the point of view of these small localities their most valuable mobile resources are absorbed by entities located in the metropolis.

– The metropolis as *an economic black hole* is constantly expanding its boundaries to form an agglomeration that includes areas with immobile resources useful to the metropolis, for example, areas with immobile industrial capital, natural resources needed for productive or municipal purposes and ecological resources useful as recreational facilities for the metropolitan population, as areas and resources for providing services that can be provided outside the central metropolitan areas.

– The transformation of a metropolis into an agglomeration increases the economic gravity field and the strength of the impact of this field on areas outside it. As a result of the increased influence of the *economic gravity of the black hole,* the towns and areas outside the metropolitan area are transformed into an area deprived of the resources necessary for their independent development. Outside the metropolis or agglomeration, an area is created with significantly reduced economic and social activity, with insufficient potential for independent development. Smaller settlements outside the economic gravity of a metropolis, agglomeration or large infrastructure investment only gain the opportunity for independent development when they are far enough away that their own potential generates a local economic gravity which can "counteract" the weaker economic gravity of the distant metropolis.

– The development of transport and telecommunications infrastructure promotes the expansion of the spatial range of metropolitan economic gravity fields, the increase in the power of mobile resources and the sustainable movement of these resources from increasingly remote

localities to the metropolis. Therefore, the design of transport infrastructure and regional and supra-regional infrastructure investments must take into account the threat to sustainable development posed by some centres of economic gravity acquiring the characteristics of economic *black holes*.

Under conditions of an open free market, there is an increasing threat to balanced regional development as a result of the influence of metropolises, agglomerations and large infrastructure investments like economic black holes. An analysis of the experience of countries where regional development has been left to the so-called *free market* shows that the lack of an active state policy has led to the emergence of multi-million mega-agglomerations with many negative social, economic and environmental phenomena.

In countries where the state abandoned an active regional development policy and relied on the doctrine of the free market as the regulator of the country's spatial development, mega-agglomerations began to emerge, now numbering up to several million inhabitants. These mega-agglomerations have a negative impact on sustainable development of other regions of not only small but also medium-sized countries. Mega-agglomerations become *economic black holes* for the large areas around them. The impact of their gravity fields leads to a polarisation of the development of regions on a national scale and sometimes goes beyond national borders. Even large national economies are affected [10].

[10] A good not only didactic example of such processes is Nigeria. As a result of unchecked economic gravity, the country's capital Lagos transformed within a few decades into a mega-agglomeration of more than 22 million people, with all the negative characteristics of an overcrowded and ecologically endangered agglomeration. As a result of the difficult living conditions in this mega-agglomeration, the Nigerian government decided in 1976 to build a new capital in the centre of the country, where the central government was moved in the early 1990s.

It is reasonable to argue that a condition for sustainable regional development that ensures optimum use of all the country's resources without the need for their economically and socially unjustified relocation is the pursuit by the state of an active central spatial planning policy. This policy should prevent the formation of agglomerations which have the characteristics of *economic black holes*. The pan-state distribution of institutional capital ensuring the "resilience" of smaller settlement units to the negative impact of the agglomeration's economic gravity fields is an effective way to influence the economic gravity fields shaped either by the market or by local governments.

Developing the theoretical and methodological basis for the study of *economic black holes* is an interdisciplinary scientific problem important for the country's sustainable regional development policy.

Concatenation and diffusion of economic gravity fields

A phenomenon which is important for the harmonisation of regional development is the diffusion of economic gravity fields. The idea is that in the case of a relatively short geographical distance between two or more urban centres and industrialised areas, *concatenation* may take place, which is colloquially speaking the overlapping of economic gravity fields. The *concatenation of economic gravity fields* results in flows of mobile resources between multiple urban centres, industrialised areas or infrastructure investments. These are multidirectional flows.

In Poland, in many regions of the country we have situations where urban centres generating economic gravity fields around them are located in such close proximity that these fields overlap. Such situations can be observed in all voivodships. Positive synergy phenomena may occur between

such urban centres, such as the creation of a common labour market, joint infrastructural investments the effects of which serve the entire subregion, institutions serving two or more urban centres and their surroundings (e.g. Toruń - Bydgoszcz, Tricity, Polish-Slovakian tourist region of the Tatra Mountains, Vienna - Bratislava).

The concatenation of economic gravity fields creates conditions for economic and social benefits thanks to economies of scale. As a result of concatenation, i.e. overlapping of economic gravity fields concerning labour markets of two cities with similar demographic potential located in close proximity, one large labour market will emerge, which will include those cities and towns located around roads connecting those cities. This common labour market creates conditions for better use and development of human, social and institutional capital for the entire settlement network covered by the concatenated fields of economic gravity. Examples of such phenomena include areas such as the Tricity, formed as a result of the concatenation of the fields of gravity of Gdańsk, Sopot and Gdynia, which will probably soon be joined by Elbląg due to the express road and faster railways, the agglomeration of Upper Silesia, and the bipolar system of Toruń-Bydgoszcz.

In the case of large differences between the potentials of centres generating overlapping economic gravity fields, mutual "sucking out" of valuable mobile resources is observed, especially in the transfer of social and institutional capital and competition for projects financed from external resources (from the central budget or international development programmes), for example Wrocław - Opole or Wrocław - Legnica, Radom - Warsaw after launching motorways and expressways connecting those cities. Interesting phenomena of concatenation of economic gravity fields will probably be observable around large linear infrastructural investments such as *Via Baltica*, *Via Carpathia*.

The construction of the motorway linking Opole and Wrocław has resulted in the concatenation of the economic gravity fields of Opole and Wrocław. Thanks to a significant shortening of the travel time, it has strengthened the use of Opole's human and social capital by Wrocław (highly qualified residents of Opole take up employment or other activities in Wrocław in the absence of adequate development opportunities in their place of residence).

The impact of the concatenation of economic gravity fields on the development of multi and bipolar regional land-use structures should be analysed from the point of view of three aspects:

– ***Institutional aspect.*** This refers to the political and institutional readiness of local authorities and other institutions located in cities forming, under the influence of the concatenation of their economic gravity fields, a multi or bipolar system, to cooperate with their respective institutions from neighbouring centres, to implement joint infrastructural projects and to exchange complementary mobile resources, e.g. highly qualified human resources, mutual provision of highly specialised services, implementation of joint research projects.

  The concatenation of economic gravity fields in the institutional aspect may lead to the creation of common institutional capital while maintaining the organisational separation of institutions. However, in the absence of the so-called *political will* to cooperate, competition detrimental to all may occur, e.g. efforts to take over voivodship institutions from one city to another, the struggle for priority in access to budgetary funds for investments at the expense of another city. Good cooperation of self-government authorities and institutions of

all centres of concentrated economic gravity is a condition for obtaining the effect of positive synergy in economy and social life for the whole region.

– ***Economic aspect.*** Under the influence of the concatenation of economic gravity fields, enterprises can use the area of these fields as a single market, as a common economic resource, the development of which is in the interest of all entities operating in it. A prerequisite for a positive economic synergy effect, for obtaining a positive effect of scale, is the implementation of joint infrastructural projects stimulating full diffusion of the economic gravity fields. For example, the construction of common transport infrastructure, the creation of common scientific and research facilities, common health care infrastructure, specialised education and the creation of cooperative ties between enterprises.

– ***Social aspect.*** Under the influence of the concatenation of economic gravity fields of different centres of the settlement network there is an intensification of population migrations between these centres. These migrations do not only mean a change of people's place of residence, which means a loss of human capital by centres of emigration and its enrichment by centres of immigration. The negative effect of migration caused by the concatenation of economic gravity fields of urban centres is the disintegration of social capital and the deterioration of the quality of human capital both in centres from which people emigrate and in immigration centres. The Warsaw agglomeration may be an example of such a process. The inflow to the Warsaw agglomeration of graduates of extramural studies at universities, which after 1990 became many good post-secondary schools, resulted in lowering

of qualifications of the staff in some branches in the Warsaw agglomeration, also in managerial positions. As a result of lower-qualified people filling managerial positions, even lower-qualified people are hired and higher-qualified people are discriminated against, which low-qualified decision-makers perceive as competitors who should be eliminated from their environment.

As mentioned above, the departure of a local social or political activist to a larger centre weakens the social capital of a small locality more than it enriches the social capital of a larger city. The qualifications of such a local activist, considered high for a small locality, may turn out to be insufficient to perform the relevant functions in a large agglomeration without him/her gaining experience at the lower levels of his/her professional career. The result of such processes of human capital migration is the lowering of the level of this capital in centres of economic gravity. The Warsaw agglomeration is an example of such processes.

The large scale of human capital migration from smaller towns to larger cities or agglomerations contributes to the disintegration of the social capital of those agglomerations. An example of such processes of social capital disintegration under the influence of migration stimulated by the concatenation of economic gravity fields of various urban centres in Poland is Warsaw and voivodship cities, especially in voivodships where political authorities are located in several cities (e.g. Bydgoszcz - Toruń, Zielona Góra - Gorzów Wielkopolski). Specific processes of changes in social capital under the influence of overlapping economic gravity fields can be observed between Wrocław and Opole.

In the case of complementary mobile economic and social resources, the mutual flow of these resources is beneficial for both regional centres and promotes the development of the entire region. These centres complement each other's social and economic resources. Highly qualified people who do not have adequate development opportunities in their place of residence may find better working and development conditions in another location. For example, an experienced researcher may not have the chance to become the head of a department or research institute at "his/her" university, but may be a valuable reinforcement of the scientific staff of a university in another locality that lacks researchers with the appropriate scientific background, experience and standing.

On the other hand, in the case of substitution resources, a stronger economic gravity field of one of the centres weakens the development opportunities of the centres with weaker fields. Then a competition between human and social capital of different centres of economic gravity appears. This competition affects all mobile resources. The result of such competition is a suboptimal use of such resources by all centres whose gravity fields overlap.

The concatenation of economic gravity fields, positive for the development of urban and industrial centres, eliminating conflicts related to the location of institutional and infrastructural capital, leads in the long term to the *diffusion* of economic gravity fields of these centres. As a result of the diffusion of economic gravity fields, localities generating these fields relatively quickly form regional agglomerations, which in turn may play the role of economic black holes in relation to other areas of the region. In Poland, examples of such advanced diffusion of economic gravity fields of many centres include Upper Silesia and the Tri-City with towns located on the Gulf of Gdansk.

Monitoring the processes of *concatenation* and *diffusion* of economic gravity fields in all provinces is an important research task. The results of this research would be useful for decision-making regarding modification of the territorial division of the country, spatial development policy, construction of nationwide infrastructural systems and location of institutional capital in localities located in the area of concatenated fields of economic gravity.

Domain types of economic gravity fields

The fields of economic gravity of cities, urbanised areas, industrialised areas or infrastructure investments consist of a number of domain fields. Various fields of political, social or economic activity concentrated in urbanised centres, especially in metropolises and agglomerations, create their own fields of economic gravity. Their territorial scope, strength and nature of influence on the surroundings and on other areas of social and economic life depend on the specificity of the processes carried out in a given field. The factors influencing the formation, development and reduction of gravity fields in individual areas are also different.

As examples, let us consider several fields for which different types of economic gravity fields arise:

– ***Labour market***

  The gravity field of the local labour market of a city or agglomeration includes the places of residence of employees whose places of work are located within that city or agglomeration. Most often the gravity field of the labour market covers the area of commuting, whether daily, cyclical, seasonal or incidental.

The gravity field of the labour market model should consist of several detailed models for the gravity fields of the different types of labour market:

(a) the gravity field of the daily commute,

(b) gravity field of cyclical commuting (weekly, commuting on specific days of the week or month),

(c) gravity fields of seasonal labour markets,

(d) gravity fields of periodic or incidental labour markets (e.g. the labour market created by specific investment projects carried out in the agglomeration).

The size and spatial extent of the gravity fields of the different types of labour markets are determined mainly by transport infrastructure, the time and conditions of commuting, the share of commuting costs borne by the worker in his/her labour income, the cost of housing close to the place of work in the case of cyclical and seasonal markets, and the possibility of finding a job on conditions acceptable to the worker in his/her place of residence outside the city or agglomeration.

In the case of daily commuting, the construction of expressways, faster suburban railways, improved commuting comfort and lower commuting costs borne by the employee result in a significant increase in the fields of economic gravity (e.g. after the completion of the expressway from Warsaw towards Krakow, Radom, located about 90 km from the centre of Warsaw, came under the influence of the field of economic gravity of the local Warsaw labour market in

the large shopping centre in Janki near Warsaw). An interesting research topic seems to be the simulation of the impact of the *Via Baltica - Via Carpatia expressway* on the formation of local markets of daily commuting, without changing the place of residence of employees, for the regional agglomerations of Białystok, Lublin or Rzeszów.

In the case of seasonal or periodical work, the gravity fields of labour markets may cover distant areas, even beyond national borders. In mega-agglomerations we observe active influence of gravity fields of seasonal or periodical labour markets on distant areas, phenomena of their space changes in specific directions, increasing or decreasing under the influence of economic factors or political decisions.

– ***Culture***

Culture, both "high" and mass, generates a strong and extensive economic gravity field not always appreciated by politicians and economists. Firstly, it is the cultural monuments, creators and cultural institutions associated with a city that create the image of that city for millions of television viewers, magazine readers and internet users. This image, in turn, influences the decisions of inhabitants of more or less distant locations to migrate from their villages and towns to agglomerations. The cultural capital of a city creates the psychological basis for decisions on domestic and foreign migration.

National and regional metropolises concentrate institutions organising cultural activity. There are television stations, publishing houses, magazine editorial offices, opera houses, theatres, and organisations bringing together people professionally involved in creativity or other activities related to the creation, dissemination of cultural

goods. Most often cultural events[11] are organised in large urban centres.

In conditions of fast and cheap transport, the cultural capital of a city creates vast economic gravity fields. People come to theatres, opera houses, concerts, museums and especially to entertainment events, sometimes from distant places.

The fields of economic gravity are actively influenced by cultural institutions and companies organising cultural events. They actively market cultural events through the mass media to encourage direct participation in cultural events. In addition, television and Internet broadcasts of cultural events strongly influence the scope and intensity of processes occurring in the fields of economic gravity in the field of culture. The study of people's direct participation in cultural events provides knowledge about the fields of economic gravity in the cultural field.

– ***Health care***

Most of the health care facilities of the region are concentrated in the urban centres or directly in their vicinity. These are in particular institutions providing highly specialised services, having modern medical equipment at their disposal and employing specialist medical staff. Concentration of these centres and medical staff in urban agglomerations results in the fact that these services are not developed in localities located outside urban centres. This is determined by economic criteria. In large urban centres it is more efficient to locate

[11] Exceptions are entertainment events and cultural festivals organised in tourist resorts during the high season, when there are enough potential participants in these events.

health care facilities than to create a network of facilities dispersed in the region.

Cities in which medical universities and other schools training medical personnel and highly specialised health care facilities (hospitals, clinics) associated with these universities are located generate strong and spatially extensive fields of economic gravity in health care.

As a result of the accumulation of qualified health care staff in large cities, the functions of health care facilities in small towns are reduced to basic diagnostics and elementary medical services. All more complex medical cases are referred to specialised hospitals and clinics, sometimes far away.

The commercialisation of health care is accelerating the creation of ever stronger fields of economic gravity in fewer and fewer places. There is a rapid process of peripheralisation of health care in smaller localities covered by the field of economic gravity. This, in turn, worsens the accessibility of highly qualified medical services outside regional centres, and in the centres themselves, queues of patients to specialised institutions are formed.

The study of economic gravity fields in the field of health care created by large cities and agglomerations should be used in the creation of health care infrastructure, which is optimal from the point of view of the population to which medical services should be provided. In particular, it is important that the dominant city in the region does not become a health care black hole for the other localities in the region.

– Higher ***education*** and ***research***

The functions of higher education for the state apparatus and the economy are performed by universities and academies conducting scientific research. Researchers from these institutions also educate students. The education of personnel for the economy and administration at the secondary level is provided by specialised higher vocational schools. These educational institutions are usually located in larger urban centres. Almost all research institutes are located in these large cities or agglomerations. As a result, in the largest cities of the regions and in agglomerations scientific and teaching staff are concentrated, which is an important human capital and social capital of the region. This staff is made up of the most talented graduates of universities, who after completing their studies are offered the possibility of a scientific career in these universities, in scientific institutes or in the research facilities of the administration.

The growing potential of scientific and didactic staff and much better job opportunities in the research sectors, as well as greater opportunities for scientific careers (in Poland, obtaining degrees and titles is possible only at some universities, these are located only in large urban centres) and teaching work in higher education attract valuable human capital from the regional environment, and often from distant regions of the country and abroad.

Legal regulations on the functioning and financing of science and higher education (e.g. in Poland the Act of 28 July 2018. *Law on Higher Education and Science*, Journal of Laws 2018 item 1668 which entered into force on 1 October 2018) not only strengthen the economic gravity fields of large urban centres in the field of science

and higher education, but block the development of scientific research and the functioning of elite higher education and research institutions outside them even where such potential opportunities exist.

A simulation of the effects of the regulations contained in the above mentioned law leads to unambiguous conclusions that under its "rule" the universities still existing in smaller towns will be reduced to the status of post-secondary vocational schools so useful in the past. The research centres that were established in Poland after 1990 outside the large urban centres will only have a chance of existence if they are integrated into the structures of the research universities of the nearby large cities. And other universities have a chance to survive rather as large branches of universities located in the urban centres of the region. Thus, they will have a peripheral status in relation to the mother university, being a place of additional teaching work for the employees of this university.

