



A comparative policy approach to climate change in cross-border regions

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ABSTRACT

This research aims to explore regional place-based approaches to climate change in cross-border regions (CBRs). CBRs face unique challenges as well as opportunities to develop innovative approaches and more resilient responses to the threats generated by climate change (CC). The study reveals the policy directionality in CBRs across multiple levels of government. Specifically, we explore how the different policy objectives – climate mitigation vs adaptation – are aligned across the international borders in Polish CBRs and their counterparts in Germany, Czechia, Slovakia, and Lithuania. The paper uses mixed methods combining qualitative data concerning both policy documents and investment figures issued at regional, national, and cross-border policy levels. The findings demonstrate the spatial sensitivity in approaches to CC across CBRs. Different levels of policy alignment are reported against the institutional set-ups of the CBRs. The analysis shows a clear consensus on the role of cross-border cooperation in addressing CC-related threats, including floods and forest fires. These threats are recognised unanimously across the CBRs' sample, although the remediation measures vary. The analysis demonstrates that a similar institutional set-up, across the two sides of the border, “*per se*” does not necessarily guarantee a coherent approach toward CC.

1. Introduction

This research investigates the spatial sensitivity in regional approaches to climate change (CC) in cross-border regions (CBRs). The study focuses on the cross-border regional policy directionality in responses to CC. CBRs and borderlands have received scientific attention by environmental management studies (see Freimund et al., 2022; Wilder et al., 2020), partly because natural obstacles such as rivers, coasts, and mountains have historically influenced the location of international borders. However, despite the growing scientific and policy interest in tackling CC, academic and policy literature falls short of evidence on climate adaptation and mitigation policies in CBRs. This paper aims to address this issue by providing a comparative case study of EU CBRs.

The CC policy framework is constructed across multiple government levels. Our scientific interest lies in CBRs, as subnational institutions have been found to be responsible for implementing CC policies (Galarraga et al., 2011). Our analysis examines policy directionality, as

approaches to CC objectives — climate mitigation versus adaptation — have been shown to be difficult to reconcile (see Moser, 2012; Landauer et al., 2019).

Therefore, we look at subnational (regional) governments, called to ensure a vertical and horizontal coordination in the multi-level governance. In the case of CBRs, the presence of an international border adds a further layer of complexity for the policy coordination. Nevertheless, the border offers a privileged perspective to assess governance and the cross-country differences in terms of CC approaches. CBRs require place-based strategies that align regional priorities with both cross-border cooperation mechanisms and national policy instruments. This study is structured around the research question: To what extent is the policy approach toward climate change (CC) consistent across cross-border regions (CBRs) in terms of goals, strategies, and implementation?

We frame policy directionality and coordination within multilevel governance through the notion of a policy assemblage (Sohn, 2016): a group of actors working collectively within the policy process to address climate change (CC). This paper uses a mixed-methods approach,

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combining qualitative data from policy documents with investment figures, to provide a multi-level perspective that includes regional, national, and cross-border policy levels. Data retrieved from multiple EU databases enables us to compare the approaches of EU CBRs to CC. We examine the hypothesis that greater alignment in CC approaches across both sides of the CBRs will result from a comparable institutional framework in terms of power decentralisation.

The findings show that an ambivalent level of alignment is emerging from the policy documents examined across the sample of CBRs. Forest fires and floods are considered the most urgent CC-generated threats almost unanimously. However, the approach to CC is place-sensitive: although the same policy objectives are recognised, the study found an asymmetry in policy actions.

The article is devised as follows: the second section recalls the literature review concerning the CC policy, the initiatives in CBRs targeting CC, as well as the rationale for a place-based approach to CC-oriented policy. The third section highlights the research strategy, unfolding the rationale and the methodological approach pursued in this study. The fourth section discusses the empirical results of the analysis. The final section displays discussion and conclusions, paving the way for further research avenues.

2. The complex interplay between climate change policy and policy scales in CBRs

2.1. Policy directionality and alignment

We aim to clarify what is the object of this research: the policy directionality in CBRs. In the literature, there are a few terms – with a limited semantic distance – which account for consistent policy approach towards a shared goal. For instance, the term policy “*directionality*” gained momentum in the innovation scholarship originating a few policy approaches including the Mission-oriented approach, the Transformative Innovation policies, and challenge-oriented approaches (see [Haddad and Bergek, 2023](#) for further detail). The common assumption requires that innovation [should] “contribute to a particular direction of transformative change” ([Weber and Rohrer, 2012](#), p. 1042). While hailed in the narrative of challenge-oriented innovation policy, policy directionality has received less attention from a practical standpoint with a few explorative studies in this regard shedding light on the plurality of directions to be pursued at different government levels (see [Priebe and Herberg, 2024](#)). Whereas the term directionality bears an evolutionary assumption as it refers to the pathway from the status quo to a desired end-goal, it gained a relational understanding since multiple actors should collectively agree on a shared vision and direction to follow ([Weber and Rohrer, 2012](#)). In a complex and multi-layered governance setting, the term resonates also with “*coordination*” and “*alignment*” of multiple actors. Although these words are semantically close each other, it is worth noting the alignment of directions as the output of the agents’ coordination efforts. In fact, [Wanzenböck et al. \(2020\)](#) conceptualized the policy directionality at different stages of alignment and convergent views of problems and solutions. [De Graaff et al. \(2025\)](#) expanded the understanding of systemic directionality into political processes. Hereby, we refer to the policy directionality as the complex process to align actors across vertical and horizontal government levels as well as stakeholders to promote policy actions towards a common shared goal. Therefore, we infer directionality through the lens of policy alignment, focusing on how climate change (CC) policy approaches reflect adaptation and mitigation strategies.

2.2. Exploring the climate change (CC) policy and the multi-level governance

CC policy approaches are assessed in this paper under the definition of CC adaptation and mitigation (see [Table 1](#)). While the two approaches

Table 1

Climate adaptation and mitigation. Source: adapted from European Environmental Agency and [Grafakos et al. \(2019\)](#).

	Climate change Adaptation	Climate change Mitigation
Definition	anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise	preventing or reducing the emission of greenhouse gases (GHG) into the atmosphere
Examples	Examples include large-scale infrastructure changes, such as building defences to protect against sea-level rise, as well as behavioural shifts, such as individuals reducing their food waste.	Examples include but not limited to increasing the share of renewable energies, or establishing a cleaner mobility system, or by enhancing the storage of these gases, by increasing the size of forests
Sectoral Focus	Selected ones related to particular climate impacts	All sectors that can reduce GHG emissions
Geographical scale of effect	Local, regional	Global
Temporal scale of effect	Short to medium term	Long term
Effectiveness	Less Certain	Certain
Level of governance	Regional, Local	International, national
Monitoring	More complex (measuring the reduction of climate risk)	Relatively easy (Measuring the reduction of GHG emissions)

adapted from (European Environmental Agency and [Grafakos et al. \(2019\)](#).

are reported to be ideally complementary, practices show areas of confrontation due to trade-offs and conditions leading to competition for resources, and potentially negative consequences of pursuing simultaneous actions (see [Moser, 2012](#); [Landauer et al., 2019](#)). For instance, the use of electricity as energy source for climate adaptation (e.g. air cooling, or water pumping) might be detrimental for mitigation (see [Sugar et al., 2013](#)). Pursuing climate adaptation and mitigation at the same time can generate different results in a different time and geographical frames. Such trade-offs suggest a clear dichotomy between adaptation and mitigation ([Grafakos et al., 2019](#)), thus, requiring policy objectives consistent across multiple scales of government ([Landauer et al., 2019](#)).

The alignment across multi-layered governance sheds light on the authorities and powers of different policy levels ([Bisaro et al., 2020](#)). While national and supranational policy stakeholders are entitled to negotiate global directionality, with a particular emphasis on CC, the subnational governments are considered “the main implementing bodies for global agreements on CC policies” ([Galarraga et al., 2011](#), 168). Accordingly, the [European Parliament \(2024\)](#) claims that “local and regional authorities and players have a crucial role to play in the success of adaptation actions, as they are most vulnerable to the impact of CC, know their territories best and can champion the necessary actions and projects”. As shown in the [Table 2](#), subnational governments have the delicate power to scale down the national and international directionality to local needs and place-specificities.

The scientific literature hails place-based approach ([Barca et al., 2012](#)) as critical for considering local resources, the nature of threats and exposure to risks which have not been considered spatially even ([Wanzenböck and Frenken, 2020](#)). As a matter of fact, recent events show that CC does not have the same effects all over the world. CC can produce effects of different types, such as droughts, heat waves as well as floods, storms and forest fires. At the same time, CC can open new windows of opportunity to regenerate regional development trajectories ([Boschma, 1996](#)), as demonstrated in the aftermath of natural disasters ([Rizzo et al., 2022](#)). In fact, designing CC-oriented policies at the local level can also adapt solutions locally, as what works in one context may not necessarily be beneficial elsewhere. Scholars have demonstrated

Table 2
CC and multi-level governance: key actors, functions and tools on different scales of action. Source: OECD (2009) and Galarraga et al. (2011).

