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Socio-cultural challenges of coal regions and their transformative capacities – a case study of Silesia

Introduction

In southern Poland, the region of Silesia stands as a testament to the enduring legacy and ongoing challenges of a coal-dependent economy. Historically renowned for its rich coal reserves, Silesia has played a pivotal role in Poland's industrial and economic development.

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The coal territory of Silesia, the largest coal basin in Europe, is deeply integrated into Poland's energy sector and industrial identity (Kaszyński 2023). With a history of coal mining dating back to the eighteenth century, Silesia has evolved into a region heavily reliant on coal mining and associated industries, such as steelworks and power generation.

This has not only shaped the economic landscape of the region but also its social and cultural aspects. Moreover, the challenges of environmental sustainability, global economic shifts and the need for cleaner energy sources have placed Silesia at a crossroads, demanding a re-evaluation and transformation of its traditional coal-centric paradigm. The current and expected shift in Silesia from a coal-dependent economy to a sustainable future highlights the complexity of this transition. This transition is not merely an economic or technological challenge but a transformation that includes all aspects of the region's fabric – social, cultural and ecological.

The socio-cultural dimension of Silesia's transition is characterized by a profound shift in the traditional societal structure. The once dominant mining industry, which shaped the region's identity and socio-economic dynamics, now faces numerous challenges. From a socio-ecological and technical standpoint, Silesia's dependency on coal presents significant difficulties. The region's energy infrastructure, which is heavily reliant on coal, faces the challenging task of transitioning towards cleaner, more sustainable energy sources. This transition is not just about replacing one energy source with another; it involves a comprehensive transformation of the region's energy ecosystem. This encompasses the development of innovative technologies, the adaptation of existing infrastructures, and most importantly, the environmental and social implications of such a transition. The challenge lies in balancing the immediate economic dependencies on coal with the long-term environmental and health benefits of cleaner energy sources (Koval et al. 2022; Hubert et al. 2023).

However, although Silesia's transition towards a sustainable future is fraught with challenges, it also presents opportunities for innovation, growth and transformation. The region's ability to navigate this transition will depend on its capacity to adapt, innovate and embrace a new identity that goes beyond its coal-dependent past. This will require a concerted effort from all sectors – government, industry, communities, and individuals – to work collaboratively towards a shared vision of sustainability. The lessons learned from Silesia's experience can serve as valuable insights for other regions globally that are facing similar challenges in their transition from traditional industrial economies to sustainable futures.

The primary objective of this paper is to comprehensively analyze and understand the energy transition of Silesia, a region historically dominated by coal mining, as it navigates the complex path towards sustainable development. This study aims to offer a multidimensional perspective on the challenges, strategies and opportunities inherent in transitioning from a coal-dependent economy to a more diversified, environmentally sustainable and socially inclusive future. It intends to contribute valuable knowledge and practical insights for policymakers, industry stakeholders, communities and researchers involved in managing and studying the complex process of transitioning traditional industrial regions towards sus-

tainable futures. The results present a significant addition to the existing body of research on industrial transformation, sustainable development and regional adaptation to global economic and environmental changes.

In this article, a novel approach to examining Silesia's coal territory is introduced, employing Bertrand's "stress-strain" theory to uniquely analyze the socio-cultural impacts of energy transition in a coal-dependent region. The research adopts a comprehensive framework that integrates socio-cultural, socio-ecological and technological dimensions, providing a holistic view of the region's transition challenges and opportunities. We employ empirical mapping of "strain situations" through Focus Group Interviews, a methodological innovation that offers concrete insights into the region's social dynamics. The use of systems theory to assess transformative capacities in socio-ecological and technological areas introduces a new theoretical perspective to the study. While focused on Silesia, our research's comparative analysis with other coal-dependent regions adds global relevance, contributing broader insights into industrial and energy transitions.

The adopted theoretical framework assumes that it is possible to infer socio-cultural stress (SCS) from past strain situations of different origins and nature, which has an impact on the social structure. SCS, in turn, is an important determinant of a region's coping strategy and shapes its transformative capacity in the long term. "The theory is based on the articulation of the 'stress-strain' pair: stress is an element inherent to the social structure in a given institutional or organisational field, that cannot be observed per se but manifest itself in 'strains' of different types such as conflicts, tensions, ambivalences, etc. Therefore the 'strains' can be interpreted also as the manifestation of the stress in action at the structural level" (Caiati et al. 2021).

1. Overview of Silesia as the coal territory

Poland's awareness of coal dates to the tenth century, yet it remained untapped during that period. The large-scale extraction of hard coal commenced much later, specifically in the latter half of the eighteenth century, marked by the establishment of the first mine in Upper Silesia in 1748 (Dulias 2016). Three hard coal basins are situated in Poland, namely: the Lower Silesian Coal Basin, the Upper Silesian Coal Basin, and the Lublin Coal Basin.

At present, extraction activities occur in two of these basins: the Upper Silesian Coal Basin and the Lubelskie Coal Basin. However, in the Lower Silesian Coal Basin, the exploitation of five deposits was discontinued as of 2000 (Pepłowska 2021). The region of Silesia remains the largest coal basin in Europe (Wehnert et al. 2018). In the Silesian Province, an extensive presence of hard coal mines, steelworks, power facilities, and heavy industry dominates much of the land. In the year 2019, a workforce of 74,500 individuals toiled within Silesia's hard coal mines, with approximately 4,000 more in Lesser Poland. This collective represents a staggering 94% of Poland's hard coal mining labor force (Kiewra et al. 2019).

Currently, nineteen out of twenty coal mines remain active within this coal-rich territory, contributing around 85% of the nation's hard coal production, inclusive of 100% of coking coal. Seventeen of these mines reside within the Silesia Province, dispersed across subregions like Tychy, Katowice, Gliwice, Sosnowiec, and Bytom, while the remaining two are in the Lesser Poland Province, specifically in the Oświęcim Subregion. These nineteen hard coal mines operate within thirty mining complexes that, in earlier times, existed as distinct coal mines (Tkocz 2006; Łukaszczyk and Popczyk 2018).