Strengthening of economic gravity in the field of science and higher education by law means successive disappearance of scientific research and high level education in scientific and didactic institutions located in smaller towns. An additional negative effect of this process is depriving smaller towns of valuable human capital, such as scientists and teaching staff of local universities. Unfortunately, during the preparation of the aforementioned Act *on Higher Education and Science,* it was not possible to explain to its main authors that in the world of global information technologies, the geographical location of a scientific centre is losing its significance, and that authentic sci-

entific discoveries may well appear outside regional capitals provided that opportunities for continuous research are created by sufficiently numerous scientific teams[12].

Factors reinforcing the negative economic gravity in the field of science and higher education are:

(a) The *parametric evaluation* of scientific results and individual researchers is not based on the scientific value of the results of the research work, but on a score awarded according to unknown criteria to the scientific journals and publishing houses in which the texts describing the results of the research work are published.

(b) *Internationalisation of research* as a criterion for funding and assessing the quality of research projects. Evaluation of the research potential of a university or institute on the basis of the so-called internationalisation of research projects, i.e. implementation of research by teams whose members are citizens of different countries. In Europe with particular preferences for projects implemented within the framework of European Union research programmes.

[12] These legal regulations in Poland have been in force since 1 October 2018. Therefore, it remains to apply for a grant to study the impact of the *Law on Higher Education and Science* on the formation of economic gravity fields and their impact on regional polarisation in science and higher education and the flow of human and social capital within and between regions by any of the universities operating in a medium-sized city covered by the economic gravity field of a university from a nearby agglomeration. This grant would probably have been rejected by the offices deciding on research funding because of the insufficient scientific and research potential of this university.

(c) *Publication citation index*. This criterion discriminates against research on narrow, but usually important scientific problems, which are dealt with by few scientists in the world. It also forces publication of research results in English, which is not always justified in terms of content, as well as efforts to place (paid) abstracts in world documentation services.

Research institutes and universities which, based on administrative and political decisions, obtain a higher parametric rating through better "scoring" of their publications, preparing research projects on topics welcomed by those deciding on the allocation of funds for research projects, helping their researchers to prepare linguistically good translations of their articles into English and paying for their publication in the highest scoring journals gain a permanent advantage over the rest of the country's universities and research institutes. Their gravity fields influence other institutes and universities of the region. There is also a gradual transfer of human capital to universities and institutes with stable sources of research funding.

Locating research institutes outside large agglomerations and supporting universities in smaller towns in such a way as to ensure that they are "immune" to having their scientific and teaching resources sucked out by the institutes and universities of the agglomeration is an important and effective policy tool for sustainable regional development.

– ***State authorities and administration***

In most countries of the world, the organs of power and administration of states and international organisations are located in large urban centres. This also applies to regional authorities and administrations. These centres are not able to generate from their demographic resources such human and social capital that would be sufficient to fill all the positions in the state apparatus and in representations of international organisations located in agglomerations. Human capital is obtained from other localities, primarily from the surrounding region. The authorities and state administration are a factor in the creation of social capital based on the human capital coming from outside.

An important source of human capital for the apparatus of power and administration concentrated in large cities is the universities located in those cities. In the case of positions that require specific qualifications, especially political availability, staff from other regions and even other countries are used, not always with good results for the region or the country concerned.

State authorities and administrations generate strong economic gravity fields with a wide geographical scope. The strength and extent of the impact of these fields depends on the gaps between the cities' own human capital, which are referred to as regional capitals, and the demand for human resources for the authorities and administrations.

In geographically smaller countries or countries with a small population, the gravity field generated by state bodies located in a single agglomeration is so strong that it leads to the concentration of all mobile resources important for the state and the economy in national

capitals (e.g. in Europe - Luxembourg, Estonia, Latvia, Finland, and to a large extent Austria, Hungary and other small countries). The phenomenon of "*capitalocentrism*" in small countries is observed on all continents.

Shaping the fields of economic gravity by means of locating state bodies in specific towns in the region, outside the main existing settlement centres, is a strong and effective tool of the state's regional policy. With good transport infrastructure and widespread telecommunications, it does not matter whether an office is located 400 metres or 400 kilometres from the Sejm building and the Chancellery of the Prime Minister. For example, Przemyśl or Suwałki might be better places than Warsaw to locate the EU Frontex office, Radzyń Podlaski or Gorzów Wielkopolski for the Supreme Court, and Słupsk or Wałbrzych for the National School of Public Administration. The above examples should be seen as a need to change the prevailing approach to the location of central government and administration bodies in the conditions of modern information and communication technologies.

The scientific analysis of the economic gravity fields generated by the bodies of state power and administration should be the basis for making decisions on the location of various state bodies in specific localities so that the spatial distribution of these bodies promotes balanced regional development and the use of all the country's resources in an optimal way.

– ***Recreation and leisure***

Large urban centres and agglomerations need conditions providing their inhabitants with living comfort adequate to the level of civilisation and economic development of the country. Therefore, in many agglomerations the policy of sustainable development pursued by state authorities and regional self-governments includes setting aside areas within or outside these agglomerations which fulfil recreational and leisure functions for their inhabitants.

The interaction of the gravity field in this domain is bidirectional.

The first direction - the agglomeration, as its population grows, including those "sucked out" of the region as a whole, creates an ever larger agglomeration by incorporating nearby or further areas for recreation and leisure of its residents. This inclusion takes place through the development of transport infrastructure connecting the central regions of the agglomeration with its recreational and leisure facilities. These hinterland areas quickly become economically dependent on the demand for leisure services. In the case of seasonal recreational services, such dependency may negatively affect the utilization of the agglomeration's tourism and recreational resources (e.g. resorts and catering facilities open for 3 months a year, high amplitude of seasonal unemployment in the agglomeration's surroundings, etc.).

The second direction - an increase in the living standards of agglomeration residents generates demand for highly specialised, qualified leisure and recreational services. The accessibility of these services is important. The accessibility criterion is the travel time and its cost. Such services can be offered in regions with a relatively large distance from the agglomeration. The urban agglomeration can create

an economic gravity field in such fields of recreation and leisure reaching towns located at a distance of many kilometres, provided that the time and conditions of travel enable the use of services offered by these towns without the necessity of changing the lifestyle and work of the persons using these services.

In the light of the theory of economic gravity, we can conclude that the greater the demographic potential of an agglomeration, the stronger the gravity field in recreation and leisure of its inhabitants and the greater its geographical scope. For a sufficiently large number of interested city residents, it pays to invest in high-speed rail and roads shortening the access to recreational places and to expand the infrastructure for providing qualified recreational services.

Models of potential economic gravity fields generated by natural resources such as unique tourist and recreational values should help to define conditions of optimal sustainable development of the regions. For example, an increase in the number of tourists visiting Warmia and Mazury and the demand for tourist, leisure and recreational services in that region could be generated by the completion of construction of *genuine* express roads connecting that region of Warmia and Mazury with the agglomerations of Warsaw and Tricity (including the time of departure from the cities). In the model of economic gravity generated by the region of Warmia and Mazury the Kaliningrad Oblast should also be taken into account. The economic gravity field of Warmia and Mazury for tourism and recreation services has a cross-border range and covers the entire Kaliningrad region. The condition of cross-border range of this field is liberalization of border traffic with Kaliningrad region.

Models of existing economic gravity fields and simulation models of the impact of planned infrastructure investments and changes in the standard of living on the recreation and leisure preferences of agglomeration inhabitants on the concatenation of economic gravity fields (e.g. the concatenation of the Warmia and Mazury field with the fields of Warsaw, Tricity and Kaliningrad Oblast) are a useful tool in the policy of sustainable regional development.

The concatenation of economic gravity fields developed for all fields makes up the complex economic gravity field of a city and agglomeration. Models of spatial delimitation and directions of influence of economic gravity fields on people, national economy entities and resource transfers should be developed for all fields of social and economic activity. The regional development policy should be based on shaping these fields in a way that ensures optimal use of all the region's resources without moving them unnecessarily from the social, economic and political point of view.

Decisions on the construction and development of infrastructures shaping economic gravity fields for long years and over a large area should not be taken by politicians and administrations on the basis of intuition or the ad hoc needs of public opinion polls, but on the basis of simulation and forecasting models of economic gravity fields.

3.3. Cross-border economic gravity

Under conditions of an open market economy and the formation of ever larger agglomerations, including mega-agglomerations, the economic gravity fields they create go beyond the political borders of states. The phenomenon of cross-border economic gravity fields is particularly evident in Europe, where the geographical area of many countries is small, and political

borders established after World War II separate areas that in the past constituted a single economic region.

Compared to gravity within one region or one country, an important factor affecting cross-border economic gravity is the asymmetry of institutions and the resulting differences in economic, social and political conditions in cross-border areas. Cross-border economic gravity is of a different nature than gravity within a single country. The direction, scope and strength of economic gravity in cross-border areas are primarily determined by institutional differences. The centres of economic gravity are regions with different institutional conditions for economic and social activities. These often have a stronger impact on the cross-border transfer of resources than the social and economic potential of border towns and agglomerations.

In cross-border areas, the economic gravity fields are shaped differently for various fields under the influence of differences in legal regulations and the application of these regulations in practice. The differences in wages, incomes, taxation, prices, institutional conditions of conducting economic activity in border areas induce stronger processes of economic gravity in various fields than the differences in economic potential between towns located in close proximity on both sides of the border. For example, the labour and retail markets of the relatively small, compared to the Grodno agglomeration, towns along the Polish-Belarusian border show a stronger economic gravitational force, attracting workers and demand from the Belarusian side, than Grodno, which has a relatively higher economic and demographic potential. A similar situation can be observed in the Polish-Ukrainian borderland, where the gravitational force of the large agglomeration of Lviv on the territory of Podkarpackie voivodship is weaker than the cross-border economic gravity of the localities of Podkarpackie Voivodship located near the Polish-Ukrainian border.

The processes of cross-border economic gravity depend on the asymmetry of institutional arrangements within neighbouring countries and on political decisions. The processes and fields of economic gravity in cross-border areas may change rapidly as a result of political or administrative decisions. Therefore, any institutional changes introduced by countries on their territory that are part of the cross-border economy should be monitored and analysed for their effects on the entire cross-border area.

It would be advisable to develop simulation models of cross-border economic gravity fields for all regions where cross-border cooperation is important and political decisions can cause rapid and profound changes in the social and economic situation. Businesses and authorities should have simulation scenarios for action in the event of changes in the direction, strength and scope of cross-border economic gravity fields in various areas under the influence of institutional changes introduced by states.

Such knowledge is even necessary when delimiting the areas of the so-called local border traffic, access of citizens of other countries to the labour market or the impact of infrastructural investments on economic gravity in cross-border areas (e.g. changes in cross-border economic gravity fields due to the *Via Carpatia* route and its branches).

It seems that the economic gravity fields of the larger cities located on Poland's eastern border, on the territory of Belarus (Grodno, Brest) and Ukraine (Lviv), will begin to influence border areas, including the gravity fields of cities such as Białystok, Lublin and Rzeszów, if these borders are opened more fully to economic cooperation with Poland. It is worth initiating research projects whose aim would be to build simulation models of cross-border impact and the effects of the concatenation of the economic gravity fields of Grodno and Białystok, Brest and Lublin or Lviv, Przemyśl and

Rzeszów after the political situation changes and the complete opening of economic borders between Poland, Belarus, Ukraine and the Kaliningrad Oblast. As mentioned above, such a study should cover the impact of the planned *Via Baltica* and *Via Carpatia* transport infrastructure on the range of these fields, the potential effects of their impact and the accompanying investment undertakings that should be taken into account in the regional development plans of Podlasie, Lubelskie and Podkarpackie regions in order to optimise the effects of this infrastructure. It would be important for the development policy of Lubuskie Voivodship to study the cross-border impact of the economic gravity field of the Berlin agglomeration on the areas located at Poland's western border.

Many cases of cross-border economic gravity fields are found throughout Europe. An interesting and important research problem for the *Tricity* regions is the construction of a predictive simulation model of the influence of the economic gravity field of the large agglomeration of St. Petersburg on the gravity fields of Helsinki, Tallinn, Narva and Tartu (Dorpat) when a political situation arises which allows for the opening of the economic border between the Russian Federation and Estonia and Finland. Such a prototype model could be used to simulate similar situations in other regions of the Tricity. For example, it would be interesting to study the formation of a cross-border economic gravity field generated by the mega-agglomeration of Istanbul to the eastern Balkans, the economic gravity in the cross-border area of La Plata with the agglomerations of Buenos Aires and Montevideo, or the economic gravity between the USA and Canada in the Great Lakes region and many other places in the world where cross-border economies are important for regional development.

An interesting research issue of cross-border economic gravity in Europe is the multi-centre cross-border economic gravity fields occurring, for

example, in the Tri-Cities area. Such a cross-border multi-centre economic gravity field exists in the region of Vienna, Bratislava, Sopron and Gyor, in the region of Trieste, Ljubljana, Zagreb and Graz, in the Slovakian-Ukrainian-Hungarian-Romanian region of Zakarpattia.

Cross-border economic gravity is important not only for regional development, but also for macroeconomic development for countries with a small geographical area, of which there are more than half in the world today. There are many such places in Europe where regional development is shaped by cross-border economic gravity fields generated by cities and agglomerations and by their cross-border diffusion. It is worth identifying similar situations in other regions of the world and initiating research on economic gravity as an integral part of the economics of regional development.

Information determinants of the delimitation of economic gravity fields

So far, there has been no systematic research of economic gravity, delimitation and measurement of the impact of economic gravity fields, their influence on social and economic processes at the regional level. The lack of such research is probably the reason that in the programming and planning of regional development the phenomena of economic gravity and their impact on the dynamics and distortions of sustainable regional development, including phenomena such as depopulation, inefficient exploitation of natural resources, polarisation of development are rarely taken into account. Decision-makers responsible for regional development policy and enterprises were not provided with systematic information allowing for a comprehensive assessment of the impact of economic gravity and changes in economic gravity fields on the effectiveness of investments, which in their intention were to

serve sustainable regional development, but in effect contributed to the polarisation of the settlement network, uncontrolled development of some localities and deepening of economic and social collapse of others.

In Poland we can observe a number of situations in which the effects of implementing costly infrastructure investments in certain areas turned out to be a surprise to decision-makers and local communities. For example, it has often happened that the launch of a long-awaited expressway or bypass in a small town has removed transit traffic from the streets of that town, but at the same time a number of small service businesses serving this traffic have been closed down because the local authorities failed to take care in advance to enable entrepreneurs to move to a nearby bypass or motorway or to create other alternative opportunities for local businesses.

The reason that monitoring and simulation of economic gravity phenomena have not yet become a permanent element of regional economic and social policy and are rarely taken into account in decision-making by state authorities and entrepreneurs is the lack of sufficiently detailed official statistical data mapping the processes of resource movement in geographical space under the influence of the concentration of various types of capital and resources in specific places. This concentration and institutional factors cause the formation of economic gravity fields and their changes. Delimitation of economic gravity fields is essential for making any social and economic decisions on infrastructure development and sustainable resource use and development.

However, official statistics are still dominated by the spatial identification of indicators according to the administrative division of the national territory. The administrative division is rarely coherent with the delimitation of economic gravity fields, the delimitation of territorial units corresponding

to the needs of management at local levels and the analysis of economic, social and environmental phenomena such as local labour markets, the regionalisation of specialised health care, the delimitation of areas for education, fire-fighting, pollution emission areas or river basins. Official statistics produce statistics for administrative units that are relatively large in area, at NUTS 2 to NUTS 4 level. Interpretation of indicators for such large areas can be of little use in practice and sometimes confusing for researchers.

For example, comparing the unemployment rate indicator for Mazowieckie Voivodship, which includes regions with the highest and the lowest unemployment in Poland (Szydłowiec and Warsaw) with the unemployment rate for other voivodships has no cognitive value for the policy in the field of employment and active counteracting of unemployment neither at the regional nor at the national level. Statistical indicators for smaller units of administrative division, such as powiats or gminas, are also inadequate for identifying processes of spatial transfer of resources, development of some localities at the expense of others, or peripheralisation of some areas. Indicators of the number of infections and illnesses due to epidemics calculated for a voivodship or a powiat are too large aggregates for making decisions on introducing special measures to protect against the spread of epidemics, since infections and illnesses appear at specific points, which can only be identified at the level of a single plot or a set of several neighbouring plots.

To study economic gravity, statistical indicators based on detailed micro-data on single facts, processes or socio-economic entities, for example, workers, households, trips, economic transactions, are needed. Also, not only spatial but multidimensional identification of these objects, phenomena or processes is necessary, which corresponds to information needs in specific decision-making situations.

Facts, actors, objects, processes related to economic gravity as its causes, factors and effects should be identified as precisely as possible in geographical space and in time:

- in geographical space - with accuracy to XY coordinates or with accuracy to the cadastral parcel or cadastral precinct in the geodetic system; for example, for the delimitation of the local labour market
- in time - with the accuracy appropriate to the dynamics of a given process; for example, for the monitoring of daily commuting - with the accuracy to the hour on each day of the week, for the seasonal labour market - with the accuracy to the week or the decade, and for the monitoring of the tourist season in regions with large amplitude of tourist traffic on the year - with the accuracy to the day or at most to the week.