Local/City	Sub-national regions (e.g. states or provinces)	National	International
<ul style="list-style-type: none"> • Implement local decisions as foreseen under national or regional law. Where authority exists, act autonomously, e.g. through land-use planning, decisions on local infrastructure (local roads, urban planning and zoning, flood control, water supply, local parks/reserves/green spaces, sanitary waste, etc.) • Identify local priorities enhance local/regional understanding working with local actors • Raise awareness; create deliberative 'space' for decision-making • Develop locally adapted policies and measures, e.g. public-private partnerships and local public procurement policies 	<ul style="list-style-type: none"> • Implementation of national laws, standards • Regional climate policy framework-near and long-term targets- regional strategic orientation • Regional laws and policies in key climate-related sectors (e.g. energy, air pollution, water) • Regulate performance in key sectors where permitted by national law to do so (e.g. building or appliance standards) • Prioritize and set out time frames for regional action (e.g. by sector) • Provide incentives, funding and authorization to enable local action on climate change • Risk characterization at regional scale; definition of risk management rules or guidance, funding and principles • Establish a monitoring system to track GHG emissions and policy performance over time • Fund core analytical inputs to facilitate regional and local decision-making • Ensure that decision-makers have the tools, information and appropriate institutional context to deliver good decisions 	<ul style="list-style-type: none"> • National climate policy framework-near and long-term targets- strategic orientation for policy • National laws, policies and standards in key climate related sectors (e.g. energy, air pollution, water). • Regulate performance (e.g. building or appliance standards) • Prioritize and set out time frames for national action (e.g. by sector) • Infrastructure funding and authorization for construction (e.g. national roads, sitting power or transmission facilities, water supply and quality, parks or reserves) • Establish a national inventory system and build understanding of nation-wide mitigation opportunities and their costs • Risk characterization at national scale; definition of risk management rules or guidance, funding and principles • Monitor performance of climate policies-national scale • Fund core analytical inputs to facilitate sub-national (regional and local) decision-making • Provide regions, local governments with tools and support to make good decisions (e.g. inventory methods) 	<ul style="list-style-type: none"> • Set out timeframe and priorities for cooperative action, collaborative framework to guide national action • Provide seed resource to support action • Monitor and peer-review and where appropriate, compliance assessment (e.g. FCCC) • Facilitate sharing of experience between nations

that considering local policy dynamics and regional knowledge can be beneficial for overall policy effectiveness (Bours et al., 2022; Bugge et al., 2022; Cappellano et al., 2022a).

Therefore, efforts to tackle CC should not be undertaken in a siloed approach, as a critical mass of investments, coordination of multiple actors, horizontal and vertical actions, and multidisciplinary efforts are required to be effective. More notably, we refer to vertical cooperation which involve different levels of administrative institutions along the chain of power and authorities (see Galarraga et al., 2011). On the one hand, policy approach towards CC is usually regulated by supranational institutions raining down to lower levels of (local) governments. Bisaro et al. (2020) noted that this is not always the case, evaluating the alignment of CC policy approaches in institutional contexts with mixed arrangements including a highly centralised standpoint, partial devolvement, and full decentralization. On the other hand, the horizontal cooperation is pursued by public institutions and stakeholders at the same geographical scale, opening for synergies in the form of national and transnational networks and coalitions (Galarraga et al., 2011). This is the case of CBRs, as shown in our conceptual framework (see Fig. 1), where there are opportunities for horizontal partnerships with institutions and players on the other side of the border (see Sohn et al., 2022). The international border implies multiple functions favouring and hindering cross-border cooperation (see Sohn and Licheron, 2018; Cappellano et al., 2022b). Thus, the CC governance requires a mix of vertical and horizontal cooperation (see Fig. 1) across multiple administrative levels and, in our case, across geographical layers (e.g. international borders). To navigate the complexity of multi-layered governance we refer to the conceptual notion of assemblage, as heterogeneous grouping of institutions, networks and actors working together albeit not forming an homogenic body, applied in CBRs (Sohn, 2016). In his theoretical discussion of the assemblage notion, Sohn (2016) frames this concept with a territorial understanding. Assemblage does not happen in the vacuum, rather it is highly dependent on the territoriality which includes the local institutional set-ups, local agents, and geographical specificities. As well noted, horizontal cooperation opens opportunities for public-private partnerships which can enable stakeholders to prioritize their interests in public policy agenda, shaping directionality. Therein, these vested-interests are assembled within the multi-layered governance framework. Yet, the literature falls short of evidence of CC-oriented policy approach in CBR and practical evidence of multi-layered governance. The salience of this study is heightened by the multiple CBRs evaluated which show differences in institutional arrangements and multiple forms of centralizations/devolvement.

2.3. The fight to climate change in CBRs

In a multilayered governance towards CC, being close to other regions presents both coordination opportunities and costs. Nevertheless, an inter-regional alignment should be pursued to maximize the public expenditure efficiency. Our analysis focuses on CBRs as international borders heighten the complexity of coordination across the two sides of the border. Cross-border regions (CBRs) are defined as a bounded territorial unit composed of multiple political territories (Perkmann, 2003). International borders work as man-made artificial lines to separate states from each other (Van Houtum, 1998).

Instead, CC and its effects do not stop at international borders (Carter et al., 2021). As a matter of fact, there is grim increasing evidence of floods, forest fires and other natural disasters straddling international borders worldwide. Therefore, the need for cross-border cooperation is heightened to adapt CBRs toward the CC-led threats. While this cooperation can be institutionalized at international level, there is evidence that cooperation happens locally in CBRs where communities from both sides of the border are confronted with similar needs and urgencies. In contrast with this, the national states bind regional agency through national regulations and policies (Weller and Beer, 2023).

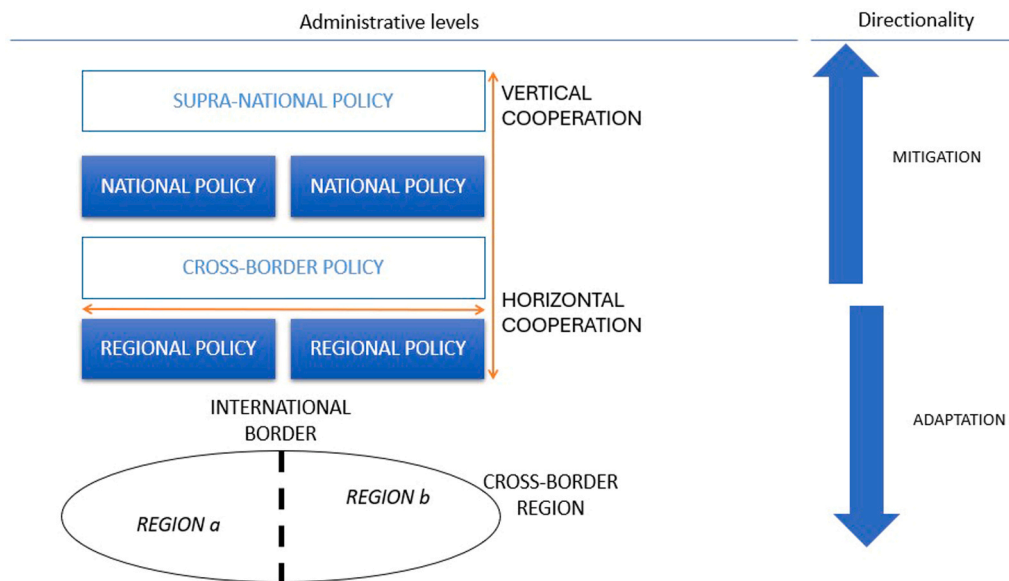


Fig. 1. Conceptual framework.

Because they rely on cross-border cooperation networks, CBRs have been shown to be sensitive to shocks and changes in border regimes that are typically nation-state dependent. The COVID-19 pandemic provided a shocking example of the disruption of cross-border cooperation due to sudden and permanent border closures (Alden and Trautman, 2025). However, in some cases, networks of cross-border regional agents have proven to offer critical resilience reaping benefits from sudden shocks – as in the case of the COVID-19 pandemic (Capello et al., 2023; Richardson and Cappellano, 2022) – (re)adapting their economic and institutional structures (Korhonen et al., 2021; Hippe et al., 2022).

