Comparative Economic Research. Central and Eastern Europe
Volume 29 Number 2, 2026
https://doi.org/10.18778/1508-2008.29.09

Climate Change Adaptation and Economic Resilience in Central and Eastern Europe: A Comparative Institutional and Policy Analysis

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Abstract

This article explores how a group of Central and Eastern European (CEE) countries, including Czechia, Hungary, Poland, Romania, and the Baltic States, are navigating the challenge of adapting to climate change. Rather than offering a one-size-fits-all account, it looks at what adaptation really means in practice: how institutions are stepping up (or falling short), how EU funds are being put to use, and how different sectors, particularly agriculture, are responding on the ground. The analysis focuses on the structures, tools, and behavioral patterns that shape climate resilience, paying close attention to micro-level decisions by farmers, households, and small businesses. Drawing on institutional and policy analysis, as well as insights from behavioral economics, the paper highlights both the momentum and the stumbling blocks facing adaptation across the region.

Keywords: climate change adaptation, economic resilience, Central and Eastern Europe, climate policy, public institutions, behavioral economics, EU funding, agriculture, comparative analysis, adaptation strategies

JEL: D91, H43, O13, Q18, Q54, Q58, R58

Funding information: University of Lodz, Lodz, Poland.
Ethical considerations: The Author assures of no violations of publication ethics and takes full responsibility for the content of the publication.
Received: 17.09.2025. Verified: 1.12.2025. Accepted: 11.03.2026

Introduction

Climate change is undoubtedly one of the defining challenges of our time, affecting not only ecosystems but also economies and societies at large (IPCC 2022, pp. 1755–1790). In Central and Eastern Europe (CEE), its impacts are particularly noticeable due to the region's uneven economic development, legacy infrastructure issues, and sectoral vulnerabilities, especially in agriculture, energy, and water management (European Environment Agency 2021, pp. 6–9). More frequent and intense weather extremes, such as droughts, heatwaves, floods, and storms, are already causing crop losses, disrupting supply chains, and pushing up the costs of insurance and public infrastructure (World Bank 2022, pp. 22–24). At the same time, European Union (EU) countries in the region are under increasing pressure to align with the European Green Deal and broader climate neutrality goals (European Commission 2020, pp. 6–13). Yet the readiness of institutions, the effectiveness of public policies, and the ability to absorb EU funds vary widely from country to country (Bassi and Domínguez 2021, pp. 8–10). Moreover, the lack of long-term policy consistency, gaps in data, and behavioral barriers, especially among farmers and small businesses, limit how quickly and effectively these societies can adapt (Grothmann and Patt 2005, pp. 201–203).

The contribution of this article is threefold. First, it advances the theoretical and empirical debate by combining institutional economics, adaptation policy analysis, and behavioral economics to explain both structural and micro-level dynamics of adaptation in post-socialist economies. Second, it provides new empirical insights through a comparative case study of five CEE countries Czechia, Hungary, Lithuania, Poland, and Romania which, despite their shared communist past and common EU membership, display significant variation in institutional capacity, adaptation performance, and policy effectiveness. Lithuania, for instance, is analyzed as a representative case of the Baltic region, where adaptation has been closely tied to spatial planning (Bassi and Domínguez 2021, pp. 14–20). Third, the paper derives policy-relevant lessons for strengthening economic resilience, with particular emphasis on EU funding instruments and the role of behavioral factors in shaping adaptation outcomes.

Unlike prior studies, this paper integrates institutional and behavioral dimensions into a comparative index of resilience for CEE countries. While previous research often examined these perspectives separately, focusing either on institutional capacity or on behavioral barriers, this study combines them within a unified analytical framework. This integrated approach provides a more comprehensive understanding of how structural and cognitive factors jointly shape adaptation outcomes across diverse post-socialist economies.

Against this backdrop, the article addresses the following research questions:

What national climate adaptation strategies have been adopted in selected CEE countries, and how are they being rolled out at institutional and sectoral levels? (addressed in Section 5, with further comparison in Section 8)

1. To what extent have EU financial instruments (e.g., RDP – Rural Development Programme; LIFE – Programme for the Environment and Climate Action (LIFE Programme); RRF – Recovery and Resilience Facility and domestic public policies contributed to measurable improvements in macroeconomic resilience and sectoral adaptation? (Addressed in Sections 5.2, 6.2, and 7 – Absorption of EU Funds)
2. Where do countries diverge or align in terms of adaptation performance and the ability to manage climate-related threats? (Addressed in Section 6 – Comparative Analysis, and Section 7 – Sectoral Vulnerability Shifts and Resilience Indicators)
3. How do behavioral and psychological factors influence the adaptation choices of farmers, businesses, and households in the CEE region? (Addressed in Sections 4.1 and 8, with policy implications in Section 9)

Methodologically, the article employs a comparative case study approach involving five CEE countries: Czechia, Hungary, Lithuania, Poland, and Romania. The analysis draws on national adaptation strategies, planning documents, and datasets from Eurostat, the OECD, and the World Bank, as well as information on public spending and EU-funded programs. It also considers legal and institutional contexts, together with barriers and enablers of adaptation at the micro level, informed by behavioral research and expert analyses (IPCC 2022, pp. 1755–1790).