Monitoring and simulation of economic gravity processes require identification of facts or phenomena at least two points in time. For example, to study the processes of economic gravity, which include commuting, i.e. the transfer of resources in the local labour market, it is necessary to identify

(a) the place of residence of the employee and the place of work with reference to the registered parcel
(b) time spent travelling to and from work to the place of residence.

In order to study the economic gravity generated by cities that are the seat of higher education institutions where students in different localities study, it is necessary to identify

(a) the student's place of residence and the location of the university where the student is studying,
(b) study time for full-time students or the periodicity of attendance at sessions by part-time students.

In order to study the economic gravity generated by a tourist region, detailed information is needed on the place of residence of tourists coming to the region, the exact duration of their stay and the expenses incurred by tourists during their stay.

Such detailed identification is not achievable on the basis of statistics based on surveys and statistical reports. It has become possible only in the last two or three decades thanks to the spread of information and communication technologies and the recording of transactions. Thanks to computerisation of all records and electronic registration of events and transactions related to social and economic processes, huge data sets are being created, which used to be called transactional[13] data, and are currently referred to as *big data.* At present, such data sources, based on which it is possible to identify individual entities, facts and processes and to develop statistical indicators for them, include registration data in IT systems, transaction data concerning mobile phone logins, credit or debit card payments, personalized identification of travel tickets, registration of cars driving on public roads, registration of patients in health care facilities, records of provided medical services and many others.

A technical and economic information basis for monitoring, modelling and simulating economic gravity processes has thus emerged. However, access to these data can be hampered by the need to protect individual data about the subjects and situations to which the data relate. Official statistics should ensure the protection of these data adequate to that of the institutions hosting the data.

[13] See J.Oleński (ed.), Alternatywne źródła pozyskiwania danych statystycznych, Systemy Informatyczne vol. 1 1990, wyd. OBRS, Warsaw 1990.

Monitoring and modelling of economic gravity processes should become an integral part of official statistical research. It is first of all about complementing the spatial and temporal identification in statistical surveys of all statistical domains which describe the state and regional development at the lowest possible level of detail, i.e. geodetic plots and the smallest settlement units or territorial units where economic or social activities are carried out (localities or their separable parts). The statistical monitoring of the movement of mobile resources in time and space and the transformation of these resources related to movement deserve special attention.

Monitoring should also include statistical observation of non-mobile resources useful for the social and economic actors of the region and of the processes of movement of mobile resources between localities with sufficient detail and frequency to build dynamic models of movement of different types of resources between localities and of technological and cooperative linkages.

Here are some conclusions for the delimitation of economic gravity fields resulting from the above methodological considerations:

– The *economic gravity* generated by areas of resource concentration and institutional factors is important for sustainable regional development.

– The *processes of economic gravity* left to the actions of the market, especially the so-called *free market*, lead to the formation of developmental disproportions in the region.

– The concentration of institutional and social capital in the centres of the settlement network and centres of intensive economic activity creates fields of economic gravity that "suck out" the resources of other localities limiting their development opportunities.

– In conditions of significant concentration of resources in one or several centres in the region or in the country under the influence of economic gravity fields, the *economic black hole syndrome* appears, resulting in deep development disparities, *polarisation* of the level of social and economic development and permanent *peripheralisation* of localities located outside the centres of economic gravity.

– Nationwide and regional infrastructure investments affect the economic gravity fields generated by urban centres and industrialised areas, their spatial extent, the strength and directions of resource transfers and the formation of agglomerations and *economic black holes*.

– When deciding on the location of infrastructure investments, their impact on changes in economic gravity fields and their effects on the sustainable development of the region should be taken into account.

– Under the conditions of an open market economy, *cross-border economic gravity* is important for the development of border regions. In the case of spatially small countries and countries where a considerable part of the economic and social potential is located in a small border area, cross-border gravity is of macroeconomic importance (e.g. Finland).

– Modern economies are characterised by profound institutional interventionism. Institutional instruments can influence the fields of economic gravity and their spatial delimitation. The policy of locating institutional capital and state support for organisations creating human and social capital evenly in the settlement network of a region are effective instruments of sustainable regional development.

– The task of institutions managing official information systems and an important research challenge for practitioners for researchers dealing with

the problems of regional development is to monitor the processes of economic gravity, to study its impact on stimulating sustainable development, to explain the processes of development disproportions and to support state bodies at the central, regional and local level with the results of this research.

– *Big data*, or *transactional data*, provides a good information basis for monitoring and modelling economic gravity. It is important to create legal, organisational and technical conditions for the use of *big data* for these purposes.

4. Delimitation of cross-border clusters as functional areas

4.1. Cluster – a stimulator of regional development

A cluster can be considered as a specific subsystem in relation to the national economy or region, within which entities and units belonging to the cluster are linked by mutual institutional, economic or technological relations, thus forming a single system that achieves specific objectives or functions. The concept of the cluster is used in various fields of science and technology. It can be used as a methodological approach useful for identifying and analysing complex, heterogeneous systems operating in many spaces: geographical, social, political, technological, economic, and legal and institutional. In economic sciences, an impulse to study clusters and their use as more efficient structures for organising the economy in economic practice was given by the concept of the industrial cluster defined in general by Michael Porter[14] . The most important practical conclusion arising from M. Porter's theory of industrial clusters is that spatial concentrations of competitive companies operating in different sectors, linked by technological and economic relations, competing and cooperating with each other, using joint infrastructural resources or sharing selected natural, technological or know-how resources, create a dynamic structure that makes it possible to obtain synergies, provided that all cluster participants identify areas in which they compete with each other and areas excluded from competition, in which competing entities cooperate with each other and cooperate on principles. A cluster defined in this way creates an *economic environment* that is beneficial to

[14] See Porter M., *Competitive advantage of nations*, Macmillan Press, London 1990 (p. 9): Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies, trade associations) in a particular field that compete but also cooperate.

all its participants, although the benefits of each may be different. An industrial cluster is a particular type of such a structure that ensures development and benefits for all participants through balanced competition and cooperation of economic entities.

Entities located in a relatively small territory compete with each other in certain areas and in others they undertake cooperation. This may lead to the creation of joint entities working for the benefit of competing companies, for example, the creation of scientific and research institutes, distribution networks, staff training. There is a synergetic effect that arises from the concentration of different economic actors operating in the same industries (competing with each other), or complementary, stimulating cooperation between entities. The industrial cluster makes it possible for economic and social entities, not only large ones, but also medium and small ones, to achieve greater efficiency and expand the market thanks to the so-called external economies of scale (this concept was defined by Alfred Marshall). This important concept defines a situation in which individual entities are given the opportunity to expand their business profile and market through cooperation with other entities, without having to rely solely on their own resources and increase their potential (fixed assets, technological facilities, marketing). Within industrial clusters there is a synergy effect, which consists mainly in training of human resources used in all entities of the cluster, development and use of infrastructure resources, exchange of staff between entities within the cluster, the diffusion of know-how, joint research and creation of development and construction facilities working for the needs of all cluster participants, a common marketing network, strengthening the *economic gravity.*

The impetus to expand the research methodology of development mechanisms became the notion of an industrial cluster. Not only in relation to in-

dustry and the region, but also to other economic as well as social and ecological systems. Types of clusters in the economy are defined from the point of view of main development factors as well as organisational criterion. According to the criterion of the main *development factors* in the methodology of research on industrial clusters in the knowledge-based economy, the following types of clusters[15] are distinguished:

– *Technology clusters* - oriented towards the creation, absorption and implementation of modern technologies and innovations, linked to scientific and research centres, which become the basis for the development of production enterprises within the cluster;

– *Production clusters* (also called traditional clusters) - oriented towards the optimisation of production processes thanks to stable cooperative ties of economic entities, supported by institutional relations; these clusters are based on better use of human and social capital of the region, on experience and knowledge resources developed as a result of historical development of industries in the region; the genesis of the development of these clusters is often associated with the use of natural resources of the region or its geographical location.

According to the *organizational criterion* the following types of clusters[16] are distinguished:

– *Network clusters*. A network cluster is formed by grouping of large, medium and small companies and other social and economic entities, linked

[15] Oleński J., Klastry transgraniczne jako stymulanty rozwoju i współpracy w warunkach otwartej gospodarki rynkowej, in: Miszczuk A. (ed.), Wyzwanie rozwojowe pogranicza polsko-ukraińskiego, Wydawnictwo Norbertinum, Lublin 2017.

[16] A. Marcusen, *Sticky places in slippery space. A typology of industrial districts*, w: Economic Geography, vol. 72 no. 3, ss. 293-313, 1996.

to each other by relatively stable cooperative ties, often shaped as the outsourcing of selected functions or tasks, mainly by large and medium-sized companies, to other entities (e.g. transport, marketing, education, research).

- *Concentric clusters*. The structure of a concentric cluster is based on one or more large companies whose co-operators (subcontractors, suppliers) are small businesses. The decisive factor in a concentric cluster is a leading, dominant monopolistic enterprise club oligopoly of large enterprises. DL is an "oligopolistic" concentric cluster.
- *Satellite clusters* are a special type of concentric clusters. A satellite cluster in a region is dependent on external technological, manufacturing or economic centres. In satellite clusters this external dependence increases the risk of disruption to the region. It seems that the Podkarpackie Aviation Cluster in its main technological segments has the characteristics of a satellite cluster in relation to global centres of aviation industry development.
- *Institutional clusters* are spatially concentrated groupings of entities created at the initiative of public institutions, often financed from public funds and supported by public administration. The initiative of public institutions in the creation and development of clusters of an institutional nature is important primarily for the development of clusters in those industries whose effects are applied in the public sector or serve the development of infrastructural systems whose development is the responsibility of the state (e.g. scientific research, higher education, national defence). Institutional factors play a decisive role in determining the directions of development of high technology clusters, especially in areas that develop thanks to the demand expressed by the public sector. Such an

example in Poland could be the Podkarpackie Aviation Cluster, as the aviation industry is a state-controlled industry due to its importance for the defence of the country, the use of technology and production of dual-use products (civil and defence) and the role of a carrier of technological progress in the national economy, especially in high technology and innovation-oriented industries.

In fact, clusters have characteristics of several of the types of clusters mentioned above. Cluster analysis should use all typological characteristics of clusters to identify features that are important both from the perspective of their development as a cluster itself as a collective of interrelated economic entities, from the perspective of the development of the region in which the cluster operates. Risks and threats to individual entities forming clusters as a whole, and to the region as a socio-economic supersystem in relation to this cluster should also be taken into account. Analysis of conditions and processes of cluster development should take into account aspects resulting from the characteristics of each type. The subject of the analysis will be The Podkarpackie Aviation Cluster (PKL), which, from a typological point of view is a complex cluster.

In the modern economy often referred to as a knowledge-based economy, particularly high efficiency has been demonstrated by technology clusters created as a result of institutional activities (institutional clusters), which after reaching a critical mass of human and social capital and industrial capital, and obtaining the appropriate economic gravity potential, have become centres of regional development in many areas, and sometimes also of industry development on a macroeconomic or even global scale. A textbook example of such a process of stimulating development on the basis of creating technological institutional clusters is Silicon Valley in California and and in Poland, the Aviation Valley in Podkarpacie.

A cluster that brings together companies that are leading in a particular industry in a region, i.e. after reaching a critical mass of human and social capital and economic potential in the region, has the effect of attracting further entities to the region by including them in the cluster. This effect is also referred to as economic gravity. The achievement by a region's industrial cluster of the potential to trigger economic gravity processes is particularly important for the sustainability and dynamics of regional development. Thanks to economic gravity, the region develops not only thanks to its own resources and the activities of its resident entities, but also attracts economic entities from other regions and even other countries.

Industries developed within a given cluster determine its spatial impact of the economic gravity. In the case of industries closely related to the use of the territory and its natural resources (e.g. tourism cluster, mining cluster, forestry cluster, maritime economy cluster), the area of the cluster is determined by the geographical borders of the region with a given specificity.

In the case of industries that are not directly related to the use of the geographical space and natural resources located in it, but to the use of human potential and infrastructure of the territory, the geographical scope of the cluster is shaped in such a way that the leading entities in these industries are located in the geographical space of the cluster defined by permanent infrastructure related to the geographical space (e.g. roads, energy grid, settlement network), but some types of activities closely related to the industry in the cluster may be located outside this space, in other regions of the country or even in other countries.

In the case of knowledge-based, high-tech industries developing on a global scale, such a phenomenon can be considered a regularity. The aviation industry is a good example of such an industry benefiting from the infrastructure of the region, but also closely linked with technology centres sometimes geographically distant. The Podkarpackie Aviation Cluster is on the one hand the leading industrial cluster of the region, and on the other hand it is an integral part of the global aviation industry, whose centres are located in several countries of the world, mainly in the USA.

From the point of view of medium-term regional development policy, especially long-term policy, analysis of the risks associated with the cooperative relationships of entities in a regional cluster with entities outside the cluster, especially with entities belonging to other clusters, especially foreign ones, is of key importance for the formation of the industry structure of the cluster and institutional solutions. The point is that the cluster, as a collective of entities operating and interacting in a relatively small territory, determining the development of the region and its social situation, should be resistant to risks from outside, and it should be possible to manage risks internally, ensuring an appropriate level of safety for all entities belonging to the cluster. For example, risks associated with changes in economic policy of foreign entities that are customers of products manufactured in the regional cluster, or risks associated with limited access to new technologies and products. Geographical distance of some activities important for entities belonging to the Podkarpackie Aviation Cluster under conditions of economic prosperity and political situation is not an obstacle in the development of the local aviation cluster in Podkarpackie. However, it is necessary to remember about these conditions - good economic situation and political situation. In the case of localization of important cluster segments outside the region, especially in

other countries, the risk of disruptions in the functioning of companies belonging to the industrial regional cluster increases significantly[17].

For example, the Podkarpackie Aviation Cluster, which works, among other things, for the defence of Poland, operates in a global industry, where the risks mentioned above may arise, for example, as a result of political decisions of countries deciding on access to certain technologies and specialised equipment produced only by a few foreign manufacturers. The lack of resilience of a regional cluster to risks generated outside it also worsens the competitive and negotiating position of entities with external collaborators and with other domestic collaborators.

An important task of entities that play a leading and coordinating role in the cluster is monitoring of risks of different types. One of them is a SWOT analysis. A SWOT analysis of the functioning and development of the cluster should be updated on a regular basis and be used both by political and administrative authorities in the region, as well as by leading entities in the cluster.

4.2. Facet classification of clusters as a tool for multi-criteria analysis of the region's economy

Under the concept of a *facet classification* we mean a multi-criteria qualification of a system or process according to several different classifications. The analysis, evaluation and projection regarding these systems or processes should take into account the characteristics described by all classifications forming a given facet classification.

[17] An example of such a risk is the fate of a local cluster of the automotive industry, which developed around a small-litre car factory in Tychy. The downturn in the automotive industry at the beginning of the 21st century caused the foreign owner of the leading company - Fiat - to shut down production at the Tychy plant and move it to its home plant in Italy (Turin). This was decided not by economic criteria but solely by political criteria.

In light of the cluster classification criteria presented by A Marcusen (op.cit.) an aviation cluster developing in Podkarpackie Voivodship can be classified within the facet classification as[18]:

1) a technology cluster, oriented towards the use and development of high technologies (e.g. related to the aviation industry),
2) an institutional cluster in which the participation of the administration is essential for the maintenance and development of the leading entities in the cluster,
3) satellite cluster to global technology and research centres in the world.

Due to the technological specificity of high technology industries, which include the aviation industry, the classification concerning the organisational structure and the spatial structure of the aviation cluster is less important for the Podkarpackie Aviation Cluster. The location of entities belonging to the aviation cluster depends primarily on the existing industrial infrastructure, the foundations of which were laid in the interwar period, and the development of which was continued after World War II. The natural and social conditions taken into account when deciding in the interwar period on the location of the aviation industry in Poland in Podkarpacie were not decisive. Geopolitical criteria - the distance from the borders with Germany and the USSR - were of the greatest importance. Currently, geographical criteria in the case of high technology clusters are in principle negligible. On the other hand, social factors have gained in importance, especially region-related human capital and social capital, which can be quickly used for the development

[18] [18] Oleński J., Klastry transgraniczne jako stymulanty rozwoju i współpracy w warunkach otwartej gospodarki rynkowej, in: Miszczuk A. (ed.), Wyzwanie rozwojowe pogranicza polsko-ukraińskiego, Wydawnictwo Norbertinum, Lublin 2017.

of the industry. An essential role in the creation of this capital is played by universities and scientific and research institutes, in which the social capital necessary for the development of high technology industries is formed.

It is important to pay attention to the place, position and economic role of clusters, both in the economy of the region and the country, against the background of the global aviation industry or within the cross-border area.

As an example here is the aviation industry cluster located in Podkarpacie.

In terms of the region's economy, it may be noticed that the aviation industry, as a result of a long-term development process, despite the difficulties resulting from the inconsistent state policy towards this sector, including the recognition of the market (which *in fact* did not exist) as a sufficient regulator of development in the first decade of transition after 1989, is a permanent component of the economy of the Podkarpackie region. The centres of this industry are the industrial centres of the region. This industry influences the development of intellectual potential for scientific research and construction works. However, it should be noted that the production effects of the aviation sector in the region and the PKL cluster as a whole are oriented towards external customers outside the region, both foreign and domestic. In this sense PKL is a kind of technological and production enclave in the Podkarpackie region, which is dependent on external national and foreign factors. Although there is a transfer of technology and personnel from the sector to other industries in the region, it concerns a small range of technologies and products developed in the sector.

