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Territorial trauma or modernization experience? The Kraków Metropolitan Area and Silesia as case studies affected by intensive energy transition processes

Introduction

The growing consequences of climate change result in the necessity to take measures that limit their potential impact. The decarbonization strategies are observed at national and international levels and applied to all sectors, including power generation, heating, transport, industry, and households aiming at low- and zero-emission changes in economies from the

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perspective of energy generation and consumption. However, until the ambitious climate goals are achieved, transition processes are inevitable.

Poland, due to its significant resources of coal, is one of the countries in which the decarbonization processes imply numerous challenges. The challenges are related to technological, environmental, economic, and social aspects. Although the development of capacities installed in wind farms and solar PV technologies have recently dynamically increased, considering the specifics of the variable renewable power generation units, the majority of electricity is still produced in coal power plants and combined heat and power plants with a slight increase in natural gas use. The burning of fossil fuels generates greenhouse emissions which have a negative impact on the environment. However, changing fuels in the power system, industry and households requires the replacement of infrastructure, which entails additional costs.

In Poland, particularly in Silesia, local communities used to have very strong personal attachments to their areas. Mines located in the region provided the highest levels of employment and gathered entire families around the mining industry, they also spurred the development of the region. Therefore, it is of the utmost importance to identify and deal with the challenges in a transitional period, including social challenges.

With this in mind, the presented study was aimed at investigating the impact of the energy transition on local communities in the Kraków Metropolitan Area and Silesia, including socio-cultural and socio-psychological aspects. Correlations factors related to the socio-psychological components in these regions are also examined and compared.

Although a growing number of studies examining decarbonization in Poland have been observed, no work focuses on the socio-psychological aspects and territorial traumas and stigmas of this process. The present study addresses this gap in the literature and contributes to the existing literature in the following manner. First, it provides a comprehensive analysis of the social perception of the coal phase-out in Poland. Second, it compares the approach of local communities in southern Poland, depending on the approach to tackling energy transition. Finally, it extends the technological and environmental discussion about decarbonization and its consequences with social perspectives, which is of the utmost importance in the sustainable development of the regions historically dependent on coal and carbon-intensive fuels in the power sector, industry and households.

The study constitutes a part of the work conducted within the project “Energy Transitions from Coal and Carbon: Effects on Societies” (acronym: ENTRANCES). The aim of the project is to investigate the challenges facing eleven regions that are highly dependent on fossil fuels in the process of the energy transition, divided into coal and carbon-intensive regions. Apart from the technological and environmental elements, the project focuses on the socio-economic-psychological aspects of transition, which have an impact on the daily life of local communities (ENTRANCES 2020).

The remaining part of the paper is structured as follows. Section 1 describes the materials and methods of the study. Section 2 presents the research framework applied to the study. Section 3 provides a description of the Silesia region and the Kraków Metropolitan Area as case studies. Section 4 defines territorial trauma and territorial stigma. Section 5 discusses

the results from a socio-cultural dimension, while Section 6 delves into the socio-psychological dimension. Finally, we conclude the analysis and provide the main remarks.

1. Materials and methods

The main objective of the ENTRANCES project and chosen case studies was to investigate challenges facing the coal and carbon intensive regions in the energy transition. Three research questions were posed for this purpose, referring successively to an in-depth description of the situation of regions defined as coal and carbon intensive regions (RQ1), the identification and analysis of the causes of deterritorialization and reterritorialization processes (RQ2) and the search for policies supporting the processes of reterritorialization of regions (RQ3). The research questions were formulated as follows:

- ◆ RQ1: What are the main socio-economic, socio-technical, socio-environmental, socio-cultural, socio-political, socio-psychological and gender challenges faced by carbon-intensive regions in transition? What strategies for dealing with them have emerged in recent years?
- ◆ RQ2: What variables have had the greatest impact on the emergence of the reterritorialization process and how do they interact with each other? What types of strategies are a key determinant of success in reterritorialization?
- ◆ RQ3: What policy or policies combination would be most appropriate to reconnect territory and communities in carbon- and coal-intensive regions while supporting their clean energy transition?

The project focused on two types of regions. The coal regions, in which coal mining is the driving force for the regional economy. In the Polish case, this was represented by the region named Silesia (SKL), specifically the Katowice subregion (PL22A according to the NUTS3 classification). Another type of regions in the project are the high-emission regions, in which the intensive use of coal and/or other fossil fuels causes a significant deterioration of air quality. In Poland, it was represented by the Kraków Metropolitan Area (KMA), (PL213 according to the NUTS3 classification). The multi-threaded and multi-level analysis reflected in the research questions required the division of case studies into several areas and units of analysis. In the process of delineation of research spaces, three perspectives were selected in the Katowice subregion (Silesia) and in the area of the KMA:

- ◆ **Coal and Carbon Territory (CCT)** – an area where coal and carbon are an important element of local identity or are a key asset for income and employment opportunities of the local community.
- ◆ **Labour Market Area (LMA)** – the area covering the CCT where most of the workforce lives and works.
- ◆ **Political Administrative Region (PAR)** – an area covering CCT related to the management of the energy transition through a directly elected legislative authority and government representatives in this area.

2. Research framework

The activities undertaken in the ENTRANCES project were aimed at an interdisciplinary analysis of five components that constitute the dimensions of the functioning of both coal regions and carbon-intensive regions.

When building the Multidimensional Analytic Framework (MAF), every component was assigned an appropriate approach. Each of these described a different unit of observation and used a different method of observation (Table 1).

For the purposes of this paper, only the socio-cultural and socio-psychological components are presented. Both had a research orientation focused on the territorial change of selected regions. The latter is understood here as those events in the history of the region that significantly and permanently influenced the economic landscape and forced a change in social practices related to functioning in this area. However, it was important to notice all activities that were related to the abandonment of coal mining (Silesia) or the reduction of coal use (KMA).