By explicitly linking these research questions to the structure of the paper, the study ensures that each one is systematically addressed in the subsequent analysis. Section 2 reviews the literature on climate adaptation, resilience, and behavioral dimensions of decision-making. Section 3 develops the theoretical framework, while Section 4 presents the methodology and data sources. Sections 5–7 provide the empirical analysis of national strategies, EU funds, sectoral and macroeconomic outcomes, as well as behavioral barriers. Section 8 offers a comparative discussion, and Section 9 concludes, providing policy recommendations.

Literature Review

Over the last twenty years, the academic conversation around climate change adaptation has grown significantly, not just in volume, but also in depth and diversity. What began as a mostly economic and environmental issue has gradually evolved into a genuinely multidisciplinary field, weaving together threads from economic modeling, governance theory, and behavioral science (Adger, Arnell, and Tompkins 2009; Sovacool, Linnér, and Goodsite 2015). This evolution reflects a growing recognition: adapting to climate change is anything but straightforward; it is as much about institutions and incentives as it is about rainfall and temperature.

A key turning point in shaping how we think about adaptation came with the publication of The Stern Review (Stern 2007), which made a compelling case for early, proactive investment in both mitigation and adaptation. More than just running the numbers, Stern underscored the moral and economic consequences of delay, laying the groundwork for how cost-benefit thinking is now applied in climate policy. However, the Review has also been criticized for its normative stance and reliance on specific discount rate assumptions that continue to fuel debate (Hallegatte et al. 2012).

Building on that momentum, Hallegatte et al. (2012) introduced the idea of decision-making under deep uncertainty, which moves us beyond rigid forecasting into the realm of flexible, adaptive strategies. While approaches like "no-regret" or "robust" planning are useful in highly uncertain contexts, these strategies often remain at the conceptual level, with limited evidence of systematic integration into policymaking in CEE (European Environment Agency 2021).

On the modeling front, Bosello, Carraro, and De Cian (2013) examined how mitigation and adaptation can either clash or complement one another in computable general equilibrium models. Their findings highlight a crucial point for fiscally constrained economies: climate policy works best when it is balanced and diversified. Similarly, de Bruin, Dellink, and Tol (2009), who embedded adaptation into the AD-DICE model (AD-DICE – Adaptation Dynamic Integrated model of Climate and the Economy), provided a more nuanced picture of how climate damages play out across different investment scenarios. Yet both approaches face limitations: they often treat adaptation as an aggregated variable, thereby overlooking institutional fragmentation and the behavioral inertia that constrain implementation in practice (Dupuis and Biesbroek 2013).

Institutional thinking has also played a major role. North's (1990) theory of institutional change remains a cornerstone for understanding why good intentions often do not translate into action. Building on his insights, scholars like Biesbroek et al. (2013) and Dupuis and Biesbroek (2013) have shown how fragmented institutions, low political will, and complex bureaucracies tend to trip up adaptation efforts – a pattern particularly visible in post-socialist CEE countries. Nonetheless, these studies frequently stop short of providing solutions for how to overcome such barriers in contexts marked by limited administrative capacity and unstable political environments.

The behavioral side of the puzzle is equally important. Grothmann and Patt (2005) developed a much-cited model of how individuals, from farmers to small business owners, respond to climate risks. They point to a critical insight: people do not always act rationally. Risk perception, heuristics, and beliefs about adaptive capacity often matter more than economic logic. This framework has since been expanded by institutions like the OECD (2017), which explored how communication and incentives might nudge people toward smarter choices. However, empirical evidence on how such behavioral insights translate into real adaptation uptake in CEE remains scarce.

Recent empirical work has examined regional differences. Kalkuhl and Wenz (2020) found that heat-related economic losses are heavily concentrated in poorer, agriculture-reliant areas, many of which are in CEE countries. These findings stress that adaptation must be tailored, not

templated, taking into account differences in exposure, vulnerability, and institutional strength. However, much of this research still focuses on macro-level outcomes, leaving micro-level dynamics and sectoral resilience underexplored.

Beyond economic and behavioral dimensions, newer strands of the literature have addressed the political economy of adaptation (Sovacool, Linnér, and Goodsite 2015), climate finance architecture (Fankhauser and Burton 2011), and the challenge of aligning policies across sectors (Adger, Arnell, and Tompkins 2009). While these contributions underline the complexity of adaptation, they also reveal a gap: few studies combine institutional, financial, and behavioral perspectives in a comparative regional context.