PKL as a *technological cluster* representing high technology industry is a carrier of technological progress in the whole national industry. The transfer of technologies developed and applied in the Polish aviation industry, foreign

technologies implemented in the cluster's facilities in Poland and know-how within the scope that can be implemented in other branches of the economy should be treated as one of the functions of the PKL on the scale of the national economy. It is about the transfer of modern technologies from the Podkarpackie Aviation Industry Cluster to other areas of the national economy, including engineering, electrical engineering, transport. From this point of view, the sector represented by PKL is of strategic importance for raising the technological level, modernity and innovativeness of other branches of industry on the national scale. The development of PKL has therefore a significant macroeconomic significance.

PKL is a *satellite cluster* to the leading aviation industry centres in the world. Links of PKL with these centres concern: licences for the production of selected aeronautical products, production technology licences, import of technology, including machinery and equipment, import of know-how and training of professionals, cooperation agreements on orders placed by foreign companies in the aviation industry, exports of products manufactured at DL to foreign counterparties, cooperation in terms of services provided by PKL companies to foreign partners (repairs, servicing, training, certification).

PKL is located in a region, a considerable part of which is under the influence of cross-border processes of the Carpathian Euroregion. The development strategy of PKL should take into account the use of significant difference in comparative costs between entities operating in the territory of individual countries rather than within a single country. In the case of Podkarpacie, these are primarily the cross-border areas of Slovakia and Ukraine. The use of the effect of comparative costs in the cross-border area refers in particular to activities that are auxiliary to the basic technological processes of the cluster. However, due to the risk associated with the participation of foreign entities in the cluster, the criterion of comparative costs in high technology industries

should be applied only in the case of technologies and processes implemented and used, while differences in comparative costs should not be decisive in the processes of strategic importance for national industry entities. In the case of politically important industries, it is easy for conflicts of interest to arise between domestic and foreign entities.

Conditions for the development of a satellite cluster

A major problem for the strategy of development and stability of the satellite cluster in the conditions of globalization is the identification and assessment of the uncertainty and risk resulting from the dependence of part of the processes implemented within the PKL on foreign markets and entities and on political decisions of other countries dominating the aviation industry. The following should be taken into account[19]:

a. *economic risks* arising from changes in the global economic climate in the aviation industry;
b. *economic risks* arising from the development of competing clusters or companies with a similar technological and production profile in other regions or in other countries offering competitive conditions to the PKL and Poland for companies forming world aviation industry centres;
c. *political risks* arising from political preferences of countries with aviation industry centres placing their orders in other countries, including Poland, and thus forming satellite industrial clusters such as the PKL. Products and technologies of the aviation industry have defence and civilian applications. These industries are "politically

[19] Oleński J., Klastry transgraniczne jako stymulanty rozwoju i współpracy w warunkach otwartej gospodarki rynkowej, in: Miszczuk A. (ed.), Wyzwanie rozwojowe pogranicza polsko-ukraińskiego, Wydawnictwo Norbertinum, Lublin 2017.

sensitive", and distribution and trade restrictions are often imposed on their products (e.g. export bans on dual-use products to certain countries). These restrictions may be imposed by international organisations, governments of countries disposing of technologies and the Polish government. Therefore, the cluster's development strategy should take into account the risks of cluster enterprises' functioning generated by political decisions.

d. *political risks* associated with the use of political mechanisms to strengthen the technological and economic position of a country with its own industry to exert political pressure on cooperative decisions. An example of such a risk is the situation related to the supply of helicopters to the Polish army and the preference shown by some decision-makers in Poland for a French manufacturer (Airbus), which has not been present in the country so far. Such a situation is a textbook example of the destruction of an existing cluster in the country by institutional factors, rather than economic or technological ones (public procurement for competition is a textbook example of a hostile takeover of a part of the domestic market with the support of the political institutions of one's own country).
e. *technological risks* connected with ensuring an appropriate technological level of processes and products and compliance with technological and organisational regimes of offered products and services. A condition for the competitiveness of high-tech industries is ensuring the highest quality of products (products and services) and adherence to technological regimes. Failure in this area by one entity belonging to the cluster may have a negative impact on the competitive position of the cluster as a whole. Therefore, quality control

and compliance with technological regimes should be performed on a cluster scale as a whole.

The importance of centres of excellence for the development and effectiveness of cross-border and international high-tech clusters

In areas of significant importance to the industry which is a leading specialisation of a given cluster an essential ingredient of durability and development of clusters is the creation of *centres of excellence*. In accordance with the practice of organising scientific and research cooperation in the European Union, whose important forms are *networks of excellence* and *centres of excellence,* the latter are understood to mean organisationally, programmatically and financially integrated human resources and information resources concentrating complex knowledge resources and scientific and research potential in a particular field of science, implementation or scientific support of practical activities.

Appropriate centres of excellence integrating human capital, scientists, specialists, practitioners organised in the form of social capital (research, implementation and consulting teams working together) should support each cluster.

Such centres are aptly described by its definition as centrally coordinated teams of researchers and developers working together on a single research and implementation programme aimed at solving a strategic problem of particular importance to the economy, industry or region. Teams collaborating within a single *centre of excellence* can be located in different geographical locations. This reduces the costs of concentrating the considerable scientific and research potential performing joint research projects despite the spatial dispersion of the scientists and engineering staff working in these

teams. Modern information and communication technologies enable efficient coordination and unrestricted communication of team members at low collaboration costs.

Centres of excellence - also known as "*laboratories without walls"* - make possible for effective use of research teams and research facilities from different institutions, effective coordination of project work as well as implementation of research results, resulting in increased competitiveness of the entire national economy.

The characteristics of *centres of excellence* is organisational independence (i.e. it is largely independent of its constituent units, while being based at a reputable research institution). As well as the impact of the *centre of excellence's* research programme on the economy or quality of life (resulting from its collaboration with industry and other users of the work), and funding of the centre's core activities from the sources of the institution that oversees national science policy (supplemented by funding from other sources).

In a number of advanced countries in high-tech clusters, *centres of excellence* have become an important policy tool for fostering innovation and competitiveness based on a programme-coordinated and information-integrated science and R&D base.

The task of the *centre of excellence* is primarily to create, enrich and disseminate national scientific, technological and factual knowledge and to cooperate in its implementation in practice, whereby the knowledge produced should be up-to-date, reflecting the global acquis. The knowledge should be multidisciplinary and respond to the needs of the main groups of users of the knowledge itself and of its implementing results; with these users the centre shall maintain regular and close contact. Dissemination of knowledge should be an integral part of cooperation and be clearly stipulated in contracts and

orders for research and implementation work, and funding for this work should be stable and long-term. The organisations forming a *centre of excellence* do not need to be geographically close to each other; ICT networks make it possible for virtual centres to function efficiently, which have a number of advantages but also some disadvantages that must not be overlooked. The advantages of virtual centres include access to a wider circle of partners, collaborators and clients, flexibility of organisational structures and staff composition of research teams and lower fixed costs, The disadvantages of virtual centres include a more difficult to achieve sense of community among the research team, lower synergy effect of direct joint work of researchers and developers, and more difficult organisation and preservation of internal knowledge resources requiring protection from unreliable competition.

Centres of excellence in clusters have a specific cycle: they are created in response to a specific demand from an industrial cluster, they develop and provide services, and then their role in the cluster declines as new technologies develop, displacing those offered by the centre from the market. In each of these stages, the scenarios for creating centres of excellence can vary. In the creation phase: centres of excellence are created "spontaneously" and "bottom-up", at the initiative of universities or research institutes, or "strategically" and "top-down" (i.e. at the initiative of, for example, cluster management or central administrative decisions at regional or national level). In the development phase: scenarios for centres of excellence will vary according to the development of skills, the ability to maintain a significant position and to remain in the "vanguard". In the phasing-out phase: they undergo a slow reduction in the scope of research and deployment or they reduce their activities usually as a result of funding constraints. In the phase of possible renewal, the question arises as to whether to change the field areas of the centre of excellence.

The success of centres of excellence as a form of organisation and coordination of research and development work and the creation and dissemination of knowledge resources therefore consists of factors such as attractive and comprehensive research offer and high scientific quality, participation of industrial partners in research, a clearly defined skills profile, national and international reputation, staff transfer between universities and institutes and industry, usefulness of the results of the work for the economy and the non-commercial public sector.

These factors should be paid attention to in the economic policy of the cluster. Centres of excellence in industrial clusters can be located at the leading industrial plants of the cluster, in the structures of universities or scientific institutes in the region, as independent research and development centres and scientific and technical information centres financed from public funds or from contributions of cluster participants.

For example, PKL, as a high-tech industrial cluster (aviation), has grounds to create a *centre of excellence* in the Podkarpackie region specialising in fields related to the aviation industry.

The analysis of the scientific and production potential of DL, the needs for research and development works and the analysis of the scientific and research potential of universities and scientific institutes in the region are the basis for determining the organisational forms and the subject scope of the centre of excellence for the PKL.

It seems that in the conditions of the Podkarpackie region, universities are predestined to create a multidisciplinary centre of excellence working for the benefit of the PKL cluster on the basis of their scientific potential.

Parainformation platform as a cross-border cluster integrator

An important instrument for the development and integration of clusters are common *parainformation platforms* for the exchange of information between entities participating in the cluster. By parainformation we mean information about resources, processes and information systems. This term, albeit etymologically incorrect, was popularised in the American professional literature on *information science,* and has become a term widely used in scientific and professional literature and in the practice of information activities, computer science and official statistics. In Polish terminology in the field of scientific and technical information, the term *referral information* was used, however, under the influence of the invasion of terms of American origin, the term parainformation is used more and more often, especially after the adoption of this term in official documents of expert teams operating within the framework of programmes of the United Nations Statistical Commission.

The aim of the *parainformation platform* (referral information platform) of the cluster is to provide all participants of the cluster and entities cooperating with them, including research units, universities, administration units and coordinating units, with effective tools for managing cluster knowledge resources and searching for relevant and contingent information in all available resources managed within the cluster and external resources. Such facilitation of access to information and exchange of information makes it possible to dynamise their mutual interaction, wide exchange of information and cooperation with business and non-commercial practice, in accordance with the *Open Innovation* concept. The concept of *Open Innovation* points to clusters as *network consortia* that are in practice the main sites for the creation or implementation of new technologies and products, i.e. innovations.

The *parainformation platform* is a tool supporting organisation of research in the form of network consortia and ensures full communication between scientific, industrial, administrative and scientific information partners at each phase of the research process. This system support is of particular importance in Poland in view of the presence of complementary research potentials between scientific partners in the level of scientific knowledge, organisational culture and management and in the adopted model of supporting scientific research by the state.

The parainformation platform is such a system support - a tool that enables research consortia joint use of complementary knowledge, equipment and organisational resource. The management of knowledge, highly complex R&D and production projects, taking into account the requirements of industry for collaboration with research institutes as well as improving the effectiveness of innovation processes, including R&D and streamlining the processes of obtaining industrial partners (including orders for research work) and scientific partners (research cooperation).

Methodological problems of delimitation of the PKL industrial cluster as a cross-border cluster

Due to the mixed nature of the PKL as an industrial cluster, the delimitation of this cluster should be multidimensional and performed in geographical space, sectoral space and institutional space.

Delimitation in *geographical space* refers to activities whose technological specificity requires the direct cooperation of production processes and the labour market.

The delimitation in the *sectoral space* takes as a basic criterion permanent cooperative ties of entities in the types of activity in which transport is not a barrier limiting cooperation.

Delimitation in the *institutional space* concerns entities linked by legal and administrative regulations, including in particular those financed from public funds. Therefore, attention should be paid to the role that grants funding research and development work integrating scientific institutions, universities, industrial enterprises and administration can play in the creation and maintenance of industrial clusters.

It should be stressed that in the creation, maintenance, consolidation and achievement of high efficiency of clusters as a form of achieving the *effect of external comparative costs,* the institutional factor plays an increasingly important role, especially in areas of strategic importance for the state and the economy. The aviation sector is one such area.

4.3. Effectiveness and risks of cross-border clusters under globalisation conditions

The geopolitical location of the Podkarpackie region creates opportunities to use the phenomenon of external comparative costs on an international scale. The differences in institutional conditions and economic costs of running a business in a cross-border economy create greater opportunities for the optimisation of economic processes than it is possible to achieve within the legal and economic system within one country. For this reason, border areas are an area of specific high dynamics of these economic processes, which are connected with locating particular phases of economic processes on the territory of two or more countries under different political, legal and economic conditions.

In regions where certain economic processes can be implemented as cross-border processes, high business efficiency can be achieved through the creation of cross-border clusters.

A *cross-border cluster* geographically functions on neighbouring territories of several countries. Entities in a cross-border cluster therefore have extended opportunities to exploit the phenomenon of external comparative costs on an international scale. In cross-border economies there are significant differences in the economic and legal conditions for conducting business and cooperation, compared to those within a single country.

A cross-border cluster is created as a result of initiatives by businesses and local authorities of neighbouring countries where political conditions favouring local international cooperation exist.

The effectiveness of economic activity within a cross-border cluster is particularly high where the creation of the cluster and its international institutional structures has the additional effect of increasing the scale of activity, e.g. the creation of a single cross-border market for services or goods, which is a concatenation of border markets of individual countries, the creation of relatively permanent cooperative ties between enterprises and other cooperating entities, an increase in the range of goods and services attracting entities from increasingly distant regions to the market.

The effect of creating a cross-border cluster is to increase the economic gravity of the cross-border region, affecting the territories of all countries forming the cross-border economic region.

The long-term, stable and sustainable development of cross-border cooperation creates a situation in which it becomes economically viable to develop cross-border infrastructure, especially technical infrastructure (transport, energy, municipal), social infrastructure (health, education), financial infrastructure (banking and insurance services) and security infrastructure (cross-border cooperation of institutions responsible for internal and external security).

Referring to the PKL example, the aviation sector *as a whole* does not qualify for the creation of a cross-border cluster due to its strategic importance for state security. But certain activities important for the aviation industry, but not covered by special protection and not crucial for state security, can be carried out not only by domestic entities, but also by foreign entities. Thus, in areas that are not of strategic importance for the functioning of the PKL cluster, foreign entities can be included in the cluster - as auxiliary sub-industries.

Cross-border clusters are usually characterised by much higher efficiency than clusters operating within one country (one political-economic system) due to a much higher comparative cost effect. This higher efficiency is a result of the asymmetry between the business conditions in the individual countries whose territories belong to the cross-border region including, in particular, institutional asymmetry (e.g. supervision by state authorities), the legal asymmetry (e.g. legal and organisational forms of business, effectiveness of enforcement of rights and obligations), economic asymmetry (e.g. more favourable prices, taxes, credit), technological asymmetry (e.g. availability of technology), environmental asymmetry (e.g. liberal environmental regulations and charges for the use of non-renewable resources) as well as social asymmetry (e.g. wages, working conditions).

In the case of a politically sensitive industry such as the aeronautics industry, *cross-border outsourcing* is a safe and effective way of expanding a cluster into other countries and thus creating a *cross-border cluste*r[20].

[20] See Ewa Szkic-Czech, TRANSBORDER OUTSOURCING - NEW METHOD OF SYNERGIZING THE RESOURCES OF NATIONAL ECONOMY in: Cierpial-Wolan M., Lasek D., Olenski J. (ed.): Foundations of transborder economics and statistics, publ. Association of Carpathian Euroregion, Rzeszów 2014.

If market economic dynamics is determined by the local variation of potentials within a single cross-border area, the level of this variation is much higher at the junctions of separate economic systems. This phenomenon is exemplified by border areas, where differences in the effectiveness of different types of activities depend on country-specific institutional factors, and result above all from the very fact of the administrative separation of countries by a border line, beyond which we have a "different world" in legal, political and economic terms. At the same time, the administratively delimited border determines, among other things, the boundaries of national law regulating the principles of functioning in every field of socio-economic life on the territory of each country. Different approaches in legal regulations cause differentiation in principles, conditions and possibilities of management, accessibility to infrastructure, resources and means, etc.

The administrative borders of countries are also the limits of the territorially binding economic policy of each country and region, resulting in the presence of local preferences, concessions, subsidies but also restrictions and rigours, shaping in effect the living conditions of the inhabitants of these areas and the level of ability to satisfy their various needs.

Thus, an administrative political border between states artificially divides territories, and with them also cultural, religious, moral, infrastructural, technical, economic and economic environments, within which peculiarities and characteristics arise, which due to their specificity become economically attractive for representatives of other, administratively separated economic systems.

The differences in principles, ways, methods and possibilities of action, the structure of resources and technical infrastructure and its construction and the degree of modernity represented, the availability of know-how,

on both sides of the border, create areas of increased business opportunities especially for entities operating close to the border. These locations favour external outsourcing mainly due to the proximity to alternative categories. Through outsourcing, entrepreneurs on one side of the border can obtain at all or on more favourable terms the categories of resources they need, which for reasons such as cost, finance, legal, technical, procedural and other, remain difficult or unavailable for them on their side of the border. By means of access to neighbouring, cross-border resources, they have a facilitated possibility of using them by transferring parts of their processes immanently connected with their own core process to the other side of the border and outsourcing them, or transferring and outsourcing entire processes.