The socio-cultural component is understood here as research action aimed at assessing the socio-cultural stress induced by decarbonization policies. The primary research method conducted was the use of focus groups. The focus group interviews were conducted online in May 2022, using Microsoft Teams and the Miro Platform. During meetings with experts, the participatory mapping of strain situations techniques was used. Participants were

Table 1. Synoptic table of five components of the Multidimensional Analytical Framework

Tabela 1. Zestawienie cech pięciu rozważanych komponentów Wielowymiarowych Ram Analitycznych

Component	Research Focus	Unit of analysis	Domain of analysis	Unit of observation	Methodology
Socio-Cultural	Territorial change	Coal and carbon territory	Stress strains in the territorial organization	Strain situation	Focus-group mapping
Socio-Psychological	Territorial change	Coal and carbon territory	Place attachment, decarbonization resilience and coping	Citizens	Online survey
Socio-Economic	Structural change	Labour-market area	Change in the socio-economic structure	The area as a whole	Quantitative data collection
Socio-Political	Clean energy transition	Political administrative region	Narrative battles to determine the meaning and “appropriation” of the energy transition	Statements and counterstatements	Text research
Socio-Ecological & Technical	Clean energy transition	Political administrative region	Capacity available in the region to shape its decarbonization pathway	Multilevel system interaction	Semi-structured interviews

Source: Caiati 2021.

recruited according to demographic factors and also according to the sectors of the economy they represent. Seven experts participated in the KMA workshop and eight in Silesia.

Through the socio-psychological component, which is the subject of our detailed analysis, cognitive and emotional dynamics contribute to the determination of a set of different coping strategies for the inhabitants of the coal and carbon-intensive territory. The primary research method conducted here was the application of online surveys (CAWI – Computer Assisted Web Interview). The selection of respondents was performed by Ariadna – the largest research panel base in Poland, which has over 300,000 registered and verified users. The sampling strategy used in both regions was based on a quota approach. The frequency distributions of two variables were used (gender and age with three categories: 16–34; 35–54; 55+). A total of $N = 458$ interviews were conducted in both studied regions ($N = 234$ in the KMA and $N = 224$ in Silesia). The research technique was based on assessing individual psychological scales through an online questionnaire and putting them against the features of the regional context.

3. Research areas

3.1. Silesia

The Silesian voivodeship is the most coal-dependent region in the European Union, and mining plays a crucial role in the local economy. However, in recent years, there has been a gradual decline in the significance of this sector due to reduced production caused by lower efficiency and the low profitability of mines. According to data from the European Commission, the number of people employed in mines in the EU is nearly 185,000, with over half of them being Polish. The Silesian voivodeship is the leader in this area, employing 79,500 people in mines. The share of the Silesian voivodeship in employment in the mining sector accounts for almost 80% of those employed in mines in Poland and 43% of those employed in the EU (JCR 2018).

In the process of the systemic transformation of the country's economy, a total of twenty-nine coal mines were closed. The reason for the liquidation was their permanent unprofitability, and recently, also a change in trends in the use of coal. As a result, there was a significant decrease in coal production from 177.4 million tons in 1989 to about 52.8 in 2022 as well as a decrease in the number of employees from 415,700 in 1989 to about 75,500 in 2022 (Tkocz 2006; Data Hub 2023). The closure of coal mines and the loss of the labour force are causing considerable concern and stress for local residents.

In 2019, the Silesian voivodeship produced 21,556.8 GWh of electricity in four power plants, placing it third among all voivodeships in Poland. The main source of electricity remains coal, while the share of renewable energy is small (4.4%) (Local Data Bank 2023). A similar situation is observed in heat production. In 2019, the Silesian voivodeship pro-

duced 44,786,294 GJ of heat in district heating companies. Coal is the primary source of heat in the region, accounting for 75.4% of total production. The share of heat from renewable sources was 2.8% (mainly biomass). At the national level, 64.9% of heat is produced in cogeneration, while in the Silesian voivodeship, it is only 58.6% (26,238.2 TJ). Heat for residential buildings is also generated in boiler rooms. In 2019, there were 33,858 such facilities in the entire country, with 11.8% (4,006 facilities) located in the Silesian voivodeship (Thermal energy... 2020).

It is worth noting that in recent years, the Silesian voivodeship has been the largest consumer of hard coal in Poland. In 2019, the region consumed a total of 16.5 million tons of this raw material, which accounted for 24.1% of the national consumption. With regard to the consumption of hard coal in households, the Silesian voivodeship was the leader, consuming about 1.2 million tons in 2019, surpassing other regions (Thermal energy... 2020). The intensive use of hard coal in both the power industry and in households had a negative impact on air quality in the region and CO₂ emission.

The Silesian voivodeship is facing air pollution problems mainly due to surface emissions and point sources. Surface emissions (also known as “low emission”) come mainly from residential and municipal sources. In 2019, these constituted the largest share in the emissions of pollutants such as suspended particulate matter (PM₁₀ and PM_{2.5}) and benzo(a)pyrene (BaP). Point sources primarily contribute to the emissions of nitrogen dioxide (NO₂) and sulphur dioxide (SO₂). In addition to emissions from low sources, the Silesian voivodeship also struggles with air pollution associated with its developed industrial sector (Annual assessment... 2020).

In 2018, carbon dioxide was the most significant air pollutant in the Silesian voivodeship, accounting for 98.1% of the emissions. Methane ranked second, contributing to 1.3% of the total gas pollutants. The Silesian voivodeship was the leader in methane emissions, accounting for 91% of national emissions, and it ranked second in carbon dioxide emissions, representing 16.8% of the national emissions. This trend has persisted over the past decade. However, it is encouraging to note that in recent years, the Silesian voivodeship has been observing a systematic decline in these emission levels (Development potentials... 2022).

3.2. Kraków Metropolitan Area

The Kraków Metropolitan Area (*Krakowski Obszar Metropolitalny* – KMA) is a peculiar functional region, including the city of Kraków and a neighbouring complex of settling units connected with the metropolis by different interactive relations. Kraków is among the oldest cities in Poland and ranks as the second largest city in the country. It is renowned for being a cultural and scientific hub. Kraków’s industrial roots can be traced back to the mid–19th century, with the emergence of large-scale factories in the early twentieth century after World War II. The Lenin Smelter, the city’s largest industrial facility, was the most

significant investment during this period. However, it was also responsible for the highest levels of air pollution and odour intensity in the region.

The KMA area is highly contaminated in terms of air quality, making it one of the most polluted areas in Poland and Europe. The use of solid fossil fuels in households, public buildings, local heating plants, and power plants has been the main reason for air pollution, especially in communes that are situated in close proximity to Kraków.

Solvay Soda Works and Bonarka Chemical Works, both of which were present before the war and expanded later, also contributed to the city's pollution. These factories have since been shut down and commercial and office buildings have taken their place. Kraków also hosts other industrial plants such as the Cement Works in Pleszów, Armatura Krakowska, Polfa, and many more. The city is home to various industries such as metallurgy, chemicals, pharmaceuticals, tobacco, machinery, clothing, food, electrical engineering, printing, leather, and footwear. In the neighbouring town of Skawina, the aluminium smelter was established after the war, and it remained a major source of pollution in the KMA area for decades. The electrolysis plant operating at the smelter was the most problematic, and it was closed down in 1981 after numerous protests. Nowadays, the Skawina smelter uses more modern technology and has a reduced impact on the environment compared to the past. The heat and power plant in Kraków, being the main source of electricity for the region and heat for Kraków is based on coal. The power plant produces around 1.1 Mg CO₂/MWh, and in 2021, it emitted a total of 1.658 million Mg of CO₂ (PGE Portal 2023). In addition to this, a combined heat and power plant located in the Skawina area supplies district heating to the KMA.