While there is a sheer literature on cross-border cooperation concerning environmental management, to date there is a paucity of studies concerning climate mitigation and adaptation policies in CBRs. Lar-a-Valencia and Giner (2013) assessed local governments engagement in addressing CC with diverse levels of commitment across four pairs of border cities along the US-Mexico borderlands. This has been also motivated by spatial factors such as the scale of the cities and the presence of universities – generating more knowledge and strengthening technical capacities – in large US-Mexican urban agglomerations, such as Tijuana-San Diego and El Paso del Norte. In the same area, the US-Mexico borderlands, there is a limited knowledge about cross-border networks working towards the climate adaptation in terms of water management (Varady, et al., 2013). Perhaps, this sensitivity to water and environmental management is particularly felt in this borderland, because the partnerships in North America coalesce informally around common problems rather than being institutionalized as in Europe (Ganster and Collins, 2017). Cappellano et al. (2024) assessed the actors' networks in EU CBRs to promote innovation tackling CC. Van Eerd et al. (2013) conducted a comparison of the North Rhine-Westphalian and Dutch policy arrangements on climate adaptation highlighting the discrepancies in terms of competences' attribution, institutional setups, and financial endowments across the two sides of the border. Riekotter (2025) explored viticulturists' practices to adapt their business toward climate change in the EU CBR across Germany, Luxembourg and France. Yet the paucity of evidence makes the case for this study is closing the gap in literature investigating the approaches adopted towards CC in CBRs and how those have aligned each other in a multi-layered policy approach.

Research highlights the importance of cross-border coherence in crisis management planning – as a complementary factor for effective adaptation to CC (European Commission, 2024). Crisis response measures – such as flood risk management, emergency coordination, and disaster preparedness – must be coordinated across borders to mitigate CC-led risks effectively. However, studies show that inconsistencies in crisis management strategies between neighbouring regions can lead to inefficiencies in cross-border disaster response and reduce the overall resilience of CBRs (European Commission, 2024). This perspective suggests that CC adaptation should focus on place-based investments and institutional coordination, particularly in emergency preparedness and early warning systems.

3. Research strategy

The ongoing explorative research is aimed to explore the EU CBRs policy landscape. The assemblage notion (Sohn, 2016), discussed in the literature, leads us to analyse how consistent is the multi-layered governance evaluating the four groups of CBRs according to the following research questions: To what extent is the policy approach toward climate change (CC) consistent across cross-border regions (CBRs) in terms of goals, strategies, and implementation?

- Do CBRs prioritize adaptation over mitigation homogeneously?
- Do CBRs recognize the same CC-led threats?
- Do CBRs promote similar interventions?

Basing on the literature, we can expect that the CBRs should prioritise CC adaptation which is reported to be more fit with the regional authority scope. Although this could be mitigated by different stages of decentralisation/ centralization in the five EU Member States evaluated. Overall, we test the hypothesis that similar institutional set-ups should display a higher degree of consistency of their policy approach toward CC.

This study gauges explicitly how the EU-funded policy instruments (ETC-funded initiatives and national/regional OPs) contribute to climate adaptation and mitigation in Polish CBRs and its EU neighbouring CBRs in Germany, Czechia, Slovakia, and Lithuania. The

research scope is limited to the EU internal border regions due to the contextual geopolitical landscape that makes impossible to compare with EU's external borders with Ukraine, Russia, and Belarus (Studzieniecki et al., 2022).

Thanks to an innovative methodology, the study assesses how the EU CBRs framed their approach to CC as well as evaluating also what are CC-led threats that each region prioritized. The analytical exercise is run at different government levels to explore the alignment of approaches to CC across the policy levels. As shown in Fig. 2, an analytical framework was built to diagnose the alignment of multi-level government approach across regional, cross-border and macro strategic policy level

3.1. Methodology

The first stage of the research relied on extracting qualitative insights through Nvivo Software that enables coding documents. We gained information from Regional and National OPs evaluating the thematic objectives that each region or nation chained to CC. When detecting clearly "climate change"-related policy actions, we ticked the thematic objectives stated in the grid. Those actions combined climate mitigation and/or adaptation including a multiple-domain solutions. Through the document analysis, the data shows which CC-led threats were prioritized. Figures on investments show how each regions assigned intervention field codes⁴ concerning those threats. This exercise was repeated at cross-border policy level, assessing the consistency with the regional plans. In a second stage of the research, numbers of projects have been assessed both at regional and cross-border regional level to understand policy alignment in recognizing the CC-led threats. Thereafter, policy documents at macro-regional level (e.g. Baltic Sea Region) were assessed against the policy alignment in terms of CC-led threats and policy approaches.

Finally, we infer results from the analysis of policy documents according to the Thematic Objectives and Intervention fields connected to the EU funding that the EU Members States manage to invest in their regions. Both categories are identified at the EU levels. The thematic objectives (TOs) of these funds are 13 and the EU regions and Member states must refer to one of them when designing their strategies, or funding policies. These objectives are defined to align with EU priorities and are key for Member States to address in their operational programs. The intervention fields are aligned with the thematic objectives and are focused on specific areas of development where investment is most needed. Each intervention field under the ESIF focuses on specific actions and areas that contribute to achieving the thematic objectives of the EU's cohesion policy.

3.2. Data sources

To answer the two groups of research questions, we adopt mixed methods combining qualitative data from different data sources (Bazeley, 2024; Johnson and Onwuegbuzie, 2004). As shown below (Table 3), data include policy documents and investments figures retrieved from European Territorial Cooperation (ETC), as well as national and regional Operational Programmes (OPs), in shaping CC policy in EU cross-border regions (CBRs).

The main data input was provided by the National and Regional Operational Programs (OPs), mandatory policy documents that each region – although in some Member States it is managed at national level – works to clarify the objectives, prioritize the threats, identify the intended actions where to invest the EU-channelled funds. As listed in Table 3, the qualitative data from National and Regional OPs from the last programming period (2014–2020) were collected for all the regions assessed along with empirical figures on projects effectively managed

⁴ **Intervention field code** represents an EU score that aims at identifying what type of investment.

through the KOHESIO⁵ project database Tables 4 and 5.

At the same time, the Interreg⁶ programs including both bilateral programs in CBRs have been assessed as well as the Macro-Baltic Sea Region program which include the regions around the Baltic shore from Lithuania, Estonia, Latvia, Finland, Sweden, Denmark, Germany, and Poland. From such a CBR and cross-border perspective, quantitative metrics on projects at CBR level are retrieved from KEEP. EU database.⁷

4. Analysis

The analysis focuses on the following CBRs around Poland (see Fig. 3) to highlight distinct, place-specific characteristics.

4.1. German Polish CBR

The German Polish CBR area supported by Interreg (Germany/Mecklenburg-Vorpommern-Brandenburg-Poland, Germany/Brandenburg/Poland and Poland-Germany/Saxony) covers a total area of 74,000 km² and has a population of nearly 5.8 million. The borderland landscape is characterized by extensive woodlands and numerous lakes. The axis of the CBR is the natural inter-state border stretching along the Neisse and Oder rivers, from the Sudeten mountains (in the south) to the Baltic Sea (in the north). Once an impenetrable spatial barrier, today the German-Polish border is open and integrative in nature, which is manifested in increased cross-border mobility and economic exchange (Dotzblasz, 2019; Knippschild and Schmotz, 2018; Szytniewski and Spierings, 2017). The region, however, experiences increasingly erratic precipitation patterns, rising temperatures, and extreme weather events, leading to heightened risks of riverine flooding, prolonged dry spells affecting forested areas, and storms exacerbating soil erosion and biodiversity loss, that require coordinated responses from both sides of the border. Joint projects demonstrate the potential for collaborative approaches to CC. However, the effectiveness of these initiatives often depends on the political will and institutional capacities of local governments (Jańczak, 2018; Wróblewski, 2021).

4.1.1. Subnational policy in the German Polish CBR

Both sides of the border experience a comparable degree of decentralization, having both Polish and German regional authorities the power to enact their strategies and policies channelling (also) the EU funding. However, the CBRs do not report a homogenous approach to CC failing to harmoniously promote Climate mitigation or adaptation. In fact, we can note that all the three German states (Mecklenburg-Western Pomerania, Brandenburg, and Saxony) envisaged their approach under the thematic objective 4E – "Promoting low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility and mitigation-relevant adaptation measures" (Operational Programme Brandenburg, 2024; Operational Programme Mecklenburg-Vorpommern 2024). This objective refers mostly to **climate mitigation approaches** which is coherent with the

⁵ **Kohesio** is a comprehensive knowledge database that offers p-to-date information on projects and beneficiaries co-funded by EU Cohesion policy, during the 2014–2020 programming period.

⁶ **Interreg** is a key European Union (EU) instruments that strengthens cooperation between regions and countries within the EU. As part of the EU's Cohesion Policy, Interreg plays a vital role in promoting regional development, cohesion, and reducing economic disparities. For the 2021–2027 period, Interreg is focused on addressing current challenges like climate change, digital transformation, and social inclusion.