Entrepreneurs located in border areas have the opportunity and should assess the level of rationality of their basic (core) business processes, selected sub-processes of the core process or individual components of these processes, through a wider range of criteria taking into account the possibility of choosing the implementation of individual sub-processes or their elements within the framework of legal regulations and economic conditions of different countries. This extension of the criteria for the analysis and evaluation of the level of profitability of the implemented business processes is provided by reference points existing in various forms on the other side of the border. Their active participation in the monitoring of the efficiency of operations broadens the range of alternative possible variants of the realisation of individual immanent processes or their components.

However, the extent of these increased opportunities decreases as the company's location moves further away from the border zone. This means that the intensity of special business opportunities and real additional economic benefits possible with outsourcing is concentrated in close proximity and at the interfaces of separate economic systems. This is where the differences in

potentials arise, and with them the conditions that are particularly conducive to outsourcing revitalising economic relations between representatives of neighbouring systems, intensifying the development of cross-border economic cooperation as well as initiating the development of cross-border cooperation in directions not yet pursued in border areas.

While *internal* (domestic) outsourcing is mainly determined by economic aspects, *external* (foreign) outsourcing, and especially *cross-border outsourcing* in border areas, is influenced by institutional factors,[21] legal regulations, asymmetries in such areas as prices, tax systems, various types of costs, as well as social factors such as business and cooperation habits, the level of mutual trust, but also corruption, the effectiveness of law enforcement by authorities and the judiciary, etc.

The *cross-border asymmetry* of legal, organisational, political, economic and environmental conditions means that, for example, entities operating on the side of the border with restrictive environmental legislation can outsource part of their activities to a neighbouring country with lenient environmental requirements. In this way, the cluster optimises costs related to the use of the environment, its protection and - unfortunately - pollution in the cross-border area.

Another example illustrating the specific potential and conditions for the development of *cross-border* economic cooperation through *cross-border outsourcing* can be the availability of a certain type of technical infrastructure, e.g. a logistics centre, a transport hub, a waste incinerator or a sewage treatment plant. The infrastructure of an entity located on the other side of the

[21] An example of this regulatory asymmetry is the more liberal legislation in some areas of environmental protection and use of non-renewable resources in Ukraine than in Poland, where the stricter standards adopted in the European Union apply.

border can be outsourced to a company located on the other side of the border, which can take over the operation of a certain immanent process or a fragment of a key production process, thus eliminating the need to finance the construction or modernisation of this infrastructure. As a result of outsourcing, they can also reduce the costs for the use of this infrastructure that would have to be borne by the company on their side of the border.

The same is true of other types of technical infrastructure such as road infrastructure, repair shops for vehicles and other machinery or equipment, storage facilities, office facilities, etc. Also of significance for the decision to outsource is the access to a specific type of homogenous resources: raw materials, deposits or qualifications, either cheaper or not available at all within a specific territorial radius (e.g. Polish IT specialists and accountants are cheaper than their British or American colleagues, and even cheaper than them are IT specialists and accountants in Poland, and in addition English is their primary professional language).

Differences in wage levels, prices of goods and services, availability of technology and infrastructure can be a strong argument for *cross-border outsourcing* in border areas. A significant role is played by the pro-development policy of the government which, unfortunately, often applies far-reaching preferences and tax exemptions to foreign capital, e.g. several-year tax exemptions for foreign companies, creating an economically unjustified institutional asymmetry between domestic and foreign entities in the country and encouraging domestic entities to locate their activities abroad. Social factors and attitudes, e.g. the level of activity of trade unions or the level of citizens' trust in national financial institutions (banks, insurance), the administration of justice and public administration, are also of significance for cross-border outsourcing decisions.

Differences in tax rates, e.g. VAT (e.g. on children's items), which is 23% on one side of the border and "0" on the other side, may be another example of the fact that cross-border outsourcing can take advantage of differences in legal systems and thus activate economic cooperation between entities in border areas.

Thus, cross-border outsourcing can be more effective than outsourcing in the area of similar economic, legal and social conditions (internal), because the company transfers to the other side of the border that part of its core business and benefits from more favourable conditions by reducing costs: wages, fees, raw materials, materials, infrastructure operation, etc. However, it must be remembered that cross-border outsourcing, like any foreign (external) outsourcing, involves greater risks. The specification of all risks and the assessment of their potential effects should be taken into account when building cross-border clusters, both industrial clusters and clusters in other areas.

The development of PKL as a cross-border cluster can be based on cross-border outsourcing. This form of "expansion" of the PKL cluster and its development as a cross-border cluster gives the possibility to use the effect of comparative costs on the entire cross-border area, and at the same time provides control and minimisation of risks associated with greater uncertainty of cooperation with foreign entities.

4.4. Cluster concatenation in cross-border functional areas

In the methodology of cluster formation, analysis and forecasting of their development it is justified to take into account the processes of *concatenation of clusters* operating within a region[22].

By *cluster concatenation* we mean a situation in which some entities belong to two or more clusters. The participation of an entity in several clusters stimulates the development of the potential of that entity, strengthens its technological, scientific or market position, as well as that of each cluster as a whole. the potential of an entity, increased by its participation in one cluster, is used in another cluster.

Cluster concatenation can occur: within the region, on a supra-regional scale, on a cross-border basis and on a global scale.

In the case of a complex industrial cluster which is PKL in the methodology of analysis of factors influencing the development of the region and the network of entities forming clusters it is justified to take into account the effects that may be brought about by the concatenation of clusters:

– The main cluster, i.e. the Podkarpackie Aviation Valley cluster includes leading economic entities directly involved in the production of aviation industry and entities cooperating with major companies and research institutes as permanent partners,

– Cluster of science and higher education of Podkarpackie voivodship (all scientific institutes and universities in the voivodship) and national and

[22] Oleński J., Klastry transgraniczne jako stymulanty rozwoju i współpracy w warunkach otwartej gospodarki rynkowej, in: Miszczuk A. (ed.), Wyzwanie rozwojowe pogranicza polsko-ukraińskiego, Wydawnictwo Norbertinum, Lublin 2017.

foreign institutes and universities cooperating with them (scientific and research cluster),

– An institutional cluster of the Podkarpackie region which can be formed by a network of cooperating institutions of public administration and other state bodies as well as socio-political and economic organisations and associations operating in the region and in the cross-border area of the region for the benefit of the main cluster, i.e. Podkarpackie Aviation Valley. An institutional cluster has a great potential for mobilising intellectual capital, social capital and institutional capital on a regional scale and on a scale of cross-border economy related to the Podkarpackie region.[23]

The impact on comprehensive regional development that high-tech clusters have are good examples illustrating methodological and practical problems of cluster concatenation and its. *A case study* of the Podkarpackie Aviation Cluster as a *case study* can be a model for research on industrial clusters in the Podkarpackie region and a valuable area of empirical research, studies on the theory and methodology of cross-border clusters in a knowledge-based open market economy.

[23] See Oleński J. ‚*Human capital, social capital and institutional capital as factors of synergy of economic development of transborder regions in knowledge-based economy*, in: Cierpial-Wolan M., Lasek B., Olenski J. (ed.) : Foundations of transborder economics and statistics, publ. Association of Carpathian Euroregion, Rzeszów 2014.

5. Delimitation of cross-border areas

In recent years, research and analysis on the impact of borders has gained particular importance, especially in the local as well as in the regional, national and transnational context. A border can be seen as both a barrier and potential for development for local communities.

The benefits of a border location can be considered on a local scale (e.g. border trade, shopping tourism; Jałowiecki, 1999; Spierings and van der Velde, 2008, Powęska, 2011; handling of cross-border traffic; development of services targeting citizens of neighbouring countries; Ciok, 2004), cross-border migration of the population and companies run by individuals (Skraba and Nowicka, 2018), as well as on a higher level of institutional cross-border cooperation (networks of links) (Dolzbłasz, 2017, 2018). The negative effects of the border are usually associated with an increase in crime (Jałowiecki, 1999; Szymańska and Stefaniak, 2014) and the socio-economic peripheralization of the area (T. Komornicki, R. Wisniewski, A. Miszczuk, 2019, pp. 467-468).

There are differences among many authors regarding the use of the concepts of a region, zone or border, borderland, cross-border area (Raczyk et al., 2012, p. 23-27; T. Komornicki, R. Wisniewski, A. Miszczuk, 2019, p. 473).

As S. Dolzbłasz points out, with the evolution of the concept of border and research approaches, the use of the term cross-border region/area has become more frequent (Blasco et al. 2014; Blatter, Clement 2000; Gorzym-Wilkowski 2005; Hall 2008; Leimgrüber 1991; Miszczuk 2015; Palmowski 2000; Potocki 2010), however, its clear definition is rare. The term seems to have emerged as an expression of the observed growth of cross-border ties and researchers' interest in this issue. In this context, a cross-border region was

originally defined by Perkmann (1999) as a combined territory under the competence of local and regional authorities participating in EU Interreg II, IIIA initiatives. Another definition by the same author (Perkmann 2007), which is separate from the EU policy on support for cross-border cooperation, states that a cross-border region is a territorial unit consisting of neighbouring sub-state units of two or more countries and which, due to internal national circumstances, are differentiated in terms of, inter alia, institutional and social features. Cross-border regions are also understood as areas whose unity lies in the existence and exploitation of advantages arising from the proximity of a border, e.g. differences in prices, wages and other regulations existing on both sides of the border, etc. (Anderson, O'Dowd 1999). Euroregions are often associated with cross-border regions (S. Dolzbłasz p. 32).

Thus, the delimitation of cross-border areas should take into account different types of cross-border interactions such as commuting, shopping, use of services, family ties, economic cooperation, cooperation of local government units, NGOs, universities, transport links, etc.

In practice, a preliminary delimitation of the cross-border area is usually carried out first based on the criterion of a combination of distance and administrative or statistical division. The analysis of socio-economic phenomena in the predefined cross-border area and its surroundings, e.g. concerning the labour market, entrepreneurship, demographic processes, tourism, usually leads to changes in the delimited area, which can be called dynamic delimitation.

Examples of delimitation of border and cross-border areas

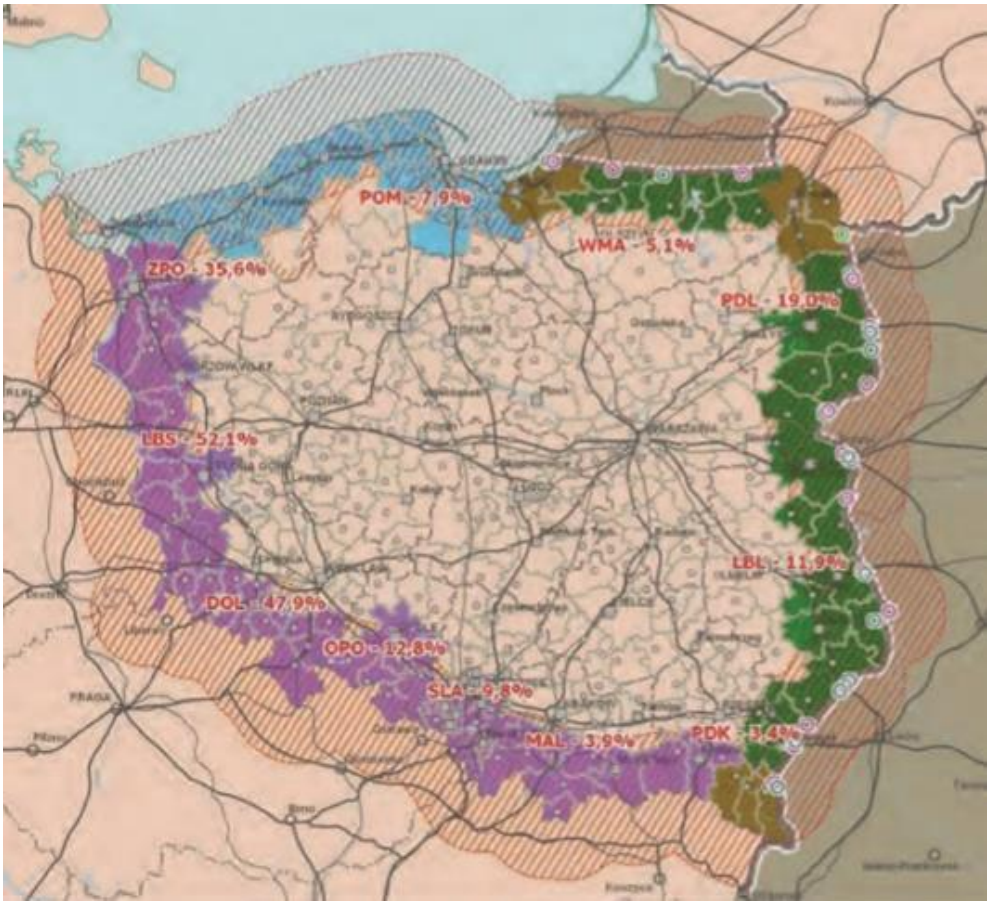
Within the framework of the National Strategy for Regional Development 2010-2020: Regions, Cities, Rural Areas, a team from the Institute of

Geography and Spatial Planning of the Polish Academy of Sciences under the guidance of Professor P. Śleszyński developed delimitation criteria for border powiats (Monitor Polski 2010).

Border powiats were distinguished according to the distance of their capital from the border or the border crossing point. They were grouped into four categories:

1. powiats whose capitals are located within 50 km of the Schengen border,
2. powiats whose capitals are located within 50 km of a border crossing point with countries outside the Schengen area,
3. powiats whose capitals are located within 50 km of the Baltic coastline,
4. powiats combining features of different categories: powiats whose capital cities are located up to 50 km from the Schengen border, including the Baltic Sea coastline, and at the same time up to 50 km from border crossings with non-Schengen countries. Such powiats are located on the Polish-Russian border (Braniewo and Elbląg), the Polish-Lithuanian-Belarusian border (Augustów, Sejny and Suwałki) and the Polish-Ukrainian-Slovakian border (Bieszczadzki, Leski and Sanocki).

Figure 1. Delimitation of border areas according to PAN



Administrative categories of urban centres

- capital and voivodship
- municipal powiat
- powiat
- cities outside the country with more than 100,000 inhabitants

LBL - 11.9% share of exports with countries bordering a given voivodship

EU and Schengen borders

Categories of border districts

- whose capitals are situated within 50 km of the Schengen border
- whose capital cities are located within 50 km from border crossings with non-Schengen countries
- whose capitals are situated within 50 km from the Baltic coastline
- transitional, combining features of different types
- a buffer zone of 50 km from the Schengen border, the Baltic coastline or border crossing points

Categories of border crossing points

- road
- railway
- tourist

An example of delimitation developed on the basis of the criterion of combining distance with administrative division is the conception according to which we choose powiats located up to 50 km from the Polish border. In order to decide whether a given powiat should be included in the border zone, a division of the powiat into localities was used. If even part of a locality was located at a distance of less than or equal to 50 km from the border, it was treated as a border locality. A powiat was included in the border zone on condition that the sum of the areas of the border towns comprising the powiat occupied more than 50% of its area. The Euclidean distance from the border was used to determine the 50 km wide border strip.

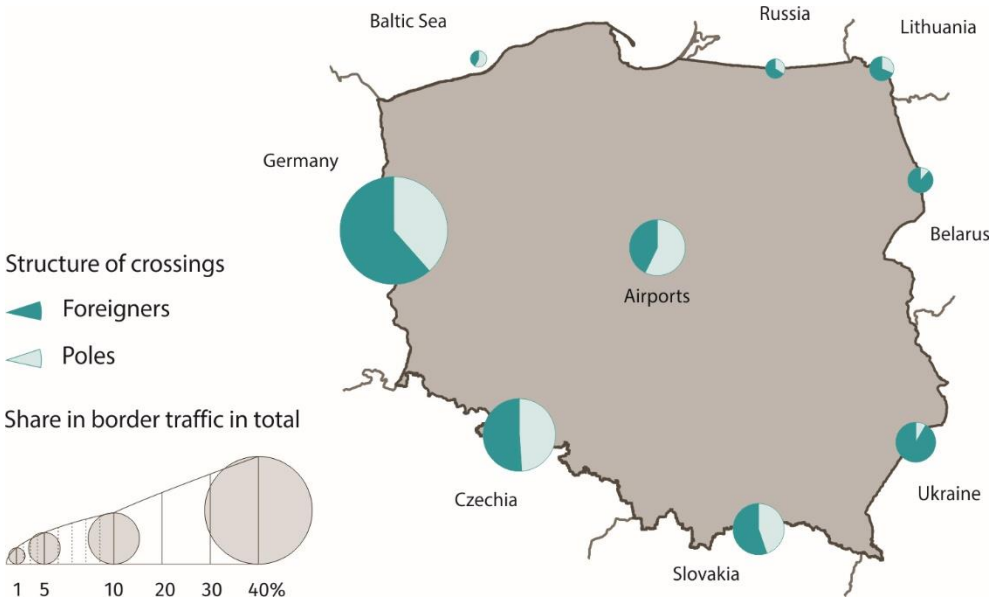
Figure 2. Delimitation of the cross-border zone according to the criterion of combination of distance (50 km) and administrative division (powiats)

A delimitation based on the criterion of functional links may concern many socio-economic or institutional aspects and be the result of systematic research and analysis.