The steel production industry was the most energy-intensive industry in Kraków. However, in the nineteen-nineties, the most environmentally harmful branches of the plant were closed. In 2018, the workforce was reduced to 3,500, and in May 2019, the owner, ArceelorMittal Poland, decided to shut down the blast furnace and steel plant due to high electricity prices, the cost of carbon certificates, and a global slowdown in the steel market (Stuch 2020).

Although since 2019 there has been a ban in Kraków on using coal for heating and cooking, more than 50% of households in communes surrounding Kraków use hard coal as basic fuel. The process of decommissioning old coal-fired boilers has been ongoing in these municipalities since 2015, and in 2017, over 7,000 boilers were replaced in the KMA, with 6,114 being in Kraków. In 2018, over 16,000 boilers were replaced in the entire Lesser Poland voivodship, with 4,256 being in Kraków (Summary... 2023). The main objective of the decommissioning process was to eliminate low emissions, including PM10, PM2.5 dust, and benzo-a-pyrene emissions.

The industry and construction sectors accounted for 27.7% of consumption, while small consumers such as agriculture, households, and other used 19.8%. Additionally, hard coal was used in public thermal plants, heat-only boilers in public power plants, and auto-producing thermal plants, although these sectors had lower consumption rates. The majority of hard coal was used in Kraków and Skawina's power plants and CHP plants,

with 787 thousand Mg and 130 thousand Mg consumed, respectively ([Local Data Bank 2023](#)). With the implementation of European climate policy and Polish legislation, hard-coal consumption is expected to decrease significantly in the future, leading to the refurbishment of local units in the coming years.

Kraków has been grappling with air pollution issues for many years due to its location in a basin, the presence of industrial plants within the Kraków Metropolitan Area (KMA), and the widespread use of classless coal and wood-fired boilers for heating in households. The issue gained increased attention in the 2010s with the availability of air-quality monitoring devices and access to accurate data. There were instances when Kraków ranked among the top three European cities with the highest levels of harmful pollutants in the air and among the top ten cities with the worst smog in the world. In response, there were protests and grassroots initiatives leading to the introduction of a law in Kraków and, subsequently, in the entire Lesser Poland voivodship aimed at addressing the problem. Currently, Kraków's air quality is improving.

In 2016, the city authorities managed to implement the Anti-Smog Resolution in Kraków, aimed at tackling air pollution in the city. The resolution, starting from September 1, 2019, allows the use of only gaseous fuels or light fuel oil in combustion installations in Kraków. The regulation applies not only to private buildings but also to public institutions, catering facilities, greenhouses, and others. This means that solid fossil fuels such as coal and biomass are not allowed to be used in any fuel combustion installations. However, the resolution does not prohibit district heating and electricity generated by hard-coal-fired power plants. The Air Protection Program for Małopolska ([Lochno et al. 2019](#)) is an important document that is part of the strategy to improve air quality in the city. This document has set out new responsibilities for the city government in terms of actions that need to be taken to achieve this goal. At the regional level, the Kraków Metropolitan Area is the main actor responsible for developing a strategic framework. One of the key objectives in this context is to achieve a high quality of life in the surrounding areas. Social and cultural aspects are also taken into account as part of this effort to decarbonize the region.

4. Territorial trauma and territorial stigma

The energy transition is currently one of the most significant challenges facing civilization. This is reflected, for example, in documents such as the Paris Agreement. Although there is broad agreement at the EU level on the objectives set out in the Paris Agreement, the challenge is to implement them at the regional level. This is particularly true in regions where fossil fuels are intensively used or where fossil fuel extraction is an important part of the regional economy. The energy transition of these regions can lead to tensions and conflicts with many negative consequences. The energy transition process goes beyond the mere technical and technological aspects of moving to clean energy sources. At the regional level, it is crucial to understand the political, economic, socio-cultural and psychological

aspects accompanying the changes. Therefore, in the ENTRANCES project, the key analytical category is territory and the people on that territory and finally what consequences the transition has on many aspects of that territory (region). Regions intensive in the use or extraction of fossil fuels are exposed to such changes, which in many cases are felt to be painful by local communities because they can generate forms of deterritorialization, i.e., a process of the progressive weakening of the links between the local community and its territory. Deterritorialization, in turn, can lead to social deprivation, as well as migration processes and regional depopulation.

The transition to clean energy is, therefore, one of the factors that may also generate other negative consequences, such as an increase in social tensions and local conflicts around the transition away from fossil fuels, the rise of nationalist sentiments and populism over time moving from the local to the national and EU level.

In order to capture the dynamics of the complex processes of territorial impacts of the transition, the project adopted a complementary theoretical and methodological framework allowing for knowledge integration. In accordance with this, a Multidimensional Analytical Framework was adopted. The Multidimensional Analytical Framework consists of five components, each based on a set of specific concepts and methodologies (see Table 1).

This paper presents the results obtained for two components – socio-cultural and socio-psychological – within which the Coal and Carbon Territory (CCT) was the unit of analysis. The choice of such a delimited area was dictated by the assumption that the territory, even without formally defined boundaries, is a form of social organization and is subject to the influence of external and internal factors that cause tensions forcing changes in the organization of such a delimited social space (Bertrand 1963; Spiesberger et al. 2021). In the theory of “stress-strain”, it makes it possible to grasp the stressors acting on a social organization by analysing the tensions and conflicts that arise when a territory is unable to adapt to the dynamics of change and maintain stability in the face of the stressors that arise. In this sense, tensions and conflicts can be considered as a manifestation or indicator of the territorial organization’s response to emerging changes. Stressors can be analysed at several levels.