In Silesia, there are four major coal-fired power plants (Jaworzno, Łagisza, Łaziska, and Rybnik) alongside three significant coal-fired heat and power plants (Jaworzno, Chorzów, and Kędzierzyn-Koźle) (Kaszyński and Kamiński 2020). Silesia also stands as a hub for the metallurgical industry, particularly in steel and aluminum production. The region hosts numerous foundries, galvanizing plants, steelworks, and refractory material facilities. Silesia is located in southern Poland, sharing a border with the Czech Republic. Approximately 4.6 million residents call this area home, ranking it as the second most densely populated region in Poland (Orlewski 2019). Furthermore, a staggering nine million individuals reside within a 100-kilometer radius of the Silesian capital, Katowice. The region boasts not only a dense population but also stands out as Poland's most industrialized and urbanized area (The Climate Group 2016). The region contributed nearly 9% to the entire country's gross domestic product. Its GDP per person ranked second in the country, reaching 61.9% of the average GDP in the entire European Union (Czaja and Rutkowska 2023). With a well-established industry, agriculture, efficient transportation networks, and a range of services, the region is showing significant development (Kulpa et al. 2022). Its potential for growth remains notably high.

It is also worth noting that the Silesia Province generates significant emissions. It is the leader in methane production, accounting for 91% of the country's emissions, and ranks second in carbon dioxide production, contributing 16.8% of the national emissions.

The Silesia region, currently one of the main coal regions in Poland, faces a series of challenges related to the necessity of undergoing an energy transformation and gradually moving away from coal extraction and combustion. The energy transformation entails significant challenges and requires a restructuring of the economic structure in the region, which is heavily dependent on the coal sector. Introducing new economic sectors, sustainable practices, and fostering innovative industries becomes a key task (Malec 2022). The shift away from coal also involves the necessity of restructuring the labor market. The energy transformation impacts the local community as it is traditionally identified with mining. In the face of these challenges, coordinated action among various stakeholders, including local authorities, businesses, civil society and governmental institutions, becomes crucial to ensuring a smooth transition and minimizing the negative social and economic consequences of this process.

2. Conceptual and methodological framework

2.1. Stress-strain theory as an explanatory framework for changes in coal regions

The socio-cultural aspect revolves around the idea that a territory functions as a social structure. It assesses whether globalization-induced socio-cultural changes, such as migration, technological advancements, and climate change, impose "stress" on the coal territory region. Stress, in this context, refers to a driving force for territorial adaptation rather than psychological stress. Rooted in the "stress-strain" theory of social organizations, the component delves into the ongoing dynamics of change and stability within the coal territory (Bertrand 1963). It identifies social forces applying structural pressure, resistance to change and the ongoing dynamics of change and stability within the territorial organization.

The theory revolves around the "stress-strain" pair inherent in the social structure of a given institutional or organizational field. Stress, an unobservable element, manifests itself in various "strains" such as conflicts, tensions, and ambivalences. These "strains" are interpreted as the structural-level manifestation of stress in action. Strain situations serve as the operational concept in identifying stress-strain elements empirically in a given territory. Three main types of strain situations are considered: conflicts or disputes (within and outside the territory), impasses or contradictions, and dependence with related uncertainty. These strain situations are the unit of observation for this component. The stress vector is a social process activating stress in the territorial organization. Stress vectors vary in characteristics, including their origins (internal or external), intensity, duration (temporary or long-lasting), and direction, as each stress vector influences the territory in a certain direction of change (Komorowska et al. 2022).

To establish the factors shaping the socio-cultural dimension, a qualitative sociological measurement was proposed. It was decided to perform focus group interviews in which agreement was needed between subjective actors. The key to achieving this and maximizing heterogeneity was the purposive selection of participants. The analysis focused on the territorial stress induced by globalization in the territory. As "territorial stress" is not directly observable, following the socio-cultural component guidelines, the focus group is aimed at mapping the "strain situations" (i.e. conflicts, impasses, etc.) and related impacts in the territory. In Silesia, the focus group was conducted online via Microsoft Teams and the Miro platform. The online meeting took place on 18th and 19th May 2022. There were eight people in the meeting, four men, and four women.

2.2. System theories in the analysis of the transformative capacity of regions

The analysis of transformative capacity in socio-ecological and technological areas was based on the identification of key indicators demonstrating the potential of coal regions to

change their development trajectories. The analytical framework was provided by systems theory, which assumes that coupled socio-ecological (SES) and socio-technical (STS) areas can be viewed as complex adaptive, self-organising systems characterized by dynamic interactions between interdependent subsystems. These interactions occur at multiple temporal and spatial scales causing emergent and non-linear changes in the systems themselves. As a result of endogenous dynamics and exogenous pressures systems, may transform not in, incremental and predictable way, but shift rapidly to alternative forms characterized by different structure, function and feedback" (Reyers et al. 2018).

The changes within them are not gradual and are determined by a trend of varying intensity. They can shift to alternative states as a result of the dynamics of internal processes or external pressures. Thus, the change is abrupt, breaking the continuity of processes by setting a new trend, breaking the continuity and throwing the system out of balance. "Transformative capacity is understood in this context as an evolving collective ability to conceive of, prepare for, initiate, and perform path-deviant change towards sustainability within and across the multiple complex systems that constitute the regional or urban area undergoing a clean energy transition. As a systemic capacity, it is not attributable to any single actor but rather results from the interactions and orientations of multiple actors in the regional or urban economic development system involved in shaping its decarbonization pathways" (Komorowska et al. 2022). This holistic understanding of the processes between the social, ecological and technological spheres presented here provides an alternative to theories of change that treat development in sectoral terms and enables understanding of how changes occur in complex systems.