⁷ **Keep.eu** allows access to aggregated data regarding projects and beneficiaries of European Union cross-border, transnational and interregional cooperation programmes among the member States, and between member States and neighbouring or pre-accession countries. The database covers the 2000–2006, 2007–2013 and 2014–2020 periods, and is currently incorporating data on the 2021–2027 period.

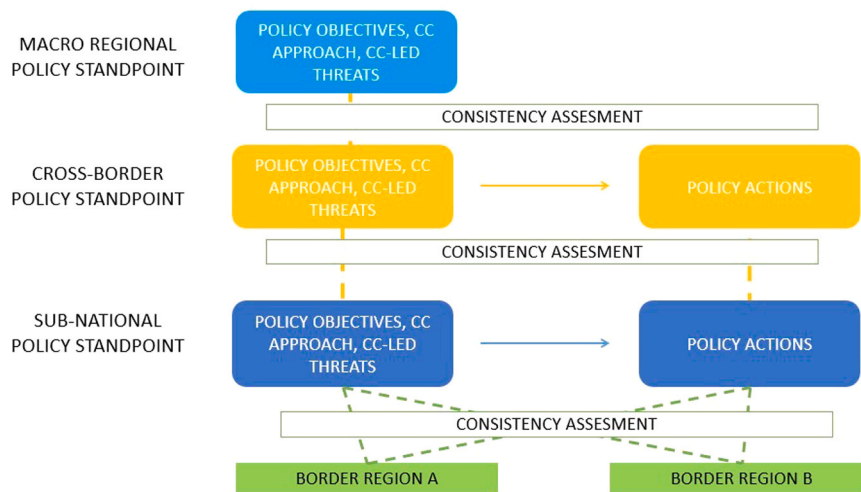


Fig. 2. Research strategy. Authors.

Table 3
Definition of funds, their objectives and spatial focus.

Name	Objective	Spatial Foci
European territorial cooperation (ETC) is one of cohesion policy’s goals and aims to solve problems across borders and to jointly develop the potential of diverse territories. Cooperation actions are supported by the European Regional Development Fund (ERDF) through three key components: cross-border cooperation (INTERREG-A), transnational cooperation (INTERREG-B), interregional cooperation (INTERREG-C), Cooperation in the outermost regions (INTERREG - D)	It aims to tackle common challenges jointly identified in the border regions and to make use of the untapped growth potential in border areas, while also enhancing the cooperation process for the purposes of the harmonious development of the Union.	Cross-border cooperation (INTERREG - A) supports cooperation between the nomenclature of territorial units for statistics (NUTS 3), which covers regions from at least two different Member States lying directly on the borders or adjacent to them.
Operational Programmes (OPs) set out the strategic priorities each Member State lays down in its Partnership Agreement with the EU, itemised by sector and territory.	OPs benefit from the resources of one or more Structural Funds, outlining the specific objectives within priority axes, on a multi-annual basis.	They can be implemented at country-level - National Operational Programmes (NOPs), or Regional (NUTS II) - Regional Operational Programmes (ROPs),

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specific objectives stated in the policy documents. Most of the German states aimed at reducing CO2 emissions through land use patterns (e.g. spatial concentration of buildings and energy infrastructures) or investing in the public transport sector.

Only the state of Saxony opted also for the thematic objective 5B – “Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems” that hints at **climate adaptation approaches** (Operational Programme Sachsen ERDF, 2024). This choice is in line with the Polish border regions (Zachodniopomorskie, and Dolnośląskie) that enacted action to increase the

level of protection against flood events, or an overall attempt to raise the effectiveness of the system to prevent the threats of CC. Lubuskie region opted to tackle CC through intervention to 6 A – “Investing in the waste sector to meet the requirements of the Union’s environmental acquis and to address needs, identified by the Member States, for investment that goes beyond those requirements” protecting the water and waste management cycle to mitigate the CO2 emissions and, in general, avoid inefficiencies in resource management (Regional Operational Programme for Zachodniopomorskie Voivodeship 2014-2020; Regional Operational Programme for Lubuskie Voivodeship 2014-2020).

We can also argue some place-specific conditions that can explain the CC policy approach in this CBR. Besides the common challenges to secure river management, our analysis shed light on the intervention fields associated with investments towards the CC. In the German/Polish CBR, the codes mostly related to Climate adaptation are predominant (see Table 6). Data show a sharp entrepreneurial approach which resonates with the economic profile of the CBR. Both intervention fields, 065 and 071, points out that these CBRs aim at promoting economic development related to CC through Research and Innovation or expanding services through new specialised enterprises.

4.1.2. Cross-border policy in the German Polish CBR

In accordance with the regional documents, all three cross-border policy documents (Interreg) focus on cooperation in climate risk management, specifically addressing CC-related disasters such as erosion, fires, floods, storms, and droughts. The main reason for including preventive measures in the programs is the extreme weather phenomena observed in these areas in recent years, leading to natural hazards—particularly floods caused by significant fluctuations in water levels on the Oder River and fires linked to extensive pine forests, low rainfall, and light sandy soils. The policy documents emphasize prioritizing actions related to climate adaptation, particularly in terms of flood and fire protection, which is the principal CC-oriented approach. This indicates that the policy directionality at both levels (regional and interregional/cross-border) is entirely consistent with recognizing the threats posed by CC.

Only the Interreg V-A programmes Germany/Mecklenburg-Vorpommern-Brandenburg-Poland and Poland-Germany/Saxony provide support for CC mitigation measures. The first document includes the protection and restoration of biodiversity among its objectives (under the priority 'Nature and culture'), which involves the implementation of innovative green infrastructure. The second program aims to support projects that enhance skills in climate protection, climate risk management, the green economy, and energy efficiency by offering a

Table 4
List of policy documents and projects' figures scrutinized at regional-national level.

CBR	REGION or MS NAME	DOCUMENT REF.	NOP	ROP	KOHESIO
PL/DE	Brandenburg	2014DE16RFOP004		X	N/A
PL/DE	Mecklenburg-Western Pomerania	2014DE16RFOP008		X	X
PL/DE	Saxony	2014DE16RFOP012			
PL/DE	Dolnośląskie	2014PL16M2OP001		X	X
PL/CZ					
PL/DE	Lubuskie	2014PL16M2OP004		X	X
PL/DE	Zachodniopomorskie	2014PL16M2OP016		X	X
PL/CZ	Opolskie	2014PL16M2OP008		X	X
PL/CZ	Czechia	2014CZ16M1OP002	X		X
PL/SK	Małopolskie	2014PL16M2OP006		X	X
PL/SK	Śląskie	2014PL16M2OP012		X	X
PL/SK	Podkarpackie	2014PL16M2OP009		X	X
PL/SK	Slovakia	2014SK16RFOP002	X		Zilina Presov
PL/LT	Podlaskie	2014PL16M2OP010		X	
PL/LT	Lithuania	2014LT16MAOP001	X		Alytaus Marijampoles

Own Authors.

Table 5
Cross-border policy documents and projects' data.

CBR	PROGRAM	DOCUMENT REF.	INTERREG	KEEP
PL/DE	Interreg V-A – Germany/Mecklenburg-Vorpommern-Brandenburg-Poland	2014TC16RFCB019	X	X
PL/DE	Interreg V-A – Germany/Brandenburg/Poland	2014TC16RFCB011	X	X
PL/DE	Interreg V-A – Poland-Germany/Saxony	2014TC16RFCB018	X	X
PL/CZ	Interreg V-A – Czech Republic-Poland	2014TC16RFCB025	X	X
PL/SK	Interreg V-A – Poland-Slovakia	2014TC16RFCB012	X	X
PL/LT	Interreg V-A – Lithuania-Poland	2014TC16RFCB031	X	X
	Interreg V-B – Baltic Sea Region	2014TC16M5TN001	X	
PL-DK-DE-LT-SE	Interreg V-A – Poland-Denmark-Germany-Lithuania-Sweden (SOUTH BALTIC)	2014TC16RFCB013	X	X

Own Authors.

comprehensive and diverse range of training courses focused on these areas.

The cross-border projects, funded by the Interreg V-A Poland Germany/ Saxony, included different actions to enhancing comprehensive approach to cross-border co-operation aspects concerning warning about and mitigating the consequences of natural disasters, with particular focus on floods. Projects pursued warning systems and guide to flood actions for the neighbouring region, joint exercise across the rescue services, and purchase of new equipment for them. The projects focused both on floods and forest fires as utmost critical threat generated by CC.

4.1.3. CC-led threats recognized in the German Polish CBR

A much higher degree of consistency in the CC approach emerges concerning the CC-led threats. In fact, Brandenburg, Saxony, Lubuskie, Zachodniopomorskie, and Dolnośląskie recognize floods as utmost CC-led challenge. Accordingly, they promote regional actions to increase flood safety in the region combining flood protection infrastructure (dykes, flood protection walls, flood embankments) with investments in the field of retrofitting of rescue units.