The socio-cultural level involved the analysis of situations generating tensions in the CCT territories, such as conflicts, contradictions or impasses causing destabilization, uncertainty and reactions at the level of the territorial organization. The study of stressors in CCTs was performed on the basis of focus-group mapping, in which local key informants participated. The informants shared their local knowledge of the stressors that have occurred and are occurring in the region as a result of various factors. A fundamental dimension of the socio-cultural analysis was to learn about those events in the regions history that most strongly affected its cultural identity and burdened society in the region. “Stress” is an element inherent to the social structure in a given institutional or organisational field that cannot be observed per se but manifests itself in “strains” of different types, such as conflicts, tensions, and ambivalences. Therefore, the “strains” can also be interpreted as the manifestation of the stress in action at the structural level (Caiati 2021). The tension-stress analysis conducted

was based on focus group mapping (or participatory mapping). The focus group consisted of local key informants who revealed their local knowledge of tensions generated by various factors related to globalization and industrialization. For the KMA, it was a two-day online session attended by seven experts representing different categories of stakeholders. In Silesia, again, two days of online FGI sessions were conducted with eight participants.

The socio-psychological level focused on analysing the impact of individual residents in territories with coal mines (Katowice sub-region) and intense pollutions caused by the use of fossil fuels (Kraków Metropolitan Area). It was assumed that the political, cultural, social and economic consequences of the closure of mines, carbon-intensive companies or the abandonment of fossil fuels as the main source of individual heat causes severe psychological stress due to the need to change lifestyles and sources of income. A concept that links the issue of territory and stressors is the so-called place attachment, which is understood as the attachment of individuals to a physical environment. Following other researchers (Raymond et al. 2010; Caiati 2021), it was assumed that place attachment consists of four vectors: place dependence, place rootedness, place identity and social bonding. In addition, a dimension of resilience was also added, which is the psychological ability to adapt positively to changes that cause stress and trauma (Luthar et al. 2000; Caiati 2021).

The study of the socio-psychological aspect of the energy transition of regions was based on a questionnaire containing ninety items representing seventeen socio-psychological constructs that have been validated by researchers in other research projects. Each item was rated by respondents based on a given scale.

5. Socio-cultural dimension of the territorial trauma and territorial stigma in Silesia and the Kraków Metropolitan Area

The participants recruited for the focus groups (FGI), separately in Silesia and the KMA, during two sessions centred on a timeline of those stories related to the region that, in their opinion, left the greatest mark on the identity and trajectory of socio-economic development.

The methodology of the work enforced the participants' agreement on the relevance of particular historical events (territorial stress situations). It should be noted that all of them had a modernization character that was in accordance with the time they happened. Importantly, within the framework of the adopted method, the historical timeline boundary was set at the end of the Second World War. Thus, all events mentioned were between 1945–2022. Participants in the FGI sessions at Silesia identified thirty-one significant and distinguishable historical events (Figure 1). Twenty-six mentioned events have shaped the character of the KMA in recent decades (Figure 2). Most of the events are exogenous in nature, which means that they are located outside the analysed territory. In the case of Silesia, six events were located inside the studied territory and in the case of KMA, only three were.

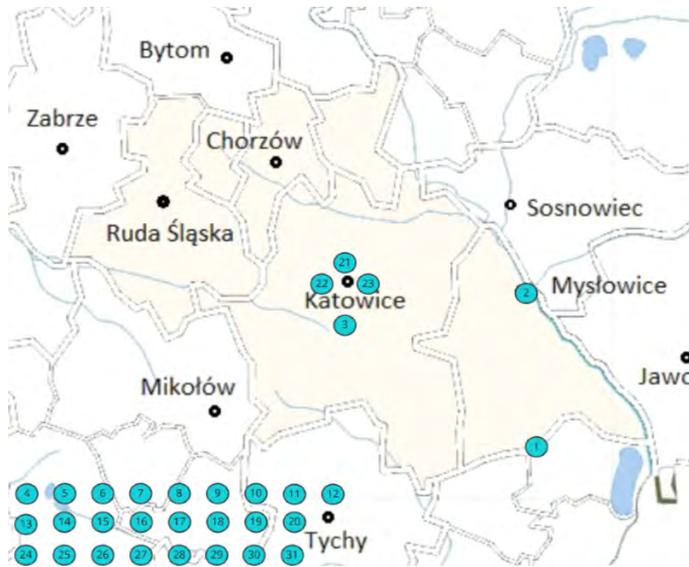


Fig. 1. Identified the main stress situations in Silesia in the years 1945–2022

Rys. 1. Zidentyfikowane główne sytuacje powodujące stres na Śląsku w latach 1945–2022

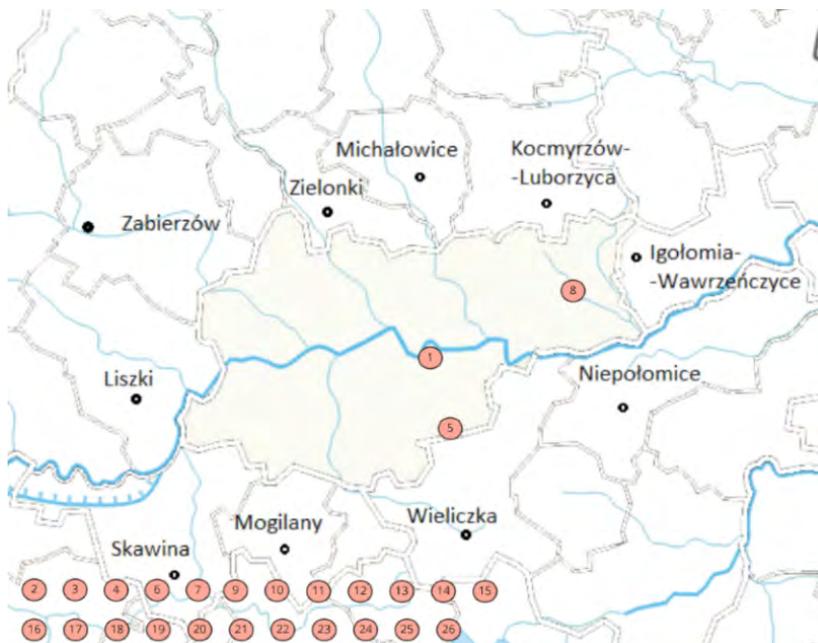


Fig. 2. Identified the main stress situations in the KMA in the years 1945–2022

Rys. 2. Zidentyfikowane główne sytuacje powodujące stres w Krakowskim Obszarze Metropolitalnym w latach 1945–2022

During the workshop, all designated events (strain situations) were clustered together with participants and then assigned to predefined types and areas.

In preparing the methodology for the FGI workshop, we distinguished four types of stress based on the direction of their impact:

- ◆ endogenous disputes and conflicts, i.e., conflicts within the local community;
- ◆ exogenous disputes and conflicts (all the other conflicts);
- ◆ impasse or contradictions (incapacity to generate viable responses);
- ◆ uncertainty and dependence (dependence from decisions or choices beyond the local community).