SES explores the interrelationship between people and the environment while considering their dynamic nature. This refers to the systems in which people are connected to their surrounding environments. STS, conversely, focuses on the study of the evolution and transformation of large systems that meet the key needs of society, such as energy, transport and food production. The study of this approach also includes an analysis of the environmental impact of these systems. Both approaches are complementary and provide valuable insights. An example of this is that a change to greener energy sources may be considered a step towards sustainable energy production from an STS perspective, but an SES analysis may take into account the environmental impacts of extracting rare elements, taking up agricultural land for investment, or producing large amounts of non-recyclable waste.

The above analytical framework was used in the project to investigate factors influencing the transformative capacities of coal regions and to what extent they are able to move away from their current path to one of the possible decarbonization paths. Transformative capacities are defined as "the type of power that effectuates deep and holistic change, resulting from particular forms of agency and interactions in a given institutional and spatial-material setting" (Wolfram et al. 2019). The operationalization of the ten key drivers of socio-ecological and/or socio-technical system transformation was based on the Transformative Capacity framework (Wolfram 2016):

1. Inclusive and multiform governance
2. Transformative leadership (in public, private, and civil society)
3. Empowered and autonomous communities in practice
4. System(s) awareness and memory
5. Sustainability foresight
6. Diverse community-based experimentation with disruptive solutions
7. Innovation embedding and coupling
8. Reflexivity and social learning
9. Working across human agency levels
10. Working across political-administrative and geographical scales

The construction of the research tool used the ten areas defined in the framework as operationalized in (Castán Broto et al. 2019).

It was intended that the boundaries of the system would be defined by the formally defined frame of the carbon region (the so-called Political Administrative Region), in other words, the Silesian Province, which is assumed to be the unit that directly manages the energy transition processes at the regional level.

Data on transformative capacities was collected through qualitative and quantitative interviews with a diverse group of stakeholders involved in various aspects of energy transition. Informants were asked to rate statements related to each of the ten defined transformative capacity factors. They were then asked to justify their ratings and elaborate on their answers to the open-ended follow-up questions. Six people (four of whom were women) participated in the study in Silesia, representing various categories of actors and stakeholders (environmental policy actors, economic policy actors, ecological, scientific and research institutes and universities).

The overall assessment of transformative capacity in each of the ten dimensions is the average of the ratings indicated by the informants during the interview. The results obtained for the key factors and sub-factors are shown in Figure 1. Each dimension was rated on a five-degree scale in which 1 meant "no evidence of transformative capacity in a given dimension" and 5 meant "fully developed transformative capacity in a given dimension" (UNDP 2008).

3. The region's past experiences and current patterns of coping with the challenges of the energy transition

3.1. Historical trajectories of the region affected by strain situations and stress vectors and the current transformative capacity of Silesia

In the focus group, a comprehensive mapping was conducted for a total of thirty one instances of strain. Table 1 offers a compilation of strain scenarios identified, agreed and

categorized by all participants. In addition, the table also gives one of the categories that the respondents used to describe the respective strain situations. A total of thirty one stress cases were comprehensively mapped in the focus group. The table summarizes the stress scenarios that all participants identified, agreed upon and categorized. Additionally, the table presents the approximate period of occurrence of these events and their duration.

Table 1. List of identified strain situation

Tabela 1. Lista zidentyfikowanych sytuacji powodujących napięcia

Years	Phase	Strain Situation	Situation type
1945–1956	1. The first decade of the post-war period	1957: Decline in land value (≈ 29)	Endogenous conflict
1956–1968	2. The first decade of the post-war period	No strain situation mapped started in this period	
1970–1979	3. The decade of Edward Gierek	1970: Privileges granted to workers in the mining sector in the 1970s (≈ 5)	Exogenous conflict
1980–1989	4. Mass strikes of workers and growing economic problems	No strain situation mapped started in this period	
1990–1996	5. Restructuring of the mining industry	1989: Payment congestion in the mining sector (≈ 4)	Endogenous conflict
		1989: Emigration of heavy industry workers to the northern regions of Poland (≈ 18)	Impasse
		1989: Lack of mobility of the younger generations and waiting for succession in the mining sector (≈ 19)	Impasse
		1989: Silesia as an attractive place to work but not to live (≈ 21)	Exogenous conflict
		1989: Immigration from satellite towns to the regional capital (≈ 22)	Endogenous conflict
		1990: Liquidation of the Coal Community (≈ 13)	Endogenous conflict
1997–2003	6. Jerzy Buzek's reform	1997: Technologies for monitoring mine work (≈ 15)	Endogenous conflict
		1997: Payment of high severance to miners of closing mines (≈ 6)	Exogenous conflict
		1997: Closure process of twenty-three mines in Silesia (≈ 8)	Dependence and uncertainty
		1997: Lack of climate change education in schools (≈ 26)	Impasse

Years	Phase	Strain Situation	Situation type
2004–2008	7. First years in the EU	2004: EU ETS policy not taking into account the economic situation of member states (≈ 23)	Exogenous conflict
		2004: Young people lean towards the environment, but forget that we need energy sources (≈ 27)	Exogenous conflict
		2004: Differences of opinion on mining viability (≈ 10)	Impasse
		2004: Foreign investment in the business sector (≈ 20)	Dependence and uncertainty
		2008: Ignoring clean coal combustion technology by climate movements (≈ 24)	Impasse
2009–2015	8. Years of unfinished reform	2008: Wrong national energy policy (≈ 25)	Dependence and uncertainty
		2008: Marginalization of technology to decarbonize coal (≈ 17)	Dependence and uncertainty
		2015: Miners strike over mining restructuring plans (≈ 7)	Exogenous conflict
2016–2022	9. Coal phase-out and just transition	2017: Hydrological droughts (≈ 28)	Endogenous conflict
		2017: Consequences of mining damage (≈ 30)	Endogenous conflict
		2017: De investment in the mining sector resulting from EU policy (≈ 9)	Dependence and uncertainty
		2017: Dependence of further deposit exploitation (geological conditions) on technology	Dependence and uncertainty
		2017: Change in the corporate policy of banks and their ability to finance mining contracts (≈ 11)	Dependence and uncertainty
		2017: Decarbonization policies in the EU (≈ 12)	Dependence and uncertainty
		2020: Attempts to obtain a concession to open a new mine (Mysłowice) (≈ 2)	Exogenous conflict
		2020: Attempts to obtain a concession to open a new mine (Imielin) (≈ 1)	Exogenous conflict
		2020: Mines as sites for the spread of COVID-19 (≈ 31)	Exogenous conflict
		2022: Extension of the railway line in connection with the plan to build a central transportation port in Poland (≈ 3)	Exogenous conflict
		2022: Changing the competence profile of employees in the mining sector (≈ 14)	Endogenous conflict

Sources: ENTRANCES Focus Group Discussion.