4.2. Czech Polish CBR

The Czech Polish CBR, covering an area of 47,100 km² and with a population of approximately 7.1 million inhabitants, stretches along an approximately 800-kilometer-long boundary. The western part is characterized by mountainous terrain, which serves as both a natural barrier and a tourism asset, significantly contributing to the local economy. The existence of national parks and other protected areas underscores the ecological importance of this region (Kołodziejczyk, 2020). The resulting geographical discontinuities, however, pose some challenges to accessibility and economic integration. In contrast, the eastern part of

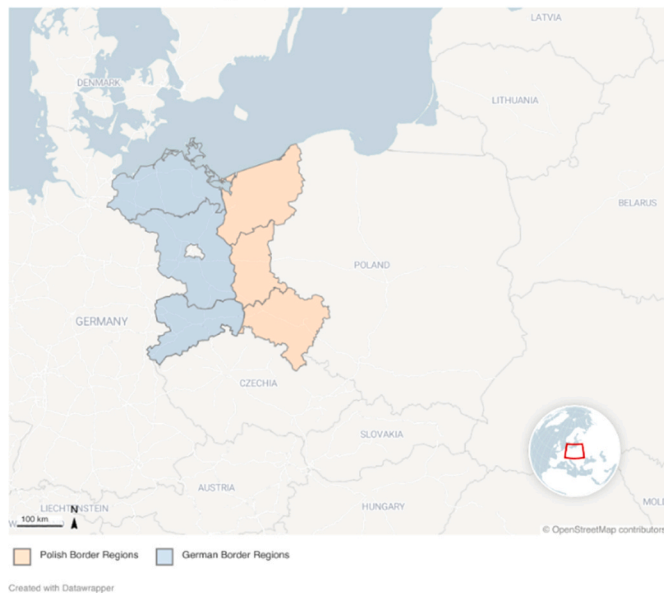
the CBR includes the densely populated areas of Upper Silesia, Cieszyn Silesia, and the Ostrava agglomeration, which are characterized by well-developed functional linkages. The establishment of Euroregions and European Groupings of Territorial Cooperation (EGTC) has fostered collaborative initiatives, helping to strengthen and maintain positive Czech-Polish relations (Böhm and Opiola, 2019). However, recent controversies surrounding the Turów mine illustrate the tensions between economic interests and environmental sustainability in the borderland. This situation underscores the need to incorporate environmental considerations into economic planning and decision-making processes (Kurowska-Pysz et al., 2022; Wróblewski et al., 2023). The Polish Czech CBR is characterized by mountainous terrain (Sudetes and Carpathians), river valleys, and densely forested areas, making it particularly susceptible to CC-related hazards such as flash floods, landslides, and wildfires.

4.2.1. (Sub)-national policy in the Czech Polish CBR

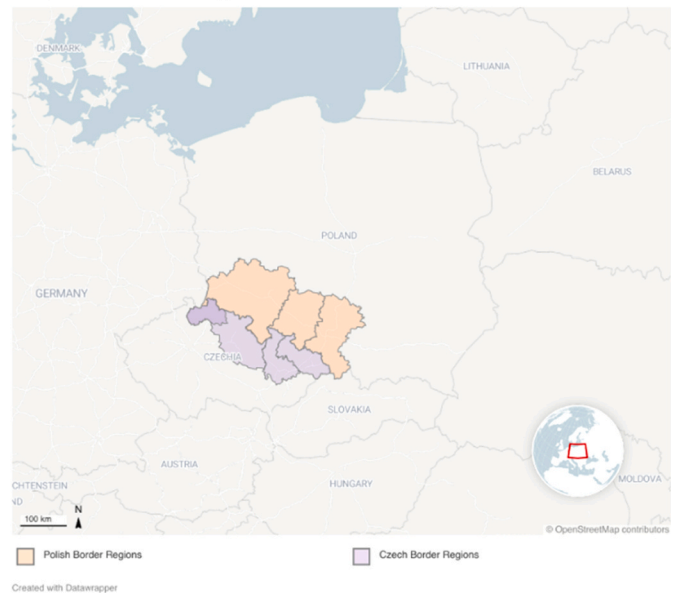
In contrast with Polish regions, the Czech regions do not have a similar degree of decentralization. They lack proper Regional Operational Programmes. Instead, we need to refer to the Czech National Operational Programme. In this CBR, there emerges a unanimous alignment across the policy documents pointing out the same approach toward Climate adaptation. In fact, all the four policy documents assessed claim the same thematic objective 5B “Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems” (Regional Operational Programme for Opolskie Voivodeship 2014-2020; Regional Operational Programme for Dolnośląskie Voivodeship 2014-2020; Regional Operational Programme for Śląskie Voivodeship 2014-2020). Despite that alignment which makes the case for a thorough climate adaptation approach to CC, there seems to be some nuanced differences across the cases assessed (see Table 7).

Flood protection infrastructures are combined with interventions to

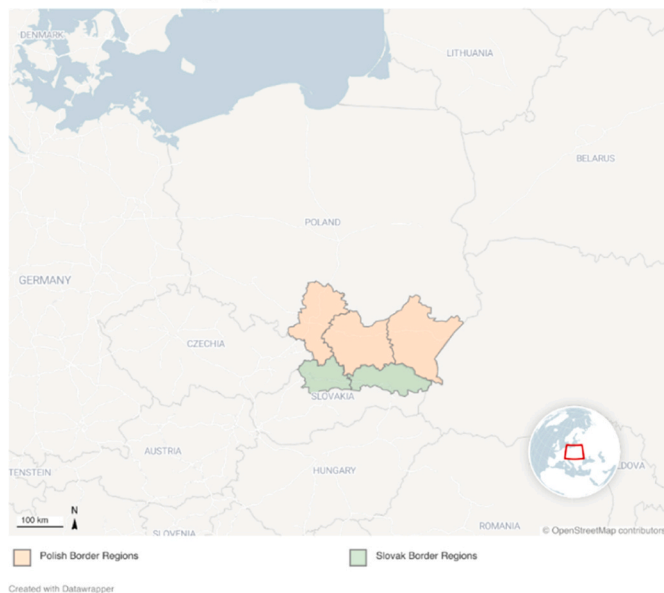
German - Polish Border Regions



Polish - Czech Border Regions



Polish Slovak Border Regions



Polish Lithuanian Border Regions

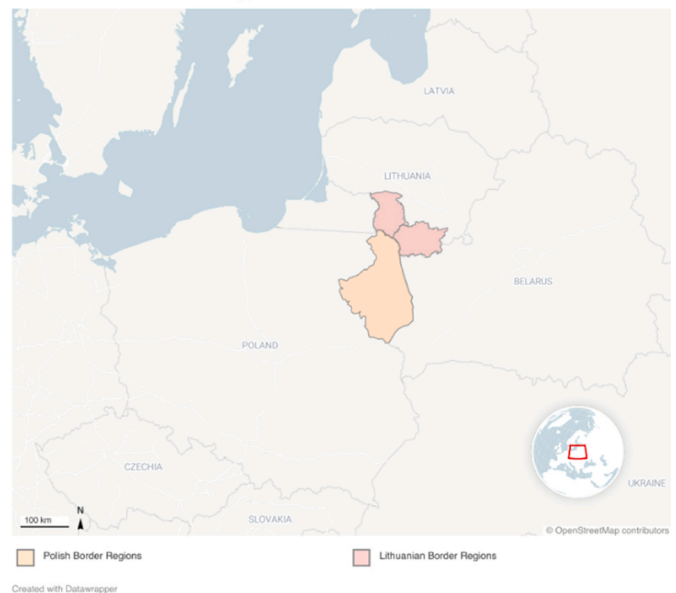


Fig. 3. CBRs assessed.

better equip the rescue services. The policy documents recognize flood as main CC-led concern, although the Czech National operational programme has a number of priorities which mix together climate adaptation and mitigation. However, having a national spatial scope does not mean necessarily that these priorities refer to the regions assessed. To triangulate this information, we retrieve data from the KOHESIO database concerning the projects in the Czech regions: Moravian Silesia, Olomuc, Liberec, Pardubice, and Hradec Kralove. Comparing the projects with Polish regions, we can see a sheer alignment of interventions aimed at ensuring a **climate adaptation approach**. Flood protection is promoted through digital flood plan, construction of a warning and information system, at extending sections of watercourses. Only Opole Voivodeship promotes the purchase of equipment in the field of medical rescue, water rescue and flood protection for OSP Krośnica and OSP Izbicko.

The river control appears to be a main driver shaping the policy approach. This is deduced from an intervention field perspective (see Table 8), we can consider a dominance of the Climate adaptation with

lesser regions and state focusing on water management and entrepreneurial approaches connected to CC.