In Table 2, the categorization of the strain situation done by the participants of the workshops is shown. In the KMA, the participants categorized strain situations in such a way that both uncertainty and dependence dominated. For example, the issue of the decision to build and close Nowa Huta was of great importance.

In Silesia, exogenous disputes and conflicts were dominant. The main point here was that this region reflected trends and transformation processes that were characteristic for the Polish economy as a whole.

Table 2. Number of strain situations mapped in each analysed area

Tabela 2. Liczba sytuacji powodujących napięcia identyfikowanych w każdym z analizowanych regionów

	Type	Endogenous conflict	Exogenous conflict	Impasse/ /Contradiction	Dependence/ /Uncertainty
KMA	N.	5	6	3	12
	%	19.2	23.1	11.5	46.2
Silesia	N.	8	10	5	8
	%	25.8	32.3	16.1	25.8

Six areas of change were selected related to different types of global cultural flows (Appadurai 1990; Spiesberger et al. 2021):

- ◆ Financescape, related to financial flows.
- ◆ Technoscape, related to flows of technologies.
- ◆ Ethnoscape, related to flows of people.
- ◆ Ideoscape, related to flows of ideologies (structured worldviews adopted by organized groups).
- ◆ Naturescape, related to the flows of non-human elements.
- ◆ Mediascape, related to flows of images and other cultural media.

Each event was assigned to only one scape. Table 3 compares the results of this selection in both regions, while Tables 4 and 5 provide lists of identified historical events causing tensions.

Table 3. Strain situations across different types

Tabela 3. Różne typy sytuacji powodujących napięcie

		Financescape	Technoscape	Ethnoscape	Ideoscape	Naturescape	Mediascape
KMA	N.	9	4	5	4	1	3
	%	34.6	15.4	19.2	15.4	3.8	11.5
Silesia	N.	15	3	3	4	3	3
	%	48.4	9.7	9.7	12.9	9.7	9.7

There are no highly significant differences between the identified structure of the strain situations in the KMA and Silesia. However, it should be noted that most of the historical moments were linked to financial factors. In Silesia, fifteen strain situations were categorized as financescape; additionally, it is the most frequent category on the KMA. This demonstrates the strong economization of transition problems. Interestingly, participants in the FGI sessions in Silesia reported more historical events that were dominated by environmental scope.

Table 4. List of the strain situations mapped in Silesia

Tabela 4. Lista sytuacji powodujących napięcie zidentyfikowana w rejonie Śląska

	Name	Type	Area	Geo	Time
1	Attempts to obtain a concession to open a new mine (Imielin)	Exo conflict	Finance	Imielin	2020
2	Attempts to obtain a concession to open a new mine (Mysłowice)	Exo conflict	Finance	Mysłowice	2020
3	Extension of the railway line in connection with a plan to build a central transportation port in Poland	Exo conflict	Finance	Katowice	2022
4	Payment congestion in the mining sector	Endo conflict	Finance	CCT	1989–1996
5	Privileges granted to workers in the mining sector in the nineteen-seventies	Exo conflict	Finance	CCT	1970–1980
6	Payment of high severance to miners of closing mines	Exo conflict	Finance	CCT	1997–2001
7	Miners' strike over mining restructuring plans	Exo conflict	Finance	CCT	2015
8	Closure process of twenty-two mines in Silesia	Dependence	Finance	CCT	1997–2001
9	Disinvestment in the mining sector resulting from EU policy	Dependence	Finance	CCT	2017–2022
10	Differences of opinion on mining viability	Impasse	Finance	CCT	2004 – present

	Name	Type	Area	Geo	Time
11	Change in the corporate policy of banks and their ability to finance mining contracts	Dependence	Finance	CCT	2017 – present
12	Decarbonization policies in the EU	Dependence	Finance	CCT	2017 – present
13	Liquidation of the coal community	Endo conflict	Finance	CCT	1990–1992
14	Changing the competence profile of employees in the mining sector	Endo conflict	Techno	CCT	2022
15	Technologies for monitoring mine work	Endo conflict	Techno	CCT	1997 – present
16	Dependence of further exploitation of deposits (geological conditions) on technology	Dependence	Techno	CCT	2017 – present
17	Marginalization of technology to decarbonize coal	Dependence	Finance	CCT	2008 – present
18	Emigration of heavy industry workers to the northern regions of Poland	Impasse	Ethno	CCT	1989–1997
19	Lack of mobility of the younger generations and waiting for succession in the mining sector	Impasse	Ethno	CCT	1989–1997
20	Foreign investment in the business sector	Dependence	Multi (Ethno/ /Finance)	Katowice	2004 – present
21	Silesia as an attractive place to work but not to live	Exo conflict	Ethno	Katowice	1989–2015
22	Immigration from satellite towns to the regional capital	Endo conflict	Multi (Ethno/Ideo)	Katowice	1989–2022
23	EU ETS policy not taking into account the economic situation of member states	Exo conflict	Ideo	CCT	2004–2022
24	Ignoring clean coal combustion technology by climate movements	Impasse	Ideo	CCT	2008–2022
25	Wrong national energy policy regarding RES	Dependence	Ideo	CCT	2008–2022
26	Lack of education on climate change in schools	Impasse	Ideo	CCT	1997–2022
27	Young people leaning towards the environment, but forgetting that we need energy sources	Exo conflict	Nature	CCT	2004–2022
28	Hydrological droughts	Endo conflict	Nature	CCT	2017–2022
29	Decline in land value	Endo conflict	Finance	CCT	1957–2022
30	Consequences of mining damage	Endo conflict	Nature	CCT	2017–2022
31	Mines as sites for the spread of COVID 19	Exo conflict	Multi (Nature, Media)	CCT	2020–2021

Source: Komorowska et al. 2022b.