The strain situations in the post-war history of Silesia were of different nature and dynamics. Participants in the focus group interviews assigned one of four categories to each of them: exogenous conflict, endogenous conflict, impasse, or dependency and uncertainty.

The examination of strain situations reveals a series of recurring conflicts within the Silesia region. One such conflict stems from the historically elevated status of workers in the mining sector, who, in addition to receiving high salaries and fringe benefits, wielded substantial influence over decision-making processes regarding the direction and dynamics of mining reform in Poland (〰 04, 〰 05, 〰 06). Naturally, endeavors aimed at restructuring unprofitable mines and reforming the entire sector generated conflicts (〰 07, 〰 13), as did technological progress and evolving requirements for the competency profile of mining employees (〰 14, 〰 15). Stress-inducing situations also arose from shifts in energy policy at both national and European Union levels (〰 23) and intergenerational disparities in perceptions of energy transition priorities (〰 27). Other stressors leading to conflict situations were associated with environmental degradation resulting from mining exploitation (〰 28, 〰 29, 〰 30), stigmatization, and deterritorialization affecting numerous Silesian localities (〰 21, 〰 22), and opposition to new external investments in the Katowice sub-region (〰 01, 〰 02, 〰 03).

Many of the impasses identified in the research are linked to divergent perspectives on the significance of the mining sector in the country's economy and energy security (〰 10). Stakeholders also perceive contradictions in simultaneously advocating for a transition to cleaner energy sources while neglecting and obstructing research into clean coal technologies (〰 24). Two other types of impasses relate to the lack of mobilization of young inhabitants of Silesia with regard to seeking employment outside of mining during the nineteen-nineties restructuring period (〰 19) and the absence of climate change education in schools (〰 26).

Stakeholders attribute the sense of dependency or uncertainty primarily to the progressive disinvestment in the mining and related sectors that has occurred since the early nineteen-nineties, driven by changes in Poland's energy policy (〰 08, 〰 11, 〰 17, 〰 25), international agreements and EU-level regulations (〰 09, 〰 12). Additionally, challenging geological conditions making it harder to exploit coal deposits contribute to this feeling of uncertainty (〰 16). Furthermore, in the region, especially in Katowice, the most dynamic development is currently observed in the business, service and IT sectors, which is fundamentally transforming the labor market and influencing the desired competency profile of the workforce (〰 20).

Strain situations affect the way a region functions and, in the long term, influence the nature and direction of processes within it defined as stress vectors. These most important historical moments (strain situations), according to the experts surveyed, were categorized into three main dimensions. A description of these dimensions can be found in Table 2.

Table 2. Types of stress situation (vectors)

Tabela 2. Typy sytuacji wywołujących napięcia

Type of stress vectors	Strain situation	Description
Change in the status of a mining-related occupational group	04; 05; 06; 19	The status of the mining-related occupational group has undergone significant changes. Historically, working in mining offered various privileges and high salaries, with the industry wielding considerable political influence. However, this landscape is evolving. In the "communist era", mining held strategic importance for its potential in the production of armaments during the Cold War. Miners enjoyed special privileges, particularly in the nineteen-seventies. The expansion of heavy industry, however, led to shortages in other sectors of the planned economy, sparking conflicts and tensions. Despite the 1989 breakthrough and subsequent decline in the condition of Polish mines, a lasting sense of privilege persisted. Mining became deeply rooted in regional identity. The profession often passed down through generations until the nineteen-nineties. Attempts at restructuring and reform in the late twentieth and early twenty-first century sparked violent protests by miners. Their significant power, strong trade unions, and political ties impeded sector reforms. Over time, public support and the miners' political influence have waned and they are no longer perceived as particularly privileged.
Disinvestments in the mining sector	13; 08; 07; 09; 11; 12; 23; 35; 16; 27; 01; 02; 03	Divestments in the mining sector have surged over the past three decades. In the era of the Polish People's Republic, heavy industry, including mining, played a crucial role in the economy, receiving consistent financial support and occasional large investments. However, after the 1989 breakthrough, most mines became economically unsustainable. Various governments attempted to reform the sector, with Jerzy Buzek's 1997–2001 initiative closing twenty-two mines and prompting around 100,000 people to leave mining. Despite efforts, the reform remained incomplete, leading to persistent issues. Factors like low mine profitability, challenging geological conditions, and EU and Polish climate policies have driven a gradual divestment trend. Social changes, such as a declining level of prestige in the mining profession and increased climate change awareness hinder new investments. Social movements actively oppose even limited new initiatives. Amid Russia's invasion of Ukraine and rising energy prices, divestment in the mining sector gains renewed importance.
Depopulation of Silesia	18; 20; 22; 21; 29; 30; 28	Silesia's population, shaped by mining identities for decades, saw a shift in the nineteen-nineties as mining families left during industry reforms. Foreign investments now focus on different sectors, causing depopulation in towns tied to mining due to migration and demographic shifts. Katowice, the region's capital, is also affected, although to a lesser extent. The outdated stigma of a polluted Silesia prompts some to work in Katowice but live elsewhere. Nearby areas with mining history face relatively low land prices due to potential damage, which further impacts population trends. After years of mining industry restructuring, families disconnected from mining often migrate back to their hometowns.