A good example are the studies on border areas carried out by public statistics: "Trips made by non-residents to Poland. The movement of vehicles and persons at the Polish border with the countries of the European Union" and "Participation of Polish citizens (residents) in trips". The study of trips of foreigners (non-residents) covers those leaving Poland through the internal and external EU border on the territory of Poland. The survey of border traffic (in both directions - from Poland and to Poland) covers persons and vehicles crossing the border of Poland with the European Union countries at selected road border crossings. The survey of participation of Poles (residents) in trips is conducted in households. In both surveys information is collected, inter alia, on expenditure incurred abroad, distance from the border to the place of shopping by foreigners in Poland and Polish residents abroad. The results of these surveys were used to prepare the delimitation of cross-border areas.

In the structure of border traffic on the Polish land border, crossings on the border with Germany (46.5%) accounted for the largest share, followed by the Czech Republic (23.8%), Slovakia (13.2%), Ukraine (8.4%), Belarus (3.4%), Lithuania (3.4%), and Russia (1.3%).

Figure 3. Border traffic of persons (from and to Poland) by border sections in 2019.



In 2019, the estimated number of crossings on the Polish border was 305.8 million, of which 180.2 million concerned foreigners (58.9% of the total) and 125.7 million Poles (41.1%). Crossings made on the Poland's land border with the European Union countries accounted for 73.5% of the total crossings, on the EU's external land border - 11.1%, at airports - 14.7% and on the maritime border - 0.7%.

Expenditure incurred by foreigners in Poland and Poles abroad was differentiated depending, inter alia, on the distance of the place of shopping from the land border as well as the section of the border they crossed.

The most money in 2019 was spent by both foreigners in Poland and Polish residents abroad on the purchase of goods and services in a strip up to 50 km from the land border (64.4% of the expenditure of non-residents trav-

elling across the land border and 48.6% of the total expenditure of Poles returning across the land border respectively). Both foreigners and Poles spent the smallest amounts between 51 and 100 km from the border.

The structure of expenditure incurred by foreigners in Poland was dominated by expenditure on goods, both at the external land border of the EU (95.1%) and at the internal border (83.8%). Expenditure on goods was also the overwhelming majority in all analysed ranges of distance from individual border sections (including with individual neighbouring countries).

The study shows that after crossing all sections of the external EU border, Polish citizens incurred most of their expenditure in the 50 km strip, mainly the closest to the border (up to 30 km). After crossing the border with Russia at these distances, they incurred respectively 96.4% (and 93.9%) of their total foreign spending, with Belarus 84.8% (and 75.6%) and with Ukraine 72.5% (and 68.7%). The highest percentage of expenditure at a distance of more than 100 km from the border was recorded among those crossing the border with Ukraine - 21.7%.

Figure 4. Extent of land border impact based on crossings of border sections by foreigners (non-residents) in 2019.

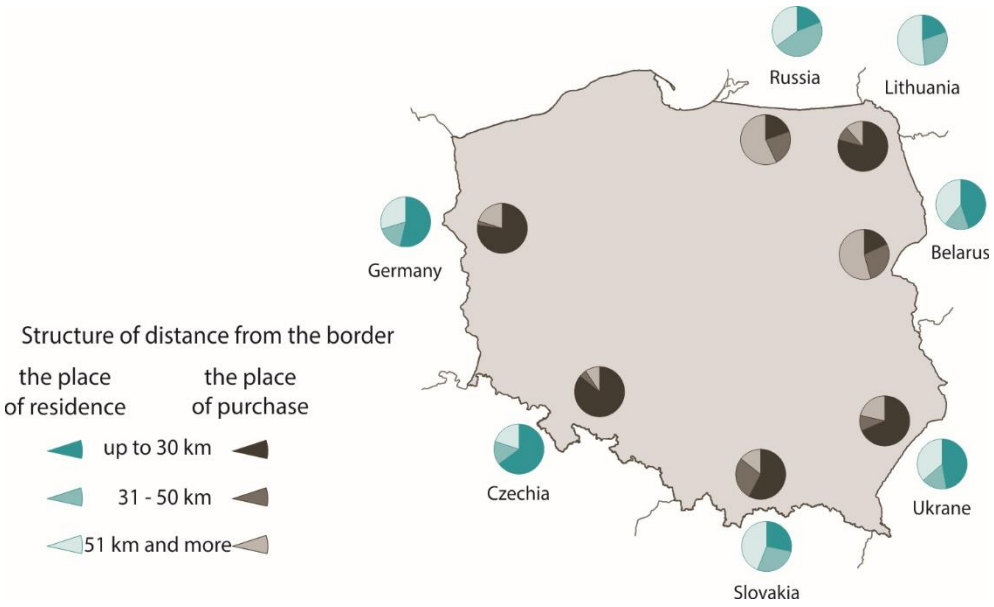
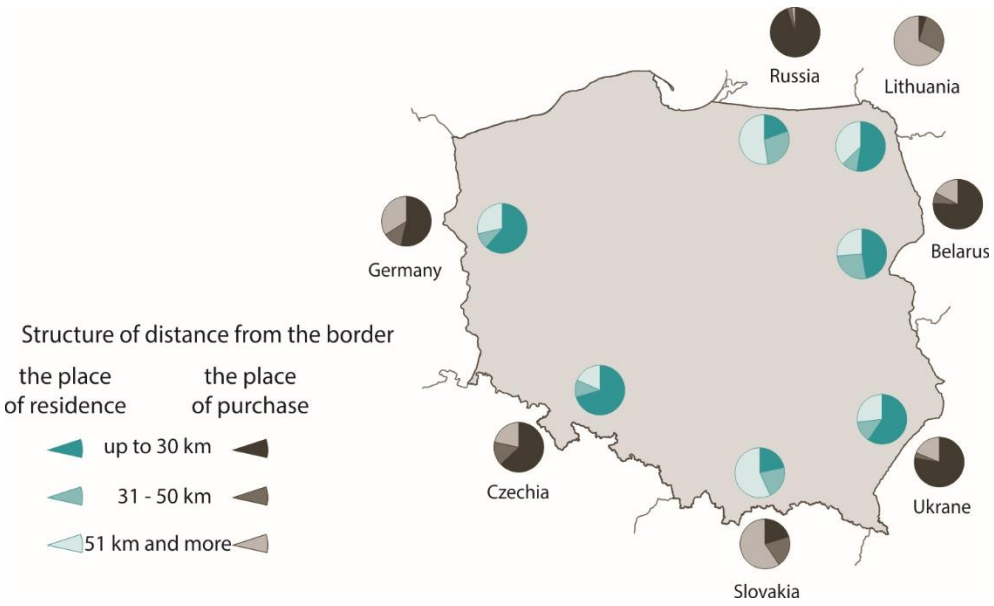


Figure 5. Extent of land border impact based on crossings of border sections by Poles (residents) in 2019.



Based on the results of the above surveys, a delimitation was prepared for the period 2014-2019, taking into account the distance from the border of the place of shopping by foreigners in Poland and Poles abroad according to individual border sections.

The systematic observation of foreigners shopping in Poland according to the different sections of the border in 2014-2019 allowed the following conclusions to be drawn:

- About 45% of foreigners crossing the border with Russia made purchases in Poland within 50 km from the border crossing point (about 20% up to 30 km). Approximately 70% of them spent their money at the distance up to 100 km from the border and about 30% at the distance over 100 km. It is worth mentioning that in July 2012 the Agreement between the Government of the Republic of Poland and the Government of the Russian Federation on rules on local border traffic was signed. It covers 20 powiats on the Polish side and the Kaliningrad Oblast on the Russian side. The local border traffic agreement with Russia entered into force on 27 July 2012. Since 4 July 2016, it has remained suspended.
- Approximately 75% of foreigners crossing the border with Lithuania spent money on shopping in Poland within 30 km from the border crossing point. The percentage of these persons increased every year - the lowest level was in 2014 and amounted to 63.4%, while the highest was in 2019 – 79.2%. The survey showed that significantly fewer foreigners shopped within a strip of 31-50 km from the border (the highest in 2014 - 16.9%, the lowest in 2019 - 9.3%).
- Approximately 45% of foreigners crossing the border with Belarus made their shopping in Poland up to 50 km from the place of crossing the border (about 20% up to 30 km). Approximately 90% made their purchases up to 100 km from the border.

In 2010, the Agreement between the Government of the Republic of Poland and the Government of the Republic of Belarus on rules on local border traffic was signed. The Agreement requires ratification by the Belarusian party.

- Approximately 70% of foreigners crossing the border with Ukraine spent money on shopping in Poland within 30 km from the border crossing point. In contrast, the share of shoppers at a distance of 31-50 km was more varied between years. The highest percentage of them occurred in 2014 - 18.5%, and the lowest in 2016 – 9.5%. It should be noted that the concluded Agreement between the Government of the Republic of Poland and the Cabinet of Ministers of Ukraine on the local border traffic regime[24] covers, on the Polish side, the area of administrative division units (gminas) reaching no further than 30 km from the border.
- About 55% of foreigners crossing the border with Slovakia made their shopping in Poland within 30 km from the border crossing point, and about 30% in the 31-50 km zone - so about 85% spent their money in the zone up to 50 km.
- Approximately 85% of foreigners crossing the border with the Czech Republic spent money on shopping in Poland within 30 km from the border crossing point. On the other hand, the percentage incurring expenditure in a band of 31-50 km from the border during the analysed period was the highest in 2015 - 7.6%, and the lowest in 2019 – 4.8%.

[24] Border zone - the area of the administrative divisions of the Contracting Parties listed in Annex No. 1 to the Agreement extending no more than 30 kilometres from the common border; if a part of such an administrative division is located between 30 and 50 kilometres from the border line, it shall nevertheless be considered part of the border zone.- Act of 6 March 2009 on ratification of the Agreement between the Government of the Republic of Poland and the Cabinet of Ministers of Ukraine on rules on local border traffic, signed in Kiev on 28 March 2008, and of the Protocol, signed in Warsaw on 22 December 2008, between the Government of the Republic of Poland and the Cabinet of Ministers of Ukraine amending the Agreement between the Government of the Republic of Poland and the Cabinet of Ministers of Ukraine on rules on local border traffic, signed in Kiev on 28 March 2008 (Journal of Laws No. 66, item 555, of 4 May 2009).

- About 75% of all foreigners crossing the border with Germany were those who made purchases within 30 km from the border crossing. Those making expenditure in a strip 31-50 km from the border accounted for a few percent (most in 2014 - 4.6%, least in 2019 - 2.8%).

Observation of Polish residents making purchases abroad between 2014 and 2019 led to the following conclusions:

- The vast majority of Poles crossing the border with Russia made purchases within 30 km from the border crossing (from 93.0% in 2014 to 95.2% in 2019). About 3% of Poles incurred their expenses in the strip 31-50 km from the border. At a distance of more than 100 km, 3.5% of Poles made their purchases in 2014, and only 0.9% in 2019.
- About 60% of Poles crossing the border with Lithuania spent money on shopping within 100 km of the border crossing, with about 25% in the 51-100 km strip and 35% in the strip up to 50 km. The survey showed that the fewest Poles made purchases within 30 km of the border (the highest in 2014 - 12.3%, the lowest in 2019 - 4.7%). The percentage incurring expenditure in the 31-50 km strip during the analysed period was the lowest in 2014 - 21.1%, and the highest in 2017 at 29.9%.
- More than 80% of Poles crossing the border with Belarus made purchases within 50 km from the border crossing point (more than 75% up to 30 km). Those making expenditure within 51-100 km from the border accounted for a few percent (least in 2014 - 2.0%, most in 2019 - 3.5%). At a distance of more than 100 km from the border, about 15% of Poles incurred their expenses.
- About 80% of Poles crossing the border with Ukraine spent money on purchases within 30 km of the border crossing point. The share of shoppers at a distance of 31-50 km from the border in the analysed period was about

3% (the lowest in 2014 - 2.0% and the highest in 2019 - 3.7%), and about 5% at a strip of 51-100 km.

- About 40% of Poles crossing the border with Slovakia did their shopping up to 50 km from the border (about 20% each in the strip of up to 30 km and 31-50 km). In contrast, around 30% of Poles spent money in the 51-100 km strip and over 100 km strip.
- About 75% of Poles crossing the border with the Czech Republic spent money on purchases within 50 km of the border crossing (about 60% up to 30 km). The percentage of those incurring expenditure in a strip 31-50 km from the border during the analysed period was highest in 2014 - 16.5% and the lowest in 2015 - 12.9%. At a distance of more than 100 km, about 15% of Poles spent their funds.
- More than 65% of the total number of Poles crossing the border with Germany were those who made purchases within 50 km from the border crossing point (about 55% up to 30 km). The share of shoppers at a distance of 51-100 km from the border in the analysed period was the lowest in 2014 - 6.1% and the highest in 2016 – 8.2%. At a distance of more than 100 km from the border, about 25% of Poles incurred their expenses.

5.1. Delimitation of cross-border areas based on the place of purchase

All border crossings in Poland were identified. Based on the questions in the survey, respondents were divided into those shopping in four ranges of distance from border crossings 0-30 km, 31-50 km, 51-100 km, over 100 km. A detailed analysis of the survey results was used to create a delimitation of the cross-border area according to the criterion of shopping:

1. A radius of 30 km was set from each crossing point and all towns in the area were taken into account. Analysis of individual border sections indicates that on average more than 70% of foreigners shop in

this zone. We assume that practically in most places there is a network of shops and services used by foreigners.

2. If foreigners were recorded shopping in the 31-50 km strip, a 50 km radius of impact of the border crossing was determined. All cities within the 31-50 km radius were identified based on the actual distance based on the road network (based on the distance base). We assume that regardless of the size of the share of foreigners shopping in this zone, the cities become the main destination.

Figure 6. Delimitation of the cross-border area according to the criterion of shopping

5.2. Delimitation of the cross-border area according to the place of residence of people travelling to neighbouring countries

The observation of Polish residents returning from abroad according to the distance of their place of residence from the border crossing point in 2014-2019 has led to the following conclusions:

- Approximately 50% of Poles who crossed the land border with Russia in the analysed period were residents of localities located up to 50 km from the border crossing point (of which about 20% up to 30 km). The highest percentage among those crossing the Polish-Russian border and living in Poland within 50 km of the border occurred in 2015 (51.8%), and the lowest in 2017 (45.9%). A significant percentage (about 40%) of the Poles crossing the analysed section of the border were residents of localities located in the strip between 50 and 100 km from the border. Thus, of the Poles who crossed the border with Russia, about 90% resided within 100 km of the border crossing point.

  The results of the survey confirm, in a way, the scope of the border area as defined in the provisions of the LBT Agreement.
- About 55% of the Polish population crossing the land border with Lithuania were residents of localities located up to 30 km from the border crossing point. On the other hand, 65% of those crossing the border lived up to 50 km from the border. The percentage of crossers (up to 50 km) varied slightly in the different years of the analysed period, with a slight decreasing trend in recent years (64.2% in 2017 and 2018 to 62.6% in 2019). The survey showed that a significant proportion (around 30%) of Poles travelling across the Polish-Lithuanian border were those living more than 100 km from the border.

- Approximately 45% of Poles crossing the land border with Belarus were living within 30 km from the border crossing point and approximately 75% living up to 50 km. The variation in the share of residents living up to 50 km from the border in individual years of the analysed period did not exceed 1.7%.

  With regard to the border zone (on the Polish side) as defined in the LBT agreement with Belarus, it should be noted that about 45% of the Polish population crossing the analysed section of the border are also inhabitants of gminas covered by the LBT zone.
- Approximately 60% of Polish residents who travelled through land border crossings with Ukraine during the period under analysis lived within 30 km of the border - the highest share was in 2017 at 60.4%, the lowest in 2014 – 55.1%. In contrast, those living within 50 km of the border accounted for more than 70%.

  The results of the survey show that out of the Polish residents crossing the border section with Ukraine, approx. 60% were residents of municipalities covered by LBT. It should be added, however, that Poles generally did not use this type of facilitation in crossing the border.
- About 45% of Poles crossing the land border with Slovakia were residents of localities up to 50 km from the border (including about 20% up to 30 km away), while about 30% of those crossing the border lived in Poland between 51 and 100 km from the border and about 25% further than 100 km. The study shown that the Polish-Slovak border is crossed not only by inhabitants of border villages, but also by a significant proportion of those living at much longer distances.
- Approximately 70% of Polish inhabitants who crossed the land border with the Czech Republic in the analysed period lived within 30 km

from the border. The percentage of these persons showed a slight upward trend during the analysed period - the lowest level occurred in 2014 and amounted to 65.1%, while the highest level took place in 2019 – 70.4%. In contrast, those living within 50 km had a share of around 80%.

- About 60% of Poles crossing the border with Germany were residents of towns up to 30 km from the border and about 70% living up to 50 km away. It should be noted that approximately 20% of those crossing the border in question declared living further than 100 km from the border. In the individual years of the analysed period the structure of Polish inhabitants crossing the Polish-German border, according to the distance of their place of residence from the border, did not show a clear trend, but was slightly varied. The study shown that the Polish-German border is crossed not only by inhabitants of border towns, but also by those living at much greater distances.