Table 5. List of the strain situations mapped in the KMA

Tabela 5. Lista sytuacji powodujących napięcie w rejonie Krakowskim Obszarze Metropolitalnym

	Name	Type	Area	Geo	Time
1	Stench in the Płaszów region	Exo conflict	Finance	Płaszów (part of XIII district in Kraków)	2017
2	Intensive development of green areas	Exo conflict	Finance	Kraków	2000
3	Clean air program	Endo conflict	Finance	Kraków	2015–2019
4	Imposition of heat supply in the form of system heat	Dependence	Finance	Kraków	1954
5	Waste incineration plant	Exo conflict	Finance	Nowa Huta (district in Kraków)	2009
6	Anti-smog resolution	Impasse	Finance	KMA	2016
7	Establishment of a paid parking zone	Impasse	Finance	Kraków	2010
8	ArcelorMittal steelworks closure	Dependence	Finance	Nowa Huta (district in Kraków)	2019
9	Moving industrial enterprises outside Kraków	Dependence	Finance	Kraków	2010
10	Housing associations – heat allocation meters	Dependence	Techno	Kraków	2010
11	Air-quality monitoring technologies	Dependence	Techno	Kraków	2016
12	Digitalization of the application process for subsidies and boiler replacement	Dependence	Techno	Kraków	2016
13	Collection of surplus energy into the grid	Dependence	Techno	Kraków	2016
14	Gas-boiler problems	Endo conflict	Multiple	Kraków	2000
15	Increased number of tourists and economic and educational immigrants	Impasse	Ethno	Kraków	2004
16	Erosion of social relations in neighbourhood communities	Endo conflict	Ethno	Kraków	2004
17	Unpreparedness to accommodate increasing numbers of residents	Dependence	Ethno	Kraków	2004
18	Reversed trend of people moving to Kraków (due to clean air) after years of moving out of Kraków due to smog	Dependence	Ethno	Kraków	2017
19	Introduction of clean transport zones and paid parking zones	Exo conflict	Ethno	Kraków	2022
20	Tensions between young and old	Endo conflict	Ideo	KMA	2016
21	Populism of science centres	Dependence	Ideo	Kraków	2018
22	Uneven and inconsistent distribution of costs associated with clean air measures	Endo conflict	Ideo	Kraków	2016

	Name	Type	Area	Geo	Time
23	Anti-smog resolution with a timetable for the removal of individual types of heat sources	Exo conflict	Ideo	Kraków	2017
24	Breaking supply chains during the pandemic	Dependence	Nature	KMA	2020
25	Inconsistency of climate action in the context of urban development	Exo conflict	Multiple	Kraków	2007
26	Decisions at EU level on changing energy sources vs. the geopolitical situation	Dependence	Multiple	KMA	2015

Source: Komorowska et al. 2022a.

6. The socio-psychological dimension of the territorial trauma and territorial stigma in Silesia and the Kraków Metropolitan Area

In accordance with the applied approach, the socio-psychological aspects of energy transformation processes in the studied regions were investigated by surveys in the respective CCT areas.

Residents of the KMA and Silesia regions filled in a questionnaire containing ninety items grouped into seventeen scales that measured sub-contexts assigned to five main indicators of the socio-psychological consequences of the decarbonization process (place attachment, moderators, decarbonization impacts, coping strategies and life satisfaction).

The correlation matrix of the scores obtained on the sub-constructs for both case studies provides important information. This is presented in Figure 3 for Silesia and in Figure 4 for Kraków Metropolitan Area.

A high level of positive correlation can be observed between the individual scales measuring the dimensions of place attachment. This attachment, and consequently the sense of belonging to the local community and local identity, is the product of four strongly interrelated factors (place identity, place dependence, place rootedness, and social bonding). Consequently, a high level of place attachment significantly reduces the intention to relocate as one of the coping strategies. In this case, place rootedness has the strongest impact.

An interesting relationship also emerges between the sub-constructs of the ‘moderators’ dimension, which relates to scales measuring general personal attitude and capacity, resilience and decarbonization impacts. Here, it can be seen, first and foremost, that psychological resilience and life optimism have a significant positive impact on coping with stress caused by the changes brought about by the energy transition process. Optimism and resilience also have a positive impact, albeit very small, on how decarbonization is perceived in terms of the fairness of the process. Optimism and resilience are moderators positively influencing life satisfaction ratings, while perceived economic threat in times of economic strain and uncertainty induced by the region’s intensive transition reduces life satisfaction.

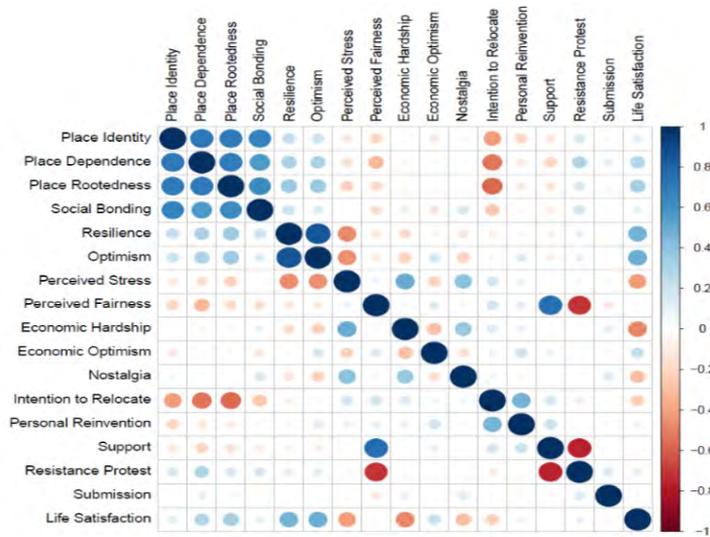


Fig. 3. Correlation among different factors related to the socio-psychological component in Silesia
 Source: Komorowska et al. 2022b

Rys. 3. Korelacja między różnymi czynnikami związanymi z komponentem społeczno-psychologicznym na Śląsku

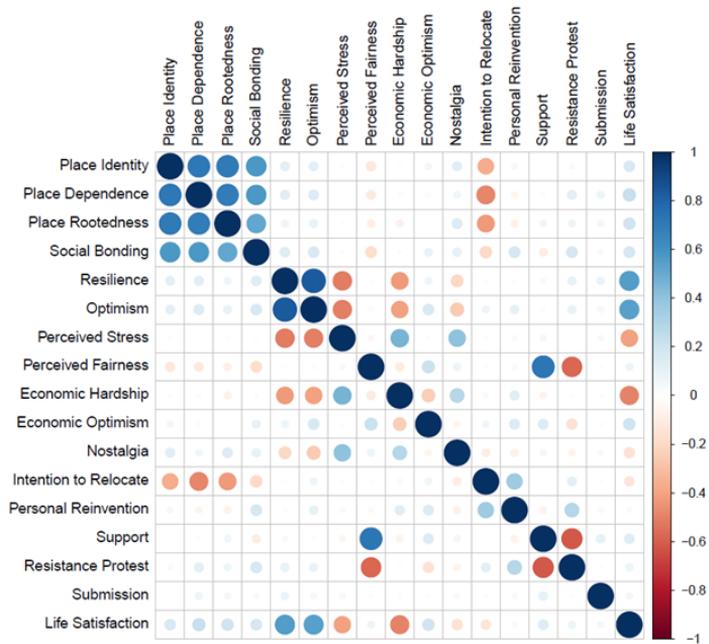


Fig. 4. Correlation among different factors related to the socio-psychological component in the KMA
 Source: Komorowska et al. 2022a

Rys. 4. Korelacja między różnymi czynnikami związanymi z komponentem społeczno-psychologicznym w Krakowskim Obszarze Metropolitalnym

One of the few differences between the two case studies is revealed in the correlation between the two components of place identity, namely, life satisfaction. The data shows that place dependence and place rootedness correlate more strongly with life satisfaction in Silesia than is the case in the KMA.