Sources: ENTRANCES Focus Group Discussion.

3.2. Transformative capacity

The region's past experiences and the key factors that create the ability to cope with challenges largely determine the transformational capacity of Silesia. Considering the results obtained from structured questionnaire interviews with experts, it must be concluded that

Silesia currently has relatively little transformative capacity. The average aggregated score for all ten dimensions was 3.3. This is the result of three interrelated groups of factors that determine the transformative capacity of the regions. The first group of factors necessary for transformative success relates to how regional decarbonization processes are governed. It includes attributes such as inclusivity and multi-stakeholder governance arrangements (C1), polycentric and socially embedded transformational leadership (C2) and the empowerment and autonomy of relevant communities of practice (C3). These are the underlying conditions for the actions of social actors through which processes that enhance the transformative potential are triggered. This happens through processes that support the understanding of interdependencies within the system in which social actors are a part (C4), provide space for the participatory definition of alternative scenarios and visions of development (C5), enable experimentation with new forms of meeting social needs (C6), and provide opportunities to integrate these innovations into social practices (C7). This cycle of transformative capacity enhancement closes with a feedback loop through which the effects of the processes set in motion are introduced into governance through social learning (C8), the effective involvement of actors operating at different levels of the organization of social life (C9), and at different levels of administrative and territorial organization (C10). The results are presented below and broken down into the three broader categories indicated above: governance and agency (covering indicators C1 to C3), capacity development processes (C4 to C7), and relational factors (indicators C8 to C10). The average assessments for each of the ten factors and subfactors are presented in Figure 1.

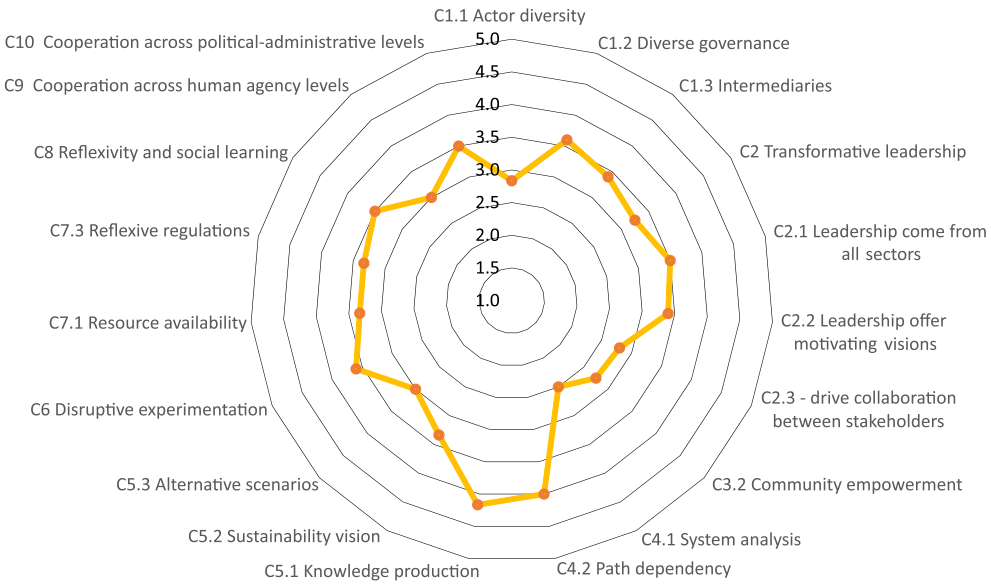

Fig. 1. Transformative capacity in the coal region of the Silesian Province
Source: Based on ENTRANCES interviews conducted for the Silesia case study

Rys. 1. Potencjał transformacyjny w regionie węglowym województwa śląskiego

The quantitative assessment of each factor was justified by the experts with specific arguments and examples. The analysis of the justifications presented during the interview gives context to the assigned numerical values and points to some key issues related to the three main categories of transformative capacity.

3.2.1. Governance and agency

The results of the assessment of factors related to governance and agency are shown in Table 3. The mean values are slightly above the middle of the scale. The context in which they are given by experts is critical to understanding these assessments. The current management of energy transition processes is perceived as chaotic, and it lacks coordination between different actors and levels of government. Communication is mainly one-way, from top to bottom, with limited consultation or agreement of positions, which leads to a lack of inclusive and multiform governance in the energy transition.

Stakeholder participation is limited, with little involvement of C4.2 citizens and reluctance from the scientific community due to time constraints and politicization. The social community's awareness of and involvement in the transformation process are negligible, particularly for those affected by energy poverty.

Table 3. Governance and agency

Tabela 3. Zarządzanie i potencjał społeczny

Factor / Subfactor	Assessment	
	mean	mode
C1. Inclusive and multiform governance		
C1.1. actor diversity	2.8	3.0
C1.2. diverse governance	3.6	4.0
C1.3. intermediaries	3.4	3.0
C2. Transformative leadership		
C2.1. coming from all sectors	3.5	3.5
C2.2. offering motivating visions	3.4	3.0
C2.3. driving collaboration between stakeholders	2.8	3.0
C3. Empowered and autonomous communities of practice		
C3.1. social-needs–focus	3.2	3.0
C3.2. community empowerment	2.8	2.5

Source: Based on ENTRANCES interviews conducted for Silesia case study.

Communities of practice were not sufficiently empowered in this region. The negative impact of energy transformation on the labor market and the quality of life in the region according to the interviewers is marginalized by the central government. Energy policy is perceived as disconnected from the needs of society and is shaped by energy trends, geopolitics and economics. Moreover, all experts drew attention to the issue of lack of coordination and autonomy among institutions involved in energy transformation. Each entity works independently without central management of the entire transformation process. Some criticize the leadership of the transition, pointing out the absence of vision and spot-on actions at the local level.