4.2.2. Cross-border policy in the Czech Polish CBR

The cross-border policy document recognizes that the cross-border need to overcome risks stemming from physical, geographic and socio-economic conditions, and the effects of natural disasters in much of the area cross a common border and have repercussions on both sides. Therefore, the document (Priority Axis ‘Shared Risk Management’) points to the need for joint monitoring of potential risks, cross-border sharing of information about them and dealing with their consequences. The Policy document prioritizes implementing comprehensive measures aimed at interconnecting risk management systems across borders to ensure a rapid and coordinated response to risks and minimize the effects on property, the health of residents and the environment. Accordingly, projects are promoted at the Interreg level to heighten the crisis prevention during natural disaster, particularly in flood protection. In this regard, the cross-border policy approach to CC is

Table 6
Intervention field for the German/Polish CBR.

REGION	INTERVENTION FIELD CODE			
	065 - research and innovation infrastructure, processes, technology transfer	087 - adaptation to climate change	071 - Development and promotion of enterprises specialised in providing services	021. Water management and drinking water conservation
BRANDENBURG	Y	Y		
MECKLENBURG-WESTERN POMERANIA	Y		Y	
SAXONY		Y	Y	
DOLNOŚLĄSKIE		Y		Y
LUBUSKIE	Y	Y		Y
ZACHODNIOPOMORSKIE		Y		

065 - **research and innovation infrastructure, processes, technology transfer** and cooperation in enterprises focusing on the low carbon economy and on resilience to climate change; 087 - **adaptation to climate change** measures and prevention and management of climate related risks (erosion, fires, flooding, storms and drought), including awareness raising, civil protection and disaster management systems and infrastructures; 071 - **Development and promotion of enterprises specialised in providing services** contributing to the low carbon economy and to resilience to climate change (including support to such services); 021. **Water management and drinking water conservation** (including river basin management, water supply, specific climate change adaptation measures, district and consumer metering, charging systems and leak reduction)

Own Authors' elaboration.

Table 7
CC-oriented thematic and specific objectives.

	Policy document source	Thematic Objective	Specific Objective
Śląskie	2014PL16M2OP012	5b	Better equipment for rescue services
Dolnośląskie	2014PL16M2OP001	5b	Increased flood safety in the region
Opolskie	2014PL16M2OP008	5b	Specific objective 1: Increased protection of people and property against the effects of natural threats, i.e. floods and droughts Specific objective 2: Increased effectiveness of response in the event of natural and civilization threats
Czech Republic	2014CZ16M1OP002	5b	Ensure flood protection of the inner city and management of rainwater Support preventive flood measures

Own Authors' elaboration.

still focused on climate adaptation. In particular, the project aims at increasing cross-border capacity to intervene actively in emergencies and crisis scenarios.

The projects, funded by the Interreg V-A Czech Republic and Poland, aimed at increasing the operational capacity of volunteer firemen units in the border area along the Olše river. Those are expected to cope with emergencies, particularly fires, flash floods, rainstorms, windstorms, through improved cross-border connections and communication among units of firefighters and emergency staff on both sides of the border. Furthermore, the acquisition of vehicles was funded to increase cross-border capacity to act of the units in dealing with emergencies and crisis situations.

4.2.3. CC-led threats recognized in the Czech Polish CBR

In sum, the policy approach in this CBR seems homogeneously promoting climate adaptation. There seems to be a sharp alignment between regional and cross-border policy approach to CC. Both sides of the CBR recognize the same CC-led threat – river floods – although having nuanced differences in climate adaptation interventions.

Table 8
Analysis of intervention fields connected to CC in (sub)-national policy documents.

Intervention field	(Sub)-national policy document
087 - adaptation to climate change measures and prevention and management of climate related risks (erosion, fires, flooding, storms and drought) including awareness raising, civil protection and disaster management systems and infrastructures	Dolnośląskie, Śląskie, Opolskie, Czech Republic
071 - Development and promotion of enterprises specialised in providing services contributing to the low carbon economy and to resilience to climate change (including support to such services)	Opolskie
021. Water management and drinking water conservation (including river basin management, water supply, specific climate change adaptation measures, district and consumer metering, charging systems and leakage reduction) and disaster management awareness systems and infrastructures	Czech Republic, Dolnośląskie

Own Authors' elaboration.

4.3. Polish Slovak CBR

The Polish Slovak CBR is characterized by the Carpathian Mountains, which, much like the Czech-Polish border region, act as a natural barrier but also serve as a major attraction for tourism (Więckowski, 2013). The development of motorways and expressways has improved connectivity, facilitating economic activities and tourism, although infrastructure still appears to be a significant barrier to cross-border integration (Michniak and Więckowski, 2021). A similar level of economic development and the structure of the economy, a rich natural and cultural heritage, developed institutional links and language proximity make very good conditions for the development of cross-border cooperation in various fields. The area supported by the Interreg Programme covers 39.2 thousand km² and has a population of 5.1 million. The Polish Slovak CBR, dominated by the Carpathian Mountains, dense forests, and river basins, faces growing CC-related vulnerabilities, including flash floods, landslides, and prolonged droughts. Rising temperatures and shifting precipitation patterns contribute to forest dieback, increased wildfire risk, and extreme weather events, such as intense storms and heavy snowfall, threatening ecosystems and local communities.

Table 9
(Sub-)national policy document analysis in the PL/SK CBR.

PL/SK	FLOOD THREAT	Thematic Objective	NAME	Specific Objective
Malopolskie	2014PL16M2OP006 Y	5b	Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems	Increased security for residents at risk of natural disasters
Śląskie	2014PL16M2OP012 Y	5b	Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems	Better equipment for rescue services
Podkarpackie	2014PL16M2OP009 Y	5b	Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems	Increased resistance to threats resulting from climate change occurring in the Podkarpackie Voivodeship
Slovak Republic	2014SK16RFOP002 N	6	Taking action to improve the urban environment, to revitalise cities, regenerate and decontaminate brownfield sites (including conversion areas), reduce air pollution and promote noise-reduction measures	Improving environmental aspects in cities and urban areas by building green infrastructure elements and adapting the urban environment to climate change, as well as by introducing systemic elements to reduce air and noise pollution

Authors' elaboration.

4.3.1. (Sub-)national policy in the Polish Slovak CBR

Similarly to the Czech case, also the Slovak institutional set-up is not homogeneous to the Polish one. In Slovak Republic the National Operational Program devises the EU-channelled funds. We then consider policy documents from the Polish regions and Slovakia. There seems to be less consistency than in other CBRs assessed. While the Polish documents point out the CC-led objective #5B ([Regional Operational Programme for Śląskie Voivodeship 2014-2020](#); [Regional Operational Programme for Malopolskie Voivodeship 2014-2020](#); [Regional Operational Programme for Podkarpackie Voivodeship 2014-2020](#)), the Slovak National document claims CC-oriented actions within the thematic objective #6B “*Preserving and protecting the environment and promoting resource efficiency*” ([Integrated Regional Operational Programme 2014-2020, 2024](#)). As shown in the [Table 9](#), Slovaks are more concerned of CC-led significant negative impact on local, low-abundant water resources and the drinking water availability. Additionally, the distribution of intervention fields is quite different with Polish regions underscoring the usual 087 connected to CC adaptation, while the Slovak side focusing on the 085 – “*Protection and enhancement of biodiversity, nature protection and green infrastructure*”.

Obviously, the National program might envisage CC-led approach less place-based than regional policy documents. To overcome this potential bias, we compare data from Kohesio concerning EU-funded projects in the Polish regions (Małopolskie, Śląskie, and Podkarpackie) as well as Slovak regions of Zilina and Presov. At this project level, the alignment across the border regions emerges significantly as some projects are referring to increase flood safety as a response to dangerous flooding conditions on both side of the border. The project combines infrastructure and purchase of equipment for flood rescue units.

4.3.2. Cross-border policy in the Polish Slovak CBR

The Interreg policy document recognises the increasing impacts of weather phenomena related to CC. Given this challenge, cross-border projects are enacted to mitigate the consequences of CC-led threats through investments in green infrastructure, as well as facilitate cross-border cooperation and strengthen the operational capacity of emergency management and disaster recovery services through the development of cooperation systems/rules, consistent/similar on both sides of the border of monitoring systems for phenomena and rapid alerts. At the same time, the policy document prioritises projects to develop and improve low-carbon, environmentally friendly transport systems to promote sustainable regional and local mobility.

The reported projects funded by the Interreg V-A Poland/Slovak Republic fail to target any threat (fire, floods) nor consider CC. Nor natural disasters are being focused on.

4.3.3. CC-led threats recognized in the Polish Slovak CBR

While there is a low level of alignment between (sub-) national and cross-border policy levels, nor between the two sides of the CBR, data of EU-funded initiatives in the Polish regions (Małopolskie, Śląskie, and Podkarpackie) as well as Slovak regions of Zilina and Presov pursue projects to increase flood safety as a response to dangerous flooding conditions on both side of the border.