On the other hand, the following conclusions emerge from the observation of foreigners leaving Poland according to the distance of their place of residence from the border crossing between 2014 and 2019:

- Approximately 65% of foreigners who crossed the Polish-Russian border in the analysed period were residents of towns located up to 50 km from the border crossing point (of which about 20% up to 30 km, and about 45% in the 31-50 km zone). More than 25% of foreigners crossing the analysed section of the border were residents of localities located within 51-100 km from the border crossing point and less than 10% lived more than 100 km from the border crossing point.
- Approximately 50% of foreigners crossing the land border between Poland and Lithuania were residents of towns located up to 50 km

from the border crossing point. Less than 20% of those crossing the analysed border lived within 30 km of the border (the lowest in 2015 - 15.1%, the highest in 2018 - 20.1%). About 70% of foreigners travelling across the Polish-Lithuanian border resided in the strip up to 100 km from the border, and about 30% were those living more than 100 km from the border.

- About 45% of the foreigners crossing the land border of Poland with Belarus were persons living within 30 km from the border crossing point and about 60% living up to 50 km. The study showed that about 25% of the foreigners travelling across the Polish-Belarusian border were those living more than 100 km from the border.
- Approximately 50% of foreigners who travelled in the analysed period through land border crossings of Poland with Ukraine lived within 30 km of the border and 15% within 31-50 km. The share of foreigners living more than 100 km from the border during the analysed period increased steadily from 9.1% in 2014 to 17.9% in 2019.
- Approximately 55% of foreigners crossing the Polish land border with Slovakia were residents of towns located up to 50 km from the border (including approximately 25% of those located up to 30 km away). On the other hand, less than 15% of those crossing the border in question lived between 51 and 100 km from the border. The study showed that the share of foreigners living more than 100 km from the Polish-Slovak border in the analysed period was steadily decreasing from 37.1% in 2014 to 29.2% in 2019.
- Approximately 80% of foreigners who crossed the Polish land border with the Czech Republic in the analysed period lived within 50 km from the border, while approximately 65% were inhabitants of towns located up to 30 km from the border. On the other hand, those living

between 51 km and 100 km constituted only around 5%. The share of foreigners living more than 100 km from the border during the analysed period was the highest in 2015 - 22.8%, and the lowest in 2018 – 14.7%.

- About 55% of foreigners crossing the Polish-German border were residents of towns located up to 30 km from the border, and about 70% living up to 50 km away. The study showed that the Polish-German border was crossed in the analysed period also by about 25% of foreigners who declared to live further than 100 km from the border and only about 5% who lived between 51 and 100 km from the border.

These conclusions were used to create delimitation of the cross-border area according to the criterion of place of residence:

1. The border impact radius for each border crossing point was determined taking into account the place of residence of residents travelling to neighbouring countries. Analysis of individual border sections shows that about 60% of residents crossing the land border with neighbouring countries declare residence within 50 km of the border crossing point.
2. Depending on the section of the border, a radius of 30, 50 and 100 km was set from the crossing point and all villages in the area were taken into account.

Figure 7. Delimitation of border areas according to the criterion of residence of residents

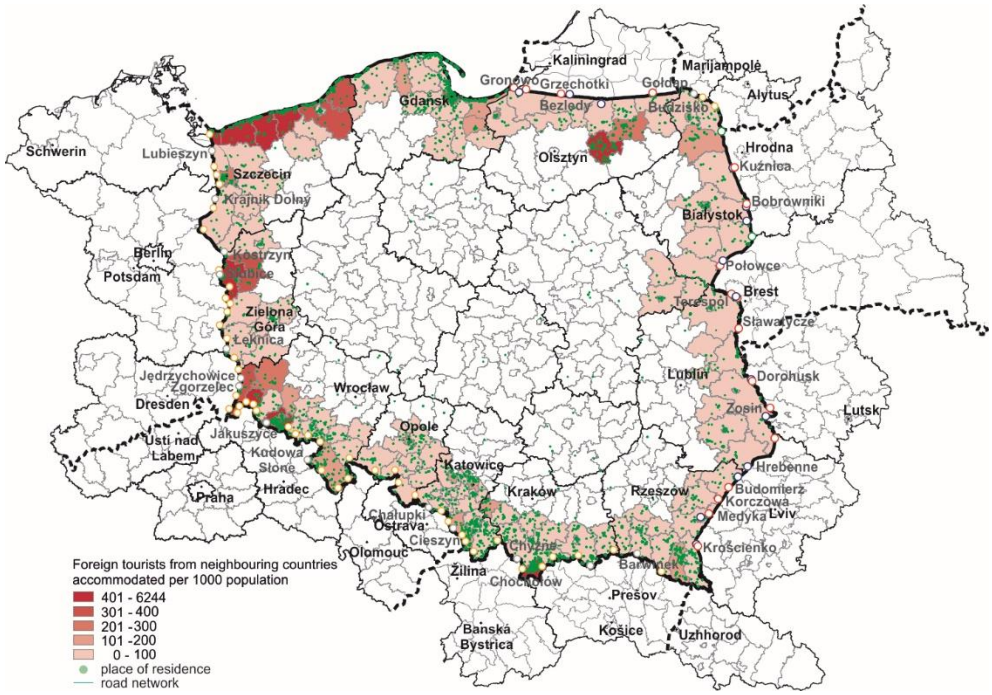
When preparing delimitations of cross-border areas, sources of information supplemented with geographical coordinates become very useful. The map below presents geographical coordinates of households in Poland participating in cross-border trips on the basis of the PKZ survey. All households located within 200 km of a land border crossing point were taken into account.

Figure 8. Geographical coordinates of households declaring trips to neighbouring countries

Analysing the place of residence of Poles crossing the border with Slovakia, we notice that they declare a relatively distant place of residence from the nearest foreign border crossing.

An important source of information used in the delimitation of cross-border areas can also be data on tourism supply, e.g. users of accommodation establishments.

Figure 9. Geographical coordinates of accommodation establishments used by foreigners from neighbouring countries.

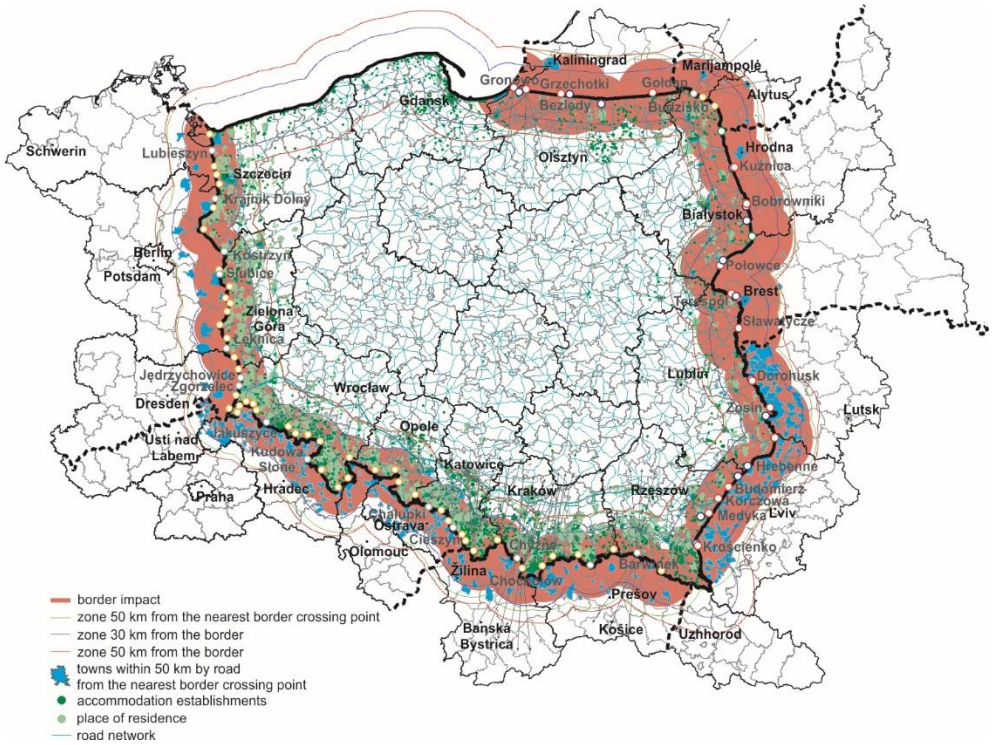


The map above shows a strong differentiation in the number of tourist accommodation establishments depending on the border sections. The largest number of foreign tourists from neighbouring countries per 1000 population used the establishments located in the districts near the maritime and Polish-German border – city of Świnoujście (6244), Kołobrzeski powiat (2666), Kamieński powiat (1914) and Słubicki powiat (1016). More than 1000 tourists from neighbouring countries per 1000 population also came to Tatrzański powiat (Polish-Slovakian border) - 1060, and almost 1000 to Mrągowski powiat (Polish-Russian border). In accommodation establishments, among tourists coming from countries neighbouring Poland, the most numerous were tourists from Germany (1225.8 thousand), while the least numerous were tourists from Slovakia (62.6 thousand).

5.3. Attempt at delimitation of the cross-border area on the basis of various sources of information

In an attempt to delimit the cross-border area, we have used all sources of information presented: data on the place of purchases made by residents and foreigners from neighbouring countries, the place of residence of residents travelling to neighbouring countries, geographical coordinates and data on the use of tourist accommodation establishments.

Figure 10: Delimitation of border areas by criterion of shopping, residence of residents and geographical coordinates of households and accommodation facilities.



1. The results of the delimitation based on shopping and residence criteria were summarised and supplemented with data from accommodation establishments. This resulted in a preliminary delimitation.

2. All towns located in the area delimited by a 30 or 50 km radius from border crossings were classified into the cross-border zone. Towns which are located in the zone of 30-50 km from the border and which were not included in the initial delimitation were also included.

6. Information basis for the delimitation of cross-border functional areas

For each area for which a model of a cross-border functional area is developed, comprehensive and comparable statistical and factual data from border regions of all countries on whose territory a functional area may be delimited should be available. In addition, the administrative territorial and geodetic divisions of these countries should be harmonised. The identification and delimitation of cross-border functional areas poses information requirements that are rarely met by the official information systems of the countries involved in cross-border economic, social or environmental processes.

The international harmonisation of administrative and geodetic divisions is particularly important because these divisions identify in geographical space all statistical and other information on phenomena, processes and systems necessary for modelling and delimiting a functional area. Without harmonisation of the territorial divisions of neighbouring countries or at least their border regions, a precise delimitation of specialised, domain-specific functional areas is impossible. In practice, however, each country has its own administrative territorial division, sometimes significantly different from those of neighbouring countries. It is necessary to spatially identify social, economic and ecological phenomena and processes down to the level of the smallest administrative units of the territorial division of the country. The smallest units of the administrative territorial division of countries differ considerably from each other both from the point of view of geographical area, population and other social, economic and ecological characteristics, both within and between countries. The use of data identified with the accuracy of even the lowest level of administrative divisions of individual countries does not provide the precision of spatial identification sufficient for the delimitation of cross-border functional areas. Such possibilities are also not provided

by the use of the five-level statistical territorial division NUTS introduced in the European Union. The countries - members of the European Union, developed their own systems of territorial identification NUTS giving identifiers of this territorial classification to their internal units of administrative division of the country. The introduction of the NUTS territorial classification in official statistical surveys throughout the European Union has not contributed to the international harmonisation of the spatial identification of economic and social phenomena and processes, but conversely, among practitioners using data from different countries, it may create the illusion of international comparability of data for cross-border areas. In practice, the territorial units identified at the fifth NUTS level differ significantly from each other in terms of qualitative and quantitative criteria. Therefore, for the needs of spatial economy and regional development policy based on functional area models, it is necessary to look for more precise methods of spatial identification, independent of the administrative division of the country.

The methodological approaches presented above (Chapters 2-4) and the exemplification of their application (Chapter 5) to the delimitation of selected types of cross-border functional areas of Poland and neighbouring countries may be regarded as methodologically correct and practically useful example of an approach to spatial identification of social, economic, technical and ecological phenomena, processes and objects, which makes it possible to obtain adequate completeness and comparability of data necessary for delimitation of cross-border functional areas and concatenation of these areas for comprehensive analyses of cross-border economy.

The availability of detailed micro-data, both official statistics and data classified as "big data", varies from country to country. Obtaining comprehensive, sufficiently comparable data necessary for the identification and delimitation of cross-border functional areas requires international cooperation

of governmental, self-governmental, scientific and research institutions and other organisations, which are the providers of spatially identifiable information for cross-border economic areas. Differences in access to data and data gaps are particularly felt by researchers as well as administrations and businesses in border regions.

In the current state of legislation in EU countries, the detailed data that should be available for functional area delimitation are anonymised micro statistical data on people, households, micro and small enterprises. These data are suitable for use for functional area delimitation only if they are spatially identified with the accuracy of a geodetic parcel or XY geographical coordinates. In most statistical surveys, their identification relates to the units of the territorial division of the country according to NUTS (level 5 or higher). This is insufficient detail for the delimitation of functional areas. Moreover, at this level there are significant differences between countries in the precision of the spatial identification of statistical units, which makes data from different countries incomparable from the point of view of the space to which they refer. Internationally uniform spatial identification is provided by XY geographical coordinates and the geodetic division of the territory of countries in agreement with the European Union ESPRIT Directive. These identification systems are independent of administrative divisions, which are specific to each country. Thanks to this, the identification of statistical units according to geographical coordinates XY gives the fullest possible comparability sufficient for the delimitation of functional areas, and a somewhat smaller, but sufficient, comparability is given by spatial identification with the detail to the geodetic parcel.

The use of anonymised micro-data from official surveys for the delimitation of cross-border functional areas is associated with the following barriers:

In official survey programmes, the spatial identification of statistical units by XY coordinates or by geodetic parcels is not internationally harmonised.

Spatial identification of statistical units by XY coordinates or by geodetic parcels is used only in some surveys, depending on the needs and interests of the offices conducting such surveys. In practice, there are few such surveys, and detailed identification rarely takes into account the needs of functional area delimitation.

Statistical surveys collecting data that may be useful for the identification and delimitation of cross-border areas, especially surveys in which the statistical units are natural persons, households or micro and small enterprises or non-business institutions, are usually representative surveys, with small samples in relation to the size of the statistical population. Therefore, the number of observations useful for the delimitation of functional areas, especially cross-border areas, is small. This limits the precision of the delimitation.

For areas of social or economic life, for ecological phenomena, for which models of cross-border functional areas are a good analytical tool to support decision-making and management processes, official statistical surveys are not coordinated on an international scale and their frequency is insufficient for the needs of the main stakeholders, such as government and self-government administration, enterprises and their associations, social and political organisations. This is due to the high cost of statistical surveys and the long time needed to fully develop the survey results, resulting in models of cross-border functional areas.

The governmental and self-governmental administrations and official statistics bodies of the EU member states attach various importance to statistical research on cross-border economies. Poland is one of the few countries

where the study of cross-border processes is one of the priorities in the programmes of methodological work and official statistical surveys. The Statistical Office in Rzeszów is a leading institution in this field in Poland and in the European Union.

The harmonisation of official statistical survey programmes incorporating surveys of cross-border economies into the canon of official surveys on an international scale is a prerequisite for the creation of a statistical basis for modelling cross-border processes and functional areas.

Due to high costs, long time, too small samples of statistical sample surveys and their limited thematic scope, alternative sources of information should be sought for the study of cross-border economies. Such opportunities have been created by the widespread use of information and communication technologies, a radical reduction in the costs of collecting and storing information, and the comprehensive "digitisation" of information systems in administration and the economy. They are referred to as "big data". This is a term that does not capture the essence of the concept. "Big data" should be understood as large, practically unlimited in quantity sets of microdata mapping elementary objects, events, processes or social, economic, technical or ecological systems primarily as large, systematically updated and supplemented, easily accessible at low cost, often negligible for the user. Data sets referred to as "big data" are, in a sense, a "by-product" of information systems serving administrations, other services carrying out public tasks, and enterprises. This information "by-product" can be used for other purposes than those for which the data were produced and collected. In public statistics, work is ongoing to use "big data" resources as a source of statistical data, instead of surveys and statistical reports. Thanks to their low cost, great detail, ongoing updating, "big data" are becoming alternative sources of information in many scientific studies. In a number of fields, official statistics in

some countries have already replaced data collection through surveys and statistical reports by calculating statistical indicators directly from data from "big data" information sets.

The term 'big data' encompasses different sets of data, relating to different objects, events and processes, of varying substantive quality, relevance, sustainability. In order for these data to be used for research, cognitive and management purposes, it is necessary to accurately identify the events, objects or processes to which these data relate and the purposes and functions of the information systems in which these data are produced and stored. In particular, the following should be distinguished:

- Registry data: information describing specific social, economic, technical objects. E.g. records of population, economic and social entities, machinery, equipment, structures, infrastructure objects.
- Inventory data: information collected in accounting and other management information systems in enterprises, public administration units, records kept by public administration bodies, social welfare, health, public safety, etc.
- Transaction data: information that is generated as a basis for and as a result of economic transactions. E.g. purchase and sale transactions, transfers in the banking system, financial transfers in the tax, customs and social security systems, transactions generated by the use of toll roads, etc.
- Monitoring data of selected sites or processes: information resulting from the observation of specific sites, objects or processes, e.g. data from monitoring state border crossings by motor vehicles and people, data on terrestrial objects resulting from remote sensing or from the digitisation of satellite images,

- Data collected and shared on the web, stored in web-enabled servers; it is information with difficult to identify sources, of indeterminate quality, and of uncertain utility. Artificial intelligence (AI) methods of factual data analysis can be used to find information on the web that is relevant to specific needs and meets the required quality criteria, and to reject information that does not meet these criteria. Work on artificial intelligence methods and their use for obtaining data useful for scientific research and practical activities of administration and entrepreneurs is *in statu nascendi*. Their practical effects in some areas can be expected in the near future,
- Factual data produced by different information actors and information systems: information resulting from scientific research, from exploratory work for cognitive purposes or for public institutions or organisations with economic activities, and others.