3.2.2. Capacity development processes

Table 4 presents the mean assessments of factors related to capacity development pocesses. According to the respondents, there are several barriers that hinder the progress of the energy transition. One of the major barriers is that the national energy policy does not address the local level and there is a lack of systemic solutions for implementing transformation in a sustainable way.

Another significant barrier is the current energy mix, which has been heavily reliant on coal for historical reasons. This poses a challenge for transitioning to cleaner energy

Table 4. Capacity development processes

Tabela 4. Procesy rozwoju zdolności do transformacji

Factor / Subfactor	Assessment	
	mean	mode
C4. System(s) awareness and memory		
C4.1. systems analysis	2.5	2.0
C4.2. path dependency	4.0	5.0
C5. Sustainability foresight		
C5.1. knowledge production	4.2	4.5
C5.2. sustainability vision (aggregate)	3.3	3.4
C5.3. alternative scenarios	3.0	4.0
C6. Disruptive experimentation	3.6	4.0
C7. Innovation embedding and coupling		
C7.1. resource availability	3.3	3.5
C7.3. reflexive regulation	3.3	3.0

Source: Based on ENTRANCES interviews conducted for Silesia case study.

sources. Additionally, the existing structure of the energy market and the maturity of administrative and political systems are external barriers to transformation.

The experts also highlighted the lack of understanding and knowledge among people regarding the benefits of transformation processes and the negative consequences of using fossil fuels. There is a need to increase knowledge and awareness as well as to address the issue of access to knowledge. Some interviewees suggested that knowledge production is dependent on research commissioning bodies and that there may be a lack of scientific independence in some cases.

Although alternative scenarios and participatory visioning exist, they are not widely used or implemented. It is difficult to assess the availability and functioning of alternative scenarios. The energy sector has undergone significant changes, particularly owing to Russian military aggression against Ukraine, which has altered the perceptions of certain energy sources.

In terms of disruptive experimentation and the embedding of innovation, the interviews indicate a lack of consistency in executive documents for current energy policies, making it challenging to conduct pilot projects. The Silesia region, like other regions of Poland, has limited opportunities in which to experiment and test new solutions. The involvement of power companies and scientific units in creating and testing new solutions has been inadequate, despite technological developments in the energy field.

3.2.3. Relational factors

As mentioned earlier, social learning and feedback, through which governance and energy policies can be adapted and adjusted, is a key element in increasing transformative capacity in the region. As can be seen in Table 5, the average assessment of each factor was a bit above the middle of the scale. However, experts highlight that while some monitoring is carried out, it is done in a non-systemic and fragmentary manner. This is because of the dispersion of climate policies among many institutions, making it difficult to have a coordinated monitoring system. Additionally, there is no coherent and comprehensive system for monitoring the effects of transformational policies at the individual recipient level. This has not been addressed by institutions at the regional or national level.

Experts also suggested that, while knowledge about the future and the consequences of energy policies is available, there is a lack of willingness to accept and use this knowledge. Furthermore, alternative scenarios that can help assess the availability and function of different policy options are not being utilized effectively.

Cooperation across political-administrative levels is also an important factor that is judged by respondents to be under-recognized. The relationship between ministries and local governments is considered a key area of cooperation. However, there are challenges in intersectoral and inter-administrative cooperation, particularly in the monitoring of spending. The transparency of spending has been criticized for making it difficult for citizens to have control.

Table 5. Relational factors

Tabela 5. Czynniki relacyjne

Factor / Subfactor	Assessment	
	mean	mode
C8. Social learning	3.5	4.0
C9. Working across agency levels	3.0	3.0
C10. Working across scales	3.5	4.0

Source: Based on ENTRANCES interviews conducted for Silesia case study.

Interviewees also mentioned the lack of willingness to adopt and understand the knowledge that has been generated thus far on energy transition processes among politicians and other social actors. Although scientific knowledge on energy transition exists, there is a lack of motivation to adopt and implement it.

Conclusions

The mining industry, which has been dominant in Silesia for over 200 years, is currently losing its strong position and the entire region with its characteristic and very traditional social structure is undergoing a profound transformation. Due to the gradual abandonment of coal as the basic fuel for energy production, the entire region is going through a difficult period in which changes must concern not only the technical and economic elements of transformation but also those of a socio-cultural nature. The new economic landscape determined by the change in the quality and type of enterprises offering jobs is changing the traditional social roles in the region. It activates women professionally and increases their professional development opportunities. At the same time, it creates the need for men to change their qualifications. The region focuses on new directions of development, paying more attention to environmental protection elements. All this is the result of many strain situations that have gradually changed the socio-cultural conditions of the region's development. The analysis of historical examples of strain situations shows that past stressors, especially in the period after the political and socio-economic transformation in 1989, have influenced the region perceived as a complex system and shaped patterns of adaptation to change determining its current transformative capacity. The impact of globalization, technological progress and environmental problems has ultimately created a community more open to change. Unfortunately, the readiness for change and the potential for transformation is not evenly distributed between different sub-regions and social groups. The region's vision is to further develop areas that are gaining importance in the modern economy, such

as industrial production, processing and logistics. Additionally, experts participating in the study highlighted that while the region's capital city (Katowice) is where the majority of investments are concentrated, there is a noticeable peripheralization of the satellite cities, which base their local economy and employment on the mining industry, where a progressive process of disinvestment has been observed for more than two decades.

Silesia's dependence on coal creates serious challenges from the point of view of the socio-technical and socio-ecological aspects. By closing the mines, the region must also create new alternative jobs for miners. The region's energy infrastructure must be changed, replacing coal with cleaner and more sustainable energy sources. This includes the development of new, innovative technologies, the adaptation of existing infrastructure where possible, as well as the effects of the transformation on the environment.