A high level of positive correlation between coping strategies can also be observed in which the response to the decarbonization impacts is just (passively) waiting for the situation to improve (support) a perceived fairness of the process. However, the lack of a sense of fairness and the unequal distribution of costs and benefits of the energy transition significantly increases the chances of an active response to change, for example, a confrontational and defensive response as a reaction to the threat of ongoing change.

The averages obtained by respondents on each construct were also analysed (Table 6). The mean is the average score spread on a scale from 1 to 5, where 5 indicates a higher value

Table 6. Mean score and standard deviations for all factors (Silesia and the KMA case studies)

Tabela 6. Średni wynik i odchylenia standardowe dla wszystkich czynników (studia przypadków Śląska i KMA)

Factors/ Latent constructs	Sub-construct	Silesia			KMA		
		mean score	standard deviation	Cronbach's Alpha	mean score	standard deviation	Cronbach's Alpha
Place Attachment	Place Identity	3.95	0.91	0.93	2.15	0.86	0.94
	Place Dependence	3.42	0.98	0.90	2.70	0.97	0.91
	Place Rootedness	3.70	0.62	0.65	2.89	0.46	0.67
	Social Bonding	3.51	0.99	0.62	3.12	1.29	0.79
Moderators	Resilience	3.55	0.71	0.80	2.45	0.67	0.87
	Optimism	3.55	0.71	0.68	2.51	0.73	0.89
Decarbo- nization Impacts	Perceived Stress	2.89	0.59	0.93	3.09	0.44	0.82
	Perceived Fairness	2.85	0.74	0.81	2.73	0.49	0.74
	Economic Hardship	3.26	0.9	0.88	3.11	0.85	0.93
	Economic Optimism	2.68	0.78	0.86	3.19	0.79	0.78
	Nostalgia	3.26	0.77	0.88	3.09	0.83	0.89
Coping Strategies	Intention to relocate	2.57	0.89	0.88	3.30	0.89	0.89
	Personal reinvention	2.53	0.79	0.78	3.42	0.86	0.84
	Support	3.19	1.12	0.90	2.43	0.97	0.91
	Resistance and Protest	2.70	0.77	0.86	3.58	0.73	0.81
	Submission	3.18	0.60	0.43	2.97	0.56	0.48
Life Satisfaction		2.92	0.87	0.85	3.11	0.84	0.87

Sources: ENTRANCES survey data (based on Komorowska et al. 2022a, b).

obtained for a given sub-construct and 1 indicates a lower value. In addition, a measure of Cronbach's Alpha was used to show the internal consistency of the items used in each scale. Internal consistency describes the degree to which all items in a test measure the same concept or construct and is therefore related to the interrelatedness of the items in the test. An Alpha score below 0.7 is not acceptable.

The scores obtained by respondents on the scales used in the questionnaire in the Silesian case study indicate medium to moderately high levels. This is the case for Place Attachment, where the mean values oscillate between 3.42 and 3.95. Optimism and Resilience were scored moderately high (3.55). Looking at decarbonization impacts, there are two sub-constructs which scored higher than others – Nostalgia (3.26) and Economic Hardship (3.26). When looking at coping strategies, it can be noted that two were rated higher than average: Support (3.19) and Submission (3.18).

Table 7. Z score and STEN for all factors (Silesia and the KMA case studies)

Tabela 7. Wynik Z i STEN dla wszystkich czynników (studia przypadków Śląska i Krakowskiego Obszaru Metropolitalnego)

Factors/Latent constructs	Sub-construct	Silesia		KMA	
		Z-score	STEN	Z-score	STEN
Place Attachment	Place Identity	-0.25	5.00	-0.38	4.74
	Place Dependence	0.03	5.56	-0.09	5.32
	Place Rootedness	-0.05	5.40	-0.30	4.90
	Social Bonding	0.18	5.86	-0.35	4.80
Moderators	Resilience	-0.49	4.52	-0.45	4.46
	Optimism	-0.38	4.74	-0.52	4.60
Decarbonization Impacts	Perceived Stress	0.44	6.38	0.26	6.02
	Perceived Fairness	0.00	5.50	0.64	6.78
	Economic Hardship	0.23	5.96	0.07	5.64
	Economic Optimism	-0.05	5.40	0.11	5.72
	Nostalgia	0.47	6.44	0.23	5.96
Coping Strategies	Intention to Relocate	0.38	6.26	0.53	6.56
	Personal Reinvention	0.28	6.06	0.31	6.12
	Support	0.09	5.68	0.49	6.48
	Resistance and Protest	-0.06	5.38	-0.45	4.60
	Submission	-0.28	4.94	-0.57	4.36
Life Satisfaction		-0.57	4.36	-0.63	4.24

Sources: ENTRANCES survey data (based on Komorowska et al. 2022a, b).

In the case of the KMA, analysis of the averages for the individual scales used in the survey indicates a moderate level of assessment of the individual indicators. This is the case for Attachment to Place, where the mean values oscillate between 2.15 and 2.89, and only Social Bond is rated better, although this dimension is not rated particularly high (3.12). The average levels of Optimism and Resilience probably translate into relatively higher ratings for dimensions such as Perceived Stress and Economic Hardship. Interestingly, Economic Optimism was rated similarly high in this case. Looking at coping strategies, it can be seen that three strategies were rated highest: Resistance and Protest, Personal Reinvention and Intention to Relocate.

An important aspect of the analysis was also to compare the results obtained by respondents in the two case studies against the average obtained for all regions studied in the ENTRANCES project. A Z-score was used to assess this, which is a measure of how many standard deviations above or below the population average a case study achieves. The STEN (Standard Ten) score shows performance using a simple standardized scale from 1 to 10, which has a normal distribution. They have a mean of 5.5 and a standard deviation of 2 and are rounded to the nearest whole number. To interpret the STEN scores, all case studies will focus on STEN scores below 4 (which should be interpreted as low compared to the case studies as a whole) and above 6 (high scores). All STEN scores around 5 show that the case study is not very different from other ENTRANCES case studies.