4.4. Lithuanian Polish CBR

The Lithuanian Polish CBR faces many socio-economic challenges characteristic of peripheral areas, such as poor communication accessibility, an adverse structure of the economy and depopulation. At the same time, it plays a critical geopolitical role, linking the territory of the Baltic States with Poland and the rest of the EU and separating the Kaliningrad region of Russia and Belarus. One of the most critical assets of the Polish Lithuanian CBR is the unique natural heritage. Its characteristic features include a mid-field landscape with forests, extensive, dense forest complexes, numerous lakes, rivers and post-glacial ponds. A remnant of the glacial activity is also a varied, undulating relief

characterised by moraine hills, uplands and embankments and numerous erratic boulders (Kurowska-Pysz et al., 2021; Studzieniecki et al., 2020). The total area covered by the Interreg programme is 49.4 thousand km², with a population of 2.3 million. The Polish Lithuanian CBR, characterized by lowland plains, extensive wetlands, and interconnected river systems, is increasingly vulnerable to climate change-related hazards such as droughts and extreme weather events. Rising temperatures and changing precipitation patterns contribute to wetland degradation and increased risks of storms and forest fires.

4.4.1. (Sub)-national policy in the Lithuanian Polish CBR

The Polish Podlaskie Voivodeship is administered regionally, instead the bordering Lithuanian regions do not have the same extent of autonomy to harness EU funding. Therefore, we consider the Lithuanian 2014–2020 EU fund investment actions program that has a national scope. This policy document recognizes flood risk reduction as a main CC-led threat supporting investments in the realm of early warning systems station system. Furthermore, the Lithuanian national policy document aims at strengthening natural disaster management capacities and response resources [...], “mitigating the negative impact of floods, heavy rains and other natural elements on the environment and infrastructure, economic activity, human health and life” (Operational Programme for EU Structural Funds, 2024).

In terms of Thematic Objectives, the Lithuanian document underscores the TO #5 A which stands for “Supporting investment for adaptation to climate change, including ecosystem-based approaches”. It is particularly aimed to prevent losses from climate change, describing floods as utmost threat. Such a sharp emphasis on CC-led threat is nuanced in the Polish regional documents where floods is recognized as a main challenge for infrastructures although CC is not mentioned in the policy objectives. Additionally, the Podlaskie policy document bears a **climate mitigation approach** while promoting low-carbon economy investments, with a focus on “reduction of air pollution through the implementation of low-carbon management plans”(Regional Operational Programme for Podlaskie Voivodeship 2014-2020,2024).

Delving into projects managed at regional level, there emerges a paralleled approach to invest in reducing risk of flooding in both Podlaskie and Alytus. Conversely, the other Lithuanian region Marijampole does not show any project in this regard. Therefore, a misalignment emerges in policy objectives as well as policy actions at regional level, while the approach to CC is limited to **climate adaptation**.

4.4.2. Cross-border policy in the Lithuanian Polish CBR

From a cross-border policy standpoint, the Interreg Lithuania-Poland does not clarify risks induced by CC, nor does it identify priority actions for mitigation or adaptation to CC, apart from generally referring to the horizontal principles of EU cohesion policy. An abundant stream of projects funded by the Interreg V-A Lithuania Poland focus on fire-fighters and their critical role in emergencies and natural disasters. The project aims to developing infrastructure and competencies in fire security and rescue field across border. Projects also funded development of cross-border emergency response infrastructure, joint trainings for emergency services of cross-border area, and the building of Cross-border Emergency Management Network. Additionally, activities were funded to raise preventive and awareness actions for communities, with special focus to older people, and socially disadvantages persons.

4.4.3. CC-led threats recognized in the Lithuanian Polish CBR

There is a low level of alignment across the two sides of the border in terms of policy objectives. Projects conducted at regional level in Podlaskie (PL) and Alytus (LT) tackle the issue of flooding in contrast with Marijampole (LT) where this issue seems disregarded. Therefore, there is no homogeneous recognition of CC-led threat. Instead, forest fires are prioritized along with draughts and storms at cross-border policy level. Whereas Interreg-funded projects do not address floods as they do not look primarily recognized as an environmental concern

Table 10
Policy analysis' results.

CBR	Subnational policy	Cross-border policy	CC-led threat
DE/ PL	Most of the German states opted for Climate mitigation measures , while the Polish Voivodeships are more focused on Climate adaptation . The thematic objectives chosen to tackle CC vary significantly across the German states. There is a dominance of intervention fields connected to CC adaptation which pursue an entrepreneurial approach. The whole set of sub-national policy documents clarifies the same approach toward Climate adaptation . Despite this alignment around the thematic objective #5b , the policy actions (projects) do not mirror the same approach including investments in flood safety as well as equipment for rescue services. The intervention fields are predominantly oriented to Climate adaptation although there are some connected to water management and entrepreneurial activities.	All Interreg program assessed, claims that cross-border cooperation is vital for strengthening resilience to consequences of CC. All policy documents bear a sharp Climate adaptation approach . The Interreg policy document bears the same stance towards the Climate adaptation . The document recognizes the value of cross-border cooperation in the areas of disaster management and Climate mitigation towards natural hazards propelled by CC.	Floods are recognized as top priority in 4 sub-national documents. There is a coherent policy actions (projects) to bolster Climate adaptation to floods at regional and Cross-Border policy level. Floods – and in general river management – are recognized as a main concern within the policy documents at (sub-)national and cross-border policy context. Projects at both government levels are enacted to mitigate the exposure to this hazard.
PL/ CZ	There is a nuanced alignment across this CBR in terms of policy objectives. The Slovak national policy document focuses on CC implications on the water availability. However, both the thematic objectives as well as intervention fields are not aligned in the CBR. Slovak Republic underscored an intervention field different from the Polish Regions. There is a sharp asymmetry across approaches towards the CC in this CBR. The Polish side bears a climate mitigation approach envisioning investment in sustainable mobility and renewable energies. The Lithuanian document claims a climate adaptation standpoint aimed to reduce losses generated by CC. The intervention fields selected as well as thematic objectives differ across the two sides of the border	The Interreg programme aims at minimizing the damages generated by CC-led threats while championing Cross-border cooperation as a mean for developing common procedures and systems for prevention, monitoring, emergency response and recovery. The Interreg programme neglects issues related to mitigation or adaptation to CC, prioritising other issues.	Floods – and in general river management – are recognized as a main concern within the policy documents at (sub-)national and cross-border policy context. Projects at both government levels are enacted to mitigate the exposure to this hazard.
PL/ SK	There is a sharp asymmetry across approaches towards the CC in this CBR. The Polish side bears a climate mitigation approach envisioning investment in sustainable mobility and renewable energies. The Lithuanian document claims a climate adaptation standpoint aimed to reduce losses generated by CC. The intervention fields selected as well as thematic objectives differ across the two sides of the border	The Interreg programme aims at minimizing the damages generated by CC-led threats while championing Cross-border cooperation as a mean for developing common procedures and systems for prevention, monitoring, emergency response and recovery.	EU-funded projects in the Polish regions (Malopolskie, Śląskie, and Podkarpackie) as well as Slovak regions of Zilina and Presov pursue projects to increase flood safety as a response to dangerous flooding conditions on both side of the border.
PL/ LT	There is a sharp asymmetry across approaches towards the CC in this CBR. The Polish side bears a climate mitigation approach envisioning investment in sustainable mobility and renewable energies. The Lithuanian document claims a climate adaptation standpoint aimed to reduce losses generated by CC. The intervention fields selected as well as thematic objectives differ across the two sides of the border	The Interreg programme neglects issues related to mitigation or adaptation to CC, prioritising other issues.	Projects at regional level in Podlaskie and Alytus tackle the issue of flooding in contrast with Marijampole where this issue seems disregarded. At cross-border policy level, forest fires are prioritized along with draughts and storms. Floods are not primarily recognized as an environmental concern.

4.5. The macro-regional Baltic Sea region

The macro-regional Baltic Sea Region programme aims to mainstream the CC and biodiversity objectives in the EU. The macro-regional programme focuses on the projects supporting research and innovation as a response to large societal challenges related to CC, low carbon economy and development and promotion of enterprises specialised in providing services contributing to the low-carbon economy and to resilience to CC. It also promotes renewable energy, energy efficiency, as well as projects to improve wastewater treatment and adapt water management practices to changing climate. The approach is based on climate adaptation as actions are envisioned in the realm of water management practices towards prevention of CC-led risks includes floods.