Research on the transformation possibilities of the Silesian Province from the point of view of the impact of technical and ecological conditions on society showed that:

- The region is characterized by low transformation capacity. It manifests itself in the fact that change management takes place primarily in a top-down approach. Top-down methods of transformation, although they claim to be inclusive, in practice exclude many local entities and actors from the possibility of co-creating transformation policies.
- The top-down approach to decarbonization is accompanied by a lack of strong and transformation-oriented leadership that would set shared visions of the decarbonization process and effects and coordinate energy transition activities undertaken at different levels and by different institutions.
- There is a lack of information flow between different levels of management: national, regional, and local.
- The level of public awareness and down-top activities for energy transformation is growing, but grassroots practices and growing expectations regarding the participation of the region's inhabitants in the decision-making process have no chance to develop due to the lack of inclusiveness of the process and the coordination of activities at various levels of social and administrative organization.
- The intensity of the transformation process is significantly higher in the Katowice subregion compared to the other subregions of the Silesian Province.

Taking into account the obtained research results, it should be noted that in light of the growing social awareness of the issue of human impact on climate change and the need to counteract it, it is necessary to intensify the implementation of transformation policies in the Silesian region. It is important that government programs are developed in cooperation with communities directly interested in the effects of these activities, taking into account counteracting unfavorable social changes leading to the deterritorialization of the region.

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REFERENCES

Bertrand, A.L. 1963. The stress-strain element of social systems: a micro theory of conflict and change. *Social Forces* 42(1), pp. 1–9, DOI: 10.2307/2574939.

Castan Broto et al. 2019 – Castán Broto, V., Trencher, G., Iwaszuk, E. and Westan, L. 2019. Transformative capacity and local action for urban sustainability. Ambio 48, pp. 449–462 (2019), DOI: 10.1007/s13280-018-1086-z.

Caiati et al. 2021 – Caiati, G., Quinti, G., Cacace, M., Feudo, F., Garcia Mira, R., Singh Gartha, N., González Laxe, F., Rey Vizoso, F.J., Filčák, R., Skobla, D., Holtemöller, O., Schult, C., Heinisch, K., Wolfram, M., Barrett, T., Knippschild, R., Rühlemann, A., Kuschan, M., Norena, M., De Luca, E., Spiesberger, M., Klöckner, C., Haley, A., Boncu, S. and Holman, A. 2021. *Report on Multi-dimensional Key Factors, Dynamics and Patterns*. [Online:] https://entrancesproject.eu/wp-content/uploads/2021/06/D1.2.-Report-on-Multidimensional-Key-Factors.pdf [Accessed: 2024-01-17].

Czaja, S. and Rutkowska, M. 2023. Ecological and climatic challenges facing documents of local development strategies (on the example of Lower Silesian municipalities in Poland). *Economics and Environment* 86(3), pp. 366–381, DOI: 10.34659/eis.2023.86.3.580.

Dulias, R. 2016. *A Brief History of Mining in the Upper Silesian Coal Basin*. [In:] *The Impact of Mining on the Landscape*, pp. 31–49, DOI: 10.1007/978-3-319-29541-1_2.

Hubert et al. 2023 – Hubert, W., Kowalik, W., Komorowska, A., Kryzia, D., Pepłowska, M. and Gawlik, L. 2023. Territorial trauma or modernization experience? The Kraków Metropolitan Area and Silesia as case studies affected by intensive energy transition processes. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 39(3), pp. 125–148, DOI: 10.24425/gsm.2023.147552.

Kaszyński, P. 2023. A decomposition analysis of primary energy consumption and economic transition: the case of Poland. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 39(4), pp. 67–84, DOI: 10.24425/gsm.2023.148167.

Kaszyński, P. and Kamiński, J. 2020. Coal Demand and Environmental Regulations: A Case Study of the Polish Power Sector. *Energies* 13(6), DOI: 10.3390/en13061521.

Kiewra et al. 2019 – Kiewra, D., Szpor, A. and Witajewski-Baltvilks, J. 2019. *Sprawiedliwa transformacja węglowa w regionie ślaskim. Implikacje dla rynku pracy*. No 02/2019, IBS Research Reports, Instytut Badan Strukturalnych. [Online:] https://ibs.org.pl/publications/sprawiedliwa-transformacja-weglowa-w-regionie-slaskim-implikacje-dla-rynku-pracy/ (*in Polish*).

Komorowska et al. 2022 − Komorowska, A., Hubert, W., Kowalik, W., Kryzia, D., Gawlik, L., Pepłowska, M., Mokrzycki, M., Uberman, R. and Mirowski, T. 2022. *Silesia Case Study Report*. [Online:] https://entrancesproject.eu/wp-content/uploads/2022/12/D3.1-Silesia-Case-Study-Report.pdf [Accessed: 2023-12-11].

Koval et al. 2022 – Koval, V., Borodina, O., Lomachynska, I., Olczak, P., Mumladze, A. and Matuszewska, D. 2022. Model Analysis of Eco-Innovation for National Decarbonisation Transition in Integrated European Energy System. *Energies* 15(9), DOI: 10.3390/en15093306.

Kulpa et al. 2022 – Kulpa, J., Olczak, P., Steculа, K. and Sołtysik, M. 2022. The Impact of RES Development in Poland on the Change of the Energy Generation Profile and Reduction of CO_2 Emissions. *Applied Sciences* 12(21), DOI: 10.3390/app122111064.

Łukaszczyk, Z. and Popczyk, M. 2018. Changing the mining industry in the heart of Silesia. [In:] *IOP Conference Series: Earth and Environmental Science* 174(1), DOI: 10.1088/1755-1315/174/1/012006.

Malec, M. 2022. The prospects for decarbonisation in the context of reported resources and energy policy goals: The case of Poland. *Energy Policy* 161, DOI: 10.1016/j.enpol.2021.112763.

Orlewski, P. 2019. Identity and distribution of the Silesian minority in Poland. *Miscellanea Geographica* 23(2), pp. 76–84, DOI: 10.2478/mgrsd-2019-0006.

Pepłowska, M. 2021. Coal supply prospects in Poland and selected European Union countries. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 37(3), pp. 31–52, DOI: 10.24425/gsm.2021.138657.