Respondents from Silesia scored higher compared to the other ENTRANCES case studies. In the factor related to the impact of decarbonization – respondents scored higher for the sub-constructs related to nostalgia (6.44) and perceived stress (6.38), while for coping strategies, higher scores were obtained for intention to relocate (6.26) and personal reconstruction (6.06). The KMA region scored higher compared to the other ENTRANCES case studies. In the factor related to the impact of decarbonization, respondents scored higher on the sub-constructs related to perceived fairness (6.78) and perceived stress (6.08), while for coping strategies, higher scores were obtained for intention to relocate (6.56), support (6.48) and personal reorganization (6.12).

Finally, it is worth mentioning the gender differences obtained on the individual scales measuring the socio-psychological consequences of the decarbonization process in both case studies. In Silesia, women showed higher levels of Personal Reactivation (men: 2.42, women: 3.64, $p < 0.05$). The remaining seventeen sub-constructs did not differ significantly between men and women. By contrast, three significant differences were found between men and women in the KMA. Women had significantly lower resilience values (men: 3.65, women: 3.46, $p < 0.05$). Women showed higher levels of both perceived stress (men: 2.67, women: 2.85, $p < 0.05$) and economic hardship (men: 2.94, women: 3.27, $p < 0.005$). Thus, the data suggest that economically and psychologically, women are more concerned about the consequences of decarbonization processes. The remaining seventeen sub-constructs are not significantly different between men and women.

Conclusions

Both the KMA and Silesia are areas strongly influenced by processes of moving away from coal. The last three decades have been a period of transformation changing the structure of the labour market and the functions of individual urban areas, which is not insignificant for the demographic processes and social practices of the residents. The smooth transition from the traumas associated with the country's economic transformation to the implementation of climate policies has meant that the dynamics of the processes can be described as territorial trauma, which is the result of overlapping strain situations in time and space.

The analysis of two of the six components studied in the ENTRANCES project presented in this article shows that the strain situation largely affects a wider area and extends beyond the map of the studied regions (especially in Silesia). This means that territorial trauma has the character of deep introductory uncertainty with regard to the transformational directions of the economic system. These are, of course, situations of conflict that are more often exogenous (between the studied area and the environment). The field of dependence and conducted conflicts are mainly financially based issues, which is most strongly visible in Silesia. Tensions arising from technological change or changes in the ethnic, cultural or environmental composition, although represented in the structure of strain situation types, are considered less important.

What was easy to predict, coping with the stress caused by the energy transition (moving away from coal) is most influenced by the declared mental resilience and the life optimism of the residents of the two regions. The mediating variable between the quality of life and transition factors is, of course, the economic situation in the labour market. It is important to note, however, that being rooted in one's place of residence more strongly influences the declared quality of life in Silesia than in the KMA, which can be read as a higher level of stigma in the region.

On the basis of the survey data, we also see a stronger attachment to place in Silesia but, simultaneously, a higher relevance of resilience and optimism. Respondents in the KMA are also distinguished by other assessments of strategies for coping with strain situations – willingness to relocate and personal reinvention. In Silesia, other attitudes may be dominant, namely mutual support, resistance and protest.

It is also worth mentioning, as is particularly evident in the case of the KMA, that women feel some of the consequences of the transition processes more strongly, particularly in terms of perceived stress and the potential negative economic consequences of the energy transition.

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**TERRITORIAL TRAUMA OR MODERNIZATION EXPERIENCE?
THE KRAKÓW METROPOLITAN AREA AND SILESIA AS CASE STUDIES
AFFECTED BY INTENSIVE ENERGY TRANSITION PROCESSES**

Keywords

energy transition, territorial trauma, coal phase-out

Abstract

Energy transition is a process that affects entire regions, not only reducing the prevailing socio-economic conditions but most importantly, creating a new framework of functioning for their inhabitants. The changes that are taking place can be described as territorial stresses, which are factors that affect not only the psychological well-being of residents but also the economic, demographic, technological and ecological conditions of the regions. The article presents the partial results of research work conducted within the ENTRANCES project. The authors compare two carbon-intensive regions: Kraków Metropolitan Area (high air pollution area) and Silesia (coal mining area). Comparing the results of the two components and thus the research methods:

- ♦ the identification and systematization of the socio-cultural stress situation (a component describing events relevant to the transformation of the regions from 1945–2022 and the sparing of its significance on the development conditions in the regions);
- ♦ the assessment of the adaptive capacity of the residents based on their attachment to the place, individual adaptation strategies for resolving tensions and the level of life satisfaction (socio-psychological component).

**TERYTORIALNA TRAUMA CZY DOŚWIADCZENIE MODERNIZACJI?
KRAKOWSKI OBSZAR METROPOLITALNY I ŚLĄSK JAKO STUDIA PRZYPADKÓW
DOTKNIĘTE INTENSYWNYMI PROCESAMI TRANSFORMACJI ENERGETYCZNEJ**

Słowa kluczowe

transformacja energetyczna, terytorialna trauma, rezygnacja z węgla

Streszczenie

Transformacja energetyczna jest procesem oddziaływującym na całe regiony, nie tylko zmieniając panujące w nich warunki społeczno-gospodarcze, ale przede wszystkim tworzy nowe ramy funkcjonowania dla ich mieszkańców. Zmiany, które zachodzą, określić można mianem stresu terytorialnego, który jest czynnikiem wpływającym nie tylko na dobrostan psychiczny mieszkańców, ale oddziałującym również na kondycje ekonomiczną, demograficzną, technologiczną i ekologiczną regionów. Artykuł stanowi prezentację częściowych wyników prac badawczych prowadzonych w ramach projektu ENTRANCES. Autorzy dokonują porównania dwóch regionów intensywnych węglowo: Krakowski Obszar Metropolitalny (obszar wysokiej emisji) oraz Śląsk (obszar górniczy).

Badanie przedstawia także zestawienie wyników dwóch analizowanych komponentów i tym samym metod badawczych:

- ♦ identyfikacji i usystematyzowania sytuacji stresu społeczno-kulturowego (komponent analizujący wydarzenia istotne z punktu transformacji regionów z lat 1945–2022) oraz oszacowanie jego znaczenia na warunki rozwoju w regionach;
- ♦ oceny zdolności adaptacyjnych mieszkańców na podstawie ich przywiązania do miejsca, indywidualnych strategii adaptacji, rozwiązywania napięć oraz poziomu satysfakcji życiowej (komponent socjopsychologiczny).