In countries advanced in terms of digitisation of administration and economy, which include most of the member states of the European Union and the European economic region, there is already now (2021) the possibility of using some of the above-mentioned "big data" resources as a source of information for cross-border research and modelling of functional cross-border areas. Such an opportunity has arisen in those areas where the European Commission, through directives regulating certain common EU policies, has introduced uniform information requirements and standards for the entire EU economic area, including the standardisation of infrastructural information systems in individual countries. International unification and standardisation of internal information infrastructure of individual countries within the EU and cooperating countries concerns in particular such areas as:

- basic administrative records and registers (e.g. population, units of territorial division of the country, entities of national economies, certain facilities and equipment),
- the deep harmonisation of official statistics within the European Statistical System,
- harmonisation of tax, customs, health insurance, social security and internal security systems,
- harmonisation of selected alert systems, gathering information on incidents requiring a cross-border security response,
- uniform information systems covering the fields covered by specific common EU policies, e.g. common agricultural policy, climate policy, information systems for monitoring compliance with production limits in the fields in which they are maintained, use of the Structural Funds, etc.

The above-mentioned examples of information systems generating and storing "big data" type resources indicate that they provide or should provide in the near future a good and low-cost information basis for cross-border research and studies on cross-border functional areas.

The advantage of internationally harmonised information systems producing "big data" as information sources for modelling cross-border functional areas is the comparability of data at the level of elementary objects described or monitored in information systems in all countries. In the European region, a household in Poland as a statistical unit does not differ from a household in Slovakia, Ukraine, Belarus or Spain, micro, small or medium-sized enterprises as units conducting economic activity in different countries do not differ from each other, although their definitions in official statistical systems may be slightly different. Transactions in retail trade of goods and

services from an economic point of view do not differ. Transactions in banking or insurance systems are identical as economic transactions on a world scale. Similarly, other events and objects as units of economic or statistical observation are defined and identified in the same way internationally.

The information collected in administrative registers, systems that handle economic transactions, business record systems, especially in business networks operating internationally in Europe, banking, telecommunications and other systems, relates to identical or nearly identical social and economic objects. Thus, using those gives "primary comparability" of international source data. These sources thus fulfil the basic condition required for modelling cross-border processes.

The barrier to the use of infrastructural information systems generating and storing big data for modelling and delimitation of cross-border economies and functional cross-border areas is not a lack of data or lack of technical capacity to access this data. In many countries, legal barriers exist that limit the possibility or even prevent the use of these data for purposes other than those for which they were produced. The second barrier, and not so much the barrier as the difficulty of using microdata classified as "big data" for research and statistical purposes, is that the information systems producing and storing these data are often technologically dispersed, have different operators, different data access procedures and different metadata standards making it difficult to integrate the data without uniform metadata, classifications and codes. The legal barrier seems to be more difficult to overcome. Admittedly, the rights of official statistics to use all sources of information for statistical purposes are enshrined in ratified UN documents as well as in EU and national legal acts. However, most big data managers take the view that since there is no explicit obligation in their internal data management regulations to provide access to "their" data to specific statistical authorities,

research institutes or municipal or city governments, they have no obligation to make the information available. Every lawyer knows that this is a fundamental misunderstanding of the principle of unity of rights and obligations, which is one of the foundations of law in democratic countries. However, the same lawyer knows that a tax information provider, a telecommunications concern or a multinational financial corporation is more powerful in the practical application of the law than a regional statistics office, researchers at universities in border towns or a local authority. Harmonisation of the law that unambiguously establishes the obligation to provide access to data for research and statistical purposes while observing all the rules protecting such data from unauthorised access and use contrary to statistical and research purposes is a task for international organisations dealing with security in the conditions of global information systems and new information needs of society, the state and the economy.

The above analysis of the possibilities of obtaining new sources of information thanks to modern ICT technologies, especially the use of "big data", shows that the added value of the above presented research on the methodology of delimitation and specific models of cross-border functional areas is the identification of information needs and information gaps that exist in official systems of social and economic information. Inconsistent legal regulations, which differ from country to country, concerning access to spatially identifiable data in big data resources not only hinder access to data, but also prevent the harmonisation of data on cross-border economic areas even if it is possible to use certain big data resources separately in individual countries. The identification of unnecessary legal restrictions on access to social and economic events, objects and processes identified in geographical space would be an important practical outcome of further research work on cross-border functional areas.

7. Conclusions and summary

This monograph is a contribution to the theory and methods of cross-border economics, their application in practice and indication of the directions of further research. The above considerations concerning the methods of delimitation of cross-border functional areas (Chapters 2-4) and the exemplification of the application of these methods to delimitation of selected functional areas in border regions of Poland and countries bordering Poland (Chapter 5) constitute a contribution to cross-border economics - a new field within economic sciences. The study focuses on socio-economic processes taking place in neighbouring territories belonging to different countries, with different economic and political systems, different legal regulations of economic processes, and differences in the scope and access to information about these processes.

A key problem of cross-border economics is the precise spatial delimitation of cross-border economies. The delimitation of the geographical, economic and social space affected by cross-border processes is the basis for socio-economic policies and activities of all actors in border regions. The geographical space of the cross-border economy also indicates the scope of necessary co-operation between local government units, economic and social organisations, for mutually beneficial development of border regions.

In the case of territorially smaller countries, cross-border processes have macroeconomic significance. The whole territory of a spatially smaller country may have a cross-border economy. Cross-border processes in certain areas of the economy**,** infrastructure or cross-border ecological resources may have a macroeconomic impact. Such phenomena also occur in spatially larger countries if economic activities, infrastructure systems or natural resources

of macroeconomic importance for the whole country are concentrated in the border region, for example in areas such as energy, water, air or land transport, water management or environmental protection.

The macroeconomic importance of cross-border economies is increasing with the progress of international market liberalisation and institutional integration of national economies in various forms, e.g. EU, EVRAZEC, NAFTA.

In methodological work within the framework of cross-border economics, the authors of this publication have chosen an approach that seems to be a priority at the current stage of development of this field of economic sciences, namely the delimitation of a cross-border economy as a complex of multiple functional areas identified in the border territories of two or more countries. As mentioned above, in the case of spatially small countries, some cross-border functional areas may cover the entire national territory.

It seems that the approaches and methods of delimitation of cross-border areas presented in this monograph and verified in Chapter 5, to the extent possible within the framework of available statistical data, not only enrich cross-border economics as a field in economic sciences, but can and should be applied in practice, in the elaboration of regional development strategies and, in some areas, also in decision-making of macroeconomic importance. In particular, models of cross-border functional areas could provide information support for decisions on major infrastructure investments of regional or macroeconomic importance.

Under the conditions of a modern knowledge-based market economy and ever deeper economic integration, an important support from economics

and official statistics for economic policy and business would be the development of models for the whole country, for all border regions, of cross-border economies as complexes of cross-border functional areas.

A condition for the realisation of this research and, at the same time, a barrier to the application of the already developed methods of cross-border economics is the insufficient harmonisation of official statistical data from different countries and difficulties in accessing source data from other information systems, in particular "big data" collections. Identification of the needs, gaps in available data and information barriers of activities that are necessary to provide the information necessary for modelling cross-border economies is an important research task that can be carried out within the framework of international scientific cooperation of interested countries. In turn, the enrichment of official statistical data with the information needed for cross-border studies could be carried out in the European Union within the framework of the European Statistical System.

The research problems, which should be undertaken within the framework of cross-border economics, are also the development of methods of bringing to comparability the data available in the statistical and administrative systems of different countries, and especially the practical use of "big data" resources as sources of data on cross-border economies. The topics of further cross-border research within the framework of international cooperation include the identification of "big data" information resources containing relevant data for cross-border economies in different countries, the identification of conditions and barriers for the availability of these data, the development of proposals for legal, organisational and technical measures for accessing these data and the development of methods for transforming data

from "big data" collections into relevant, internationally comparable statistical data and their harmonisation with official data developed by the statistical offices of individual countries.

Cross-border economics and the application of methods for modelling cross-border economies carried out within its framework can fulfil the role of a stimulator of internationalisation of scientific research in the field of economics, statistics, law and administration and other social sciences. In fact, the research problems mentioned above can only be solved through the co-operation of economists, statisticians, information systems managers and practitioners involved in the elaboration of development strategies of many countries.

Bibliography

[1] Bartosiewicz B., Delimitacja obszarów funkcjonalnych małych i średnich miast w regionie łódzkim, Studia Miejskie, tom 18, 2015

[2] Bocian A. (ed.), Podlasie – wizje przemian i rozwoju, Publ. Fundacja Promocji Rozwoju Podlasia, Białystok 2016

[3] Bocian A., (ed.), Globalizacja, etyka, polityka, Tom V, Wydawnictwo Uniwersytetu w Białymstoku, Białystok 2014

[4] Cierpial-Wolan M., Border traffic and movement of goods and services – methodology and results, in: Cierpiał-Wolan M., Lasek D., Oleński J., (ed.), Foundations of transborder economics and statistics, Publ. Carpathia, Rzeszów 2014

[5] Cierpiał-Wolan M., Lasek D., Oleński J. (ed.), Foundations of transborder economics and statistics, Publ. Association of the Carpathian Euroregion, Rzeszów 2014

[6] Cierpiał-Wolan M., Oleński J., Wierzbieniec W. (ed.), Transborder economics - new challenges of regional development in democratic world, Wydawnictwo Państwowej Wyższej Szkoły Techniczno-Ekonomicznej w Jarosławiu, Jarosław 2013

[7] Czech-Szkic E., International outsourcing as the instrument of strengthening and intensifying economic cooperation in transborder economies, in: Cierpiał-Wolan M., Lasek D., Oleński J. (ed.), Foundations of Transborder Economics and Statistics, Publ. Association of Carpathian Euroregion Poland, Rzeszów 2014

[8] Delimitacja krok po kroku, Oprac. Instytut Rozwoju Miast, Publ. Ministerstwo Inwestycji i Rozwoju, Warszawa 2019

[9] Dobrzyńska E., Europejskie klastry logistyczne, Ekonomia i Zarządzanie, 2011

[10] Dołzbłasz S., 2015, Symmetry or asymmetry? Cross-border openness of service providers in Polish-Czech and Polish-German border towns, Moravian Geographical Reports, 23 (1), pp. 2-12

[11] Dołzbłasz S., Raczyk A., 2010, Współpraca transgraniczna w Polsce po akcesji do UE, Wolters Kluwer Polska, Warszawa

[12] Dołzbłasz S., Sieci współpracy transgranicznej na pograniczach Polski, Rozprawy naukowe Instytutu Geografii i Rozwoju Regionalnego 40, Uniwersytet Wrocławski, Wrocław 2017

[13] Fukuyama F., Zaufanie – kapitał społeczny a droga do dobrobytu, Publ. PWN, Warszawa 1997

[14] Gawroński H., Miejskie, wiejskie, specjalne – obszary funkcjonalne podstawą dla zintegrowanych inwestycji terytorialnych, https://www.prawo.pl/samorząd/ obszary-funkcjonalne-miejskie-wiejskie-specjalne.982111.html

[15] Gerber J., Lara F., De la Parra C., 2010, Reimagining the U.S.-Mexico Border: Policies towards a More Competitive and Sustainable Trans-border Region. Global Economy Journal 10(4): 1-17

[16] Grycuk A., Klastry jako instrument polityki regionalnej, „Infos", Biuro Analiz Sejmowych, Warszawa 2010

[17] Jastrzębski L., Obszary funkcjonalne w polityce rozwoju województwa zachodniopomorskiego, Regionalne Biuro Gospodarki Przestrzennej Województwa Zachodniopomorskiego, Szczecin 2016

[18] Kieżun W. (ed.), Sprawniejsze państwo, Wydawnictwo Poltext, Warszawa 2015

[19] Kłosiewicz-Górecka U., Klastry – idea i praktyka w Polsce, Handel Wewnętrzny, 4/2011

[20] Komornicki T., Wisniewski R., Miszczuk A., Delimitacja przygranicznych obszarów problemowych, Przegląd Geograficzny 2019, 91,4, pp.

467-486, Instytut Geografii Przestrzennego Zagospodarowania PAN, Warszawa

[21] Komornicki T., Wiśniewski R., Miszczuk A., 2019, Delimitacja przygranicznych obszarów problemowych, Przegląd Geograficzny, no. 91, 4, Instytut Geografii i Przestrzennego Zagospodarowania PAN, Warszawa, pp. 467-486

[22] Koncepcja przestrzennego zagospodarowania kraju 2030, Opracowanie Komitetu Przestrzennego Zagospodarowania Kraju PAN, Warszawa 2011

[23] Markusen A., A typology of industrial districts, Economic Geography, No.72, July 1966

[24] Mikolajczyk B., Kurczewska A., Fiła J., Klastry na świecie, Difin 2009

[25] Mroczek K., Tokarski T., Trojak M., Grawitacyjny model zróżnicowania ekonomicznego rozwoju województw, Gospodarka Narodowa, No. 3/2014

[26] Nadvi K., Barrientos S., Industrial Clusters and Poverty Reduction, UNIDO, Vienna 2004

[27] Oleński J., Asymmetry of economic potentials as the foundation of development and integration of economies in trans-border regions, in: Cierpiał-Wolan M., Oleński J., Wierzbieniec W. (ed.), Trans-border economies – new challenges of regional development in democratic world, Wydawnictwo Państwowej Wyższej Szkoły Techniczno-Ekonomicznej w Jarosławiu, Jarosław 2013

[28] Oleński J. (ed.), Alternatywne źródła pozyskiwania danych statystycznych, Systemy Informatyczne, tom 1/1990, Publ. OBRS, Warszawa 1990

[29] Oleński J., Infrastruktura informacyjna państwa w globalnej gospodarce, Publ. Nowy Dziennik, Warszawa 2006

[30] Oleński J., Strategie rozwoju e-państwa w perspektywie 2030 roku, in: Roczniki Kolegium Analiz Ekonomicznych Szkoły Głównej Handlowej, zeszyt 48/2018, Warszawa 2018

[31] Oleński J., Tolerancja ekonomiczna, Gospodarka Planowa, No. 8-9/1967

[32] Oleński J., Klastry transgraniczne jako stymulanty rozwoju i współpracy w warunkach otwartej gospodarki rynkowej, in: Miszczuk A. (ed.), Wyzwanie rozwojowe pogranicza polsko-ukraińskiego, Wydawnictwo Norbertinum, Lublin 2017

[33] Porter M., On Competition, 2nd ed., Harvard Business School Publ., Boston 2008

[34] Porter M., The Competitive Strategy, Technique for Analyzing Industries and Competitors, Free Press, New York 1988

[35] Practical Guide do Clusters Development, DTI, London 2004

[36] Raczyk A., Dołzbłasz S., Leśniak-Johann M., 2012, Relacje współpracy i konkurencji na pograniczu polsko-niemieckim, Wydawnictwo Gaskor, Wrocław

[37] Reitel B., 2006, Governance in Cross-border Agglomerations in Europe - The Examples of Basel and Strasbourg. Europa Regional, 14(1): 9-21

[38] Rosenkiewicz K., Obszary funkcjonalne jako nowa kategoria polityki regionalnej i polityki przestrzennej w Polsce, in: Rozwój regionalny i polityka regionalna No. 47/2019, Publ. Uniwersytet im. Adama Mickiewicza w Poznaniu, www.pressto.amu.edu.pl

[39] Rugemer C., The Fragility of Gigantism, eu.europa.eu/research/research-eu/article_earth22, Special Issue 2008

[40] Szkic-Czech E., Automatic road traffic measurement – the system of economic monitoring of transborder cooperation and integration, in:

Cierpiał-Wolan M., Lasek D., Oleński J., (ed.), Foundations of transborder economics and statistics, Publ. Carpathia, Rzeszów 2014

[41] Szkic-Czech E., Transborder outsourcing – new method of syneryzing the resources of national economy, in: Cierpial-Wolan M., Lasek D., Olenski J. (ed.): Foundations of transborder economics and statistics, Publ. Association of Carpathian Euroregion, Rzeszów 2014

[42] Śleszyński P., Delimitacja miejskich obszarów funkcjonalnych stolic województw, Przegląd Geograficzny, 86(2), 2013

[43] Ustawa z dnia 27 marca 2003 roku o planowaniu i zagospodarowaniu przestrzennym (z późniejszymi zmianami), Dz.U. 2020.0.293, Rozdział 4a

[44] What are Industrial Clusters, RTA, San Diego Association of Governments, www.sandag.rta.org

[45] Wisła R., Filipowicz K., Tokarski T., Zróżnicowanie rozwoju ekonomicznego krajów UE na podstawie modelu grawitacyjnego wzrostu, Wiadomości Statystyczne, No. 7 (686)

[46] Zacher L., Pułapki urbanizacji w perspektywie globalnej, in: Kleer J., Strzelecki Z. (ed.), Megamiasta przyszłości – szanse czy zagrożenia rozwoju, Publ. Komitet Prognoz „Polska 2000 plus", PAN, Warszawa 2015