5. Discussion and conclusions

This research explored the place-based approach to climate change (CC) in cross-border regions (CBRs). Using a multi-level analytical approach, it assessed policy alignment across the border in CBRs in Poland. We relied on policy documents and project figures retrieved at the subnational level, as well as the cross-border policy standpoint and, finally, the macro-regional strategy programme. The study was limited to internal EU borders, examining neighbouring regions in Germany, the Czech Republic, Slovakia, and Lithuania. CBRs face common problems generated by CC, as well as national regulations and policies. Therefore, they can serve as observatory areas in which to trial alternative solutions.

We assume the policy assemblage (Sohn, 2016), that involves EU regions and Member States, to mediate through horizontal and vertical cooperation in CBRs ensuring a policy directionality towards CC (see Fig. 1). Therefore, the analysis is conducted at several investigation layers, as shown in Fig. 2. The study unfolds the policy directionality inferring evidence from the analysis on alignment in all CBRs towards CC.

The extent of policy directionality, inferred through the alignment, is inspected through three layers. First, we inspected whether CBRs prioritize homogeneously adaptation or mitigation across multi-level governance. A second element of alignment concerns a similar recognition of CC-led threats (see Table 10). A third element of analysis is inspected through the study of intervention fields that can shed light on the space-sensitivity of CBR approaches to CC. The study also evaluated the space sensitivity in the CC policy approaches in CBRs, unfolding the intervention fields associated with the EU investments in the CBRs. The German Polish CBR shows a convergent emphasis on an entrepreneurial approach to CC. Therefore, we can infer there is a mutual interest from both sides of the border to invest in research & innovation to find solutions to CC. The Polish/Czech CBR demonstrates a sheer alignment on climate change adaptation. Therein, we can assume the urgency to control the river management is equally felt as a main driver of their policies.

The list of evaluated CBRs shows different degrees of centralisation or decentralisation. Except for the German and Polish regions, all the CBRs have different institutional set-ups. The study tested the hypothesis that CBRs with similar institutional set-ups should display a higher degree of consistency in their policy approach towards CC. In this regard, the findings are ambivalent and do not permit a coherent interpretation of the alignment of CBR policies towards CC vis-a-vis their institutional set-ups. The Polish Czech CBR appears to be the only case in which all policy documents are coherent in their approach to CC, prioritising climate adaptation as well as intervention fields and thematic objectives. However, policy actions (projects) are not necessarily aligned. There is a high degree of alignment in regional and cross-border policies in recognising floods as the main threat and in adopting a climate adaptation approach. This degree of policy directionality shared on both sides of the border hints at an effective 'assemblage', where

multiple Euroregions (Glacensis, Pradziad, Silesia, and Śląsk Cieszyński) form a heterogeneous grouping of agents that work together to influence regional and cross-border policy tenets.

The German Polish CBR where there is a higher similarity for the institutional set-ups, display a consistent recognition of CC-led threat, although policy objectives at subnational level are reportedly asymmetric. The analysis on intervention field demonstrates homogeneous entrepreneurial approach to CC, shown on both sides of the CBR. While asymmetries of objectives might hint at a lack of horizontal coordination across institutional actors, the dominance of entrepreneurial activities related to CC reflects a very place-based approach probably driven by private or non-public agents.

The other CBRs, which show strong institutional set-up asymmetries, display less homogeneity in their approaches to CC. A significant lack of horizontal coordination arises in the Polish Slovakian CBR, where CC approaches fail to have similar thematic objectives. Seamlessly, intervention fields are asymmetrically identified. Also, the vertical coordination, along the Slovak policy landscape, displays a low level of policy alignment. The regional projects in the Slovak Republic are found to match the CC-led threat of flood prevention, in line with their Polish counterparts.

Likewise, the Polish Lithuanian CBR seems to pursue different approaches (mitigation vs adaptation). More alignment arises in the recognition of the same CC-led threat, though at different extents. The Macro-regional Baltic Sea Region, which geographically overlaps with some of the CBRs assessed (German Polish, and Polish Lithuanian), emerges matching the climate adaptation approach and the emphasis on research & innovation in the field.

Finally, we can then argue that a similar institutional set-up "per se" does not necessarily guarantee a coherent approach toward CC. Perhaps, a new research stream should look deeper into the reasons for the different degrees of consistency in CBR approaches towards CC.

Despite the whole sample of Polish CBRs being selected around Polish internal EU borders, we cannot assume that Polish CBRs have similar economic and institutional structures. The Eastern Polish region, bordering Lithuania is economically outperformed (GDP per capita) by most of its countrymates assessed in the sample. Also, the aggregated set of Polish regions bordering the Slovak Republic shows ambivalent performances which lagging behind the rest of the Polish regions assessed. The differences in policy alignment may be attributed to the number of Euro-regions and, more broadly, platforms for cross-border cooperation. Future research would be beneficial to establish that such institutional and economic variations are indeed causal factors for cross-border policy alignment regarding climate change.

This research contributes to academic literature in several areas while providing policy recommendations. Firstly, it addresses a significant gap in CC policy literature by focusing on climate adaptation and mitigation policies in CBRs, which is an under-researched area despite the growing scientific and policy interest in mitigating the impacts of CC and reducing emissions. The study fills this gap by providing a comparative, place-based analysis. Secondly, the study contributes to the growing body of literature on multi-level governance by examining the interaction between subnational, national, and transboundary policies. The research highlights the complexities of vertical (regional to national) and horizontal (cross-border) policy coordination, providing insights into policy alignment. The findings reveal mixed results regarding the alignment of regional and cross-border policy frameworks. Of the cases analysed, only the Polish Czech CBR demonstrates strong policy alignment, resulting in a consistent set of objectives, investment priorities, and an integrated approach to CC, primarily focusing on climate adaptation, despite variations in project implementation. In contrast, other CBRs do not demonstrate such clear alignment of priorities and investments, despite floods and forest fires being widely recognised as key concerns in all assessed regions.

Thirdly, approaches to climate change (CC) vary between border regions in terms of thematic objectives, interventions, and activities,

reflecting place-specific needs and interests. In this context, international borders act as barriers that define the geographical scope of policies and regulations. Fourthly, almost all Interreg policy documents emphasise the importance of cross-border cooperation in CC adaptation. They advocate the coordination of rescue and disaster management services as well as prevention efforts, including the exchange of information and the development of a common early warning database. Finally, by intersecting regional policy analysis with CC governance and cross-border cooperation studies, this research appeals to scholars in environmental policy, regional studies, international relations, and innovation policy. It underscores the importance of interdisciplinary perspectives in addressing complex societal challenges such as CC.

The study provides several key lessons for policymakers, highlighting the importance of cross-border and multi-level coordination in addressing CC threats. First, it highlights the need for greater cross-border cooperation, as national policies are often uncoordinated, limiting the effectiveness of existing mechanisms such as Interreg programmes. Second, the research highlights the inherent trade-offs between adaptation and mitigation strategies, demonstrating that policy coordination is crucial to balancing these competing priorities. Third, it shows that national regulations often constrain regional governments' climate strategies, limiting their ability to engage in flexible, cross-border initiatives. Beyond direct policy implications, the study also contributes to academic research on policy alignment, multi-level governance, and place-based climate adaptation. First, it positions CBRs as 'observatories' where alternative policy solutions can be tested, providing valuable insights for broader governance structures. Second, it highlights the role of policy direction in CC governance, emphasising the need for alignment between different levels of government. Third, the study supports the argument that place-based policies are crucial in addressing regional CC risks. Finally, it highlights tensions between horizontal (cross-border) and vertical (regional to national) governance, calling for more research on optimising multi-level governance.

Building on these findings, the research provides valuable policy takeaways that can extend beyond CBRs and inform climate strategies in non-border regions. It highlights the wider importance of inter-regional cooperation in the design and implementation of CC-oriented policies. As climate governance takes place at multiple levels, greater coordination is needed – not only within CBRs representing horizontal cooperation between neighbouring regions, but also through vertical coordination between regional to national governments. In general, the paper underscores the importance of cross-border cooperation, which obviously depends on local capacities and mutual trust among actors, reinforcing the need for stronger institutional frameworks to support cooperative climate action.

While representing a first study to highlight CC-oriented policies in CBRs, the study does have its limitations. Firstly, some neighbouring countries did not match the institutional set-up with national policy documents mainstreaming EU funding. This might disguise the research findings as priorities might not necessarily reflect the specific needs of the regions we assess in this study. We circumvented this issue, considering data on investments at that regional level, both from EU structural funds as reported in the Kohesio database and the ones funded by the Interreg as reported in the Keep database. Secondly, this analysis focuses on CBRs around Poland, which is not recognized as the EU Member States more committed to CC. Extending the scope of this analysis to other Member States might generate more robust findings.

CRedit authorship contribution statement

Andrzej Jakubowski: Writing – review & editing, Validation, Methodology. **Joanna Kurowska-Pysz:** Writing – review & editing, Validation. **Francesco Cappellano:** Writing – original draft, Resources, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

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