Reyers et al. 2018 – Reyers, B., Folke, C, Moore, M., Biggs, R. and Galaz V. 2018. Social-Ecological Systems Insights for Navigating the Dynamics of the Anthropocene. *Annual Review of Environment and Resources* 43(1), pp. 267–89, DOI: 10.1146/annurev-environ-110615-085349.

Tkocz, M. 2006. Effects of hard coal mining restructuring in Poland (*Efekty restrukturyzacji górnictwa węgla kamiennego w Polsce*). *Prace Komisji Geografii Przemysłu Polskiego Towarzystwa Geograficznego* 9, pp. 28–39 (*in Polish*).

The Climate Group 2016. *States and Regions. Partner Region Profile – Silesia*. [Online:] https://energy.ec.europa.eu/system/files/2020-07/silesia_regional_profile_-_start_technical_assistance_0.pdf [Accessed: 2023-12-20].

UNDP 2008. *Capacity Assessment Methodology: User's Guide*. Capacity Development Group Bureau for Development Policy November 2008. [Online:] http://content-ext.undp.org/aplaws_publications/1670209/UNDP%20Capacity%20Assessment%20Users%20Guide.pdf [Accessed: 2024-01-11].

Wehnert et al. 2018 – Wehnert, T., Hermwille, L., Mersmann, F., Bierwirth, A. and Buschka, M. 2018. *Phasing-out coal, reinventing European regions: an analysis of EU structural funding in four European coal regions.* Final report. [Online:] https://epub.wupperinst.org/frontdoor/deliver/index/docId/7167/file/7167_Phasing_Out_Coal.pdf [Accessed: 2024-01-11].

Wolfram, M. 2016. Conceptualizing urban transformative capacity: A framework for research and policy. *Cities* 51, pp. 121–130, DOI: 10.1016/j.cities.2015.11.011.

Wolfram et al 2019 – Wolfram, M., Borgström, S. and Farrelly, M. 2019. Urban Transformative Capacity: From Concept to Practice. *Ambio* 48, pp. 437–448, DOI: 10.1007/s13280-019-01169-y.

SOCIO-CULTURAL CHALLENGES OF COAL REGIONS AND THEIR TRANSFORMATIVE CAPACITIES – A CASE STUDY OF SILESIA

Keywords

energy transition, decarbonization, Silesia, social-cultural chances

Abstract

This article presents the results of a study of the determinants of energy transformation of coal-dependent regions. The case study was on the region of Silesia. This region is the main producer of hard coal and coking coal in Poland, with nineteen mines and numerous coal-fired power plants. Silesia is highly industrialized and urbanized, contributing significantly to Poland's GDP. However, it is also a leader in terms of methane and carbon dioxide emissions. The study used an approach based on Alvin L. Bertrand's 'stress-strain' theory, to investigate the socio-cultural stresses emerging as a result of the interaction of external factors and internal process dynamics within the region itself. Then, using Marc Wolfram's systems-based analytical framework approach, the current transformative capacity of Silesia was analyzed. The theoretical framework adopted assumes that socio-cultural stress can be inferred from past situations of tension, influencing the social structure of the region and shaping accepted patterns of adaptation to change. Socio-cultural stress emerges as a key determinant of a region's coping strategy and shapes its ability to transform in the long term. The research approach presented in this article adopts a comprehensive framework that integrates socio-cultural, socio-ecological and technological dimensions, providing a holistic view of a region's transformation challenges and opportunities. The research was conducted using focus group interviews and a structured interview questionnaire. Participants in

the research were individuals representing a diverse community of experts and activists involved in the energy transition process in Silesia, including local government officials, businesses, professional associations and social activists.

WPŁYW WYZWAŃ SPOŁECZNO-KULTUROWYCH REGIONÓW WĘGLOWYCH NA ICH ZDOLNOŚCI TRANSFORMACYJNE NA PRZYKŁADZIE ŚLĄSKA

Słowa kluczowe

transformacja energetyczna, dekarbonizacja, Śląsk, zmiany społeczno-kulturowe

Streszczenie

Artykuł przedstawia wyniki badań nad uwarunkowaniami transformacji energetycznej regionów węglowych na przykładzie Śląska. Region ten jest głównym producentem węgla kamiennego i koksującego w Polsce, z 19 kopalniami i licznymi elektrowniami węglowymi. Śląsk jest wysoce uprzemysłowiony i zurbanizowany, wnosząc znaczący wkład w polski PKB. Jest jednak również liderem pod względem emisji metanu i dwutlenku węgla. W prezentowanych badaniach wykorzystano podejście bazujące na teorii „napięć-odkształceń" Alvina L. Bertranda, do badania stresu społeczno-kulturowego pojawiającego się w efekcie oddziaływania czynników zewnętrznych i wewnętrznych procesów w samym regionie. Następnie, korzystając z ram analitycznych Marca Wolframa opartych na podejściu systemowym, przeanalizowano obecne zdolności transformacyjne Śląska. Przyjęte ramy teoretyczne zakładają możliwość wnioskowania o stresie społeczno-kulturowym z przeszłych sytuacji napięć, wpływających na strukturę społeczną regionu i kształtujących przyjęte wzory adaptacji do zmian. Stres społeczno-kulturowy wyłania się jako kluczowy czynnik determinujący strategię radzenia sobie regionu i kształtuje jego zdolność do transformacji w perspektywie długoterminowej. Zaprezentowane w artykule podejście przyjmuje perspektywę, która integruje wymiar społeczno-kulturowy, społeczno-ekologiczny i technologiczny, zapewniając holistyczny obraz wyzwań i możliwości transformacji w regionie. Badania przeprowadzone były przy wykorzystaniu zogniskowanych wywiadów grupowych oraz ustrukturyzowanego kwestionariusza wywiadu. Uczestnikami badań były osoby reprezentujące zróżnicowane środowisko ekspertów i działaczy zaangażowanych w proces transformacji energetycznej Śląska – samorządowców, przedsiębiorstw, stowarzyszeń zawodowych czy działaczy społecznych.