In sum, while the literature now offers a rich and dynamic foundation for thinking about climate adaptation, it often remains fragmented across disciplines and levels of analysis. Key gaps include (i) insufficient empirical evidence on how EU funds shape resilience outcomes in CEE, (ii) limited integration of behavioral economics into adaptation policy, and (iii) a lack of comparative insights on how post-socialist institutional legacies affect adaptive capacity. This study seeks to address these gaps by bringing together economic analysis, institutional diagnostics, and behavioral insights to better understand what adaptation looks like and what constrains it in the specific and diverse context of CEE.

Theoretical Framework

Adaptation Economics and the Resilience of Economic Systems

Adaptation economics, which has emerged as a central strand within environmental and climate economics, addresses a fundamental question: how can societies identify, evaluate, and implement measures that reduce the economic and social costs of climate change? At its core, this field examines the capacity of economies to adjust to new climatic conditions by investing in resilient infrastructure, reforming policy frameworks, and strengthening institutional systems that support long-term adaptation (Stern 2007; European Commission 2023a). Recent updates to the EU Adaptation Strategy emphasize these themes, highlighting the need for proactive, evidence-based, and behaviorally informed adaptation policies aligned with the European Green Deal and new Common Agricultural Policy of the European Union CAP 2023–2027 mechanisms (DG AGRI 2023; European Commission 2023b).

A clear conceptual foundation is, therefore, essential for analyzing how economic systems respond to climate-related shocks. In the literature, the terms resilience, adaptive capacity, and institutional preparedness are sometimes used interchangeably, despite representing analytically distinct dimensions of climate response (North 1990; IPCC 2022). Resilience refers to an economic or socio-institutional system's overall ability to withstand climatic disturbances, limit losses, and restore essential functions after a shock (IPCC 2022). Adaptive capacity denotes the resources, skills, behavioral dispositions, and institutional arrangements that enable individuals, firms, and public authorities to adjust their practices in response to actual or expected impacts (Grothmann and Patt 2005; Hallegatte et al. 2012). Institutional preparedness captures the coherence of strategic frameworks, administrative capacity, and coordination mechanisms required for effective adaptation (Biesbroek et al. 2013;

Dupuis and Biesbroek 2013). While interconnected, these concepts operate at different analytical levels: adaptive capacity reflects potential, institutional preparedness describes enabling conditions, and resilience represents observable performance under climatic stress.

To provide a structured analytical basis for cross-country comparison, this study adopts the widely used three-stage typology of resilience (Adger, Arnell, and Tompkins 2009; IPCC 2022). Absorptive resilience concerns the capacity to buffer shocks through existing mechanisms such as flood defenses, emergency response systems, or insurance markets, which help reduce immediate economic losses (European Environment Agency 2021). Adaptive resilience reflects the ability to adjust behaviors, technologies, and institutional practices over time, for example, by adopting irrigation, diversifying energy sources, or strengthening multi-level governance – areas increasingly supported under CAP 2023–2027's eco-schemes and risk-management instruments (DG AGRI 2023). Transformative resilience involves deeper structural change when incremental measures are insufficient, including reconfigurations of governance systems, land-use patterns, or sectoral structures (Sovacool, Linnér, and Goodsite 2015; IPCC 2022). Recent behavioral research further suggests that transformation also requires overcoming cognitive barriers, risk misperceptions, and institutional distrust, underscoring the behavioral dimension of resilience (Beauchamp 2023; D'Adda 2023).

Applying this typology to CEE helps explain why countries may hold comprehensive formal strategies yet continue to exhibit high vulnerability: absorptive and adaptive mechanisms may exist, but transformative reforms often lag behind, reflecting persistent implementation gaps, behavioral obstacles, and institutional path dependencies typical of post-socialist governance systems (North 1990; Biesbroek et al. 2013). In this context, the notion of resilience has gained prominence in economic debates, emphasizing not only the capacity to withstand shocks but also to maintain essential economic functions such as stable employment, fiscal balance, and continuity of production during extreme weather events (IPCC 2022; World Bank 2022).

Adaptation economics is particularly relevant today because it evaluates both the benefits of timely adaptation and the costs of inaction. By weighing these trade-offs, it provides policymakers with a clearer understanding of the expected returns to investment in resilience-enhancing measures (European Environment Agency 2021; European Commission 2023b). It also highlights the challenges of allocating scarce public resources when there is deep uncertainty and rapidly evolving climate risks, a central concern in current EU discussions on climate finance, CAP reforms, and national adaptation planning (Hallegatte et al. 2012; OECD 2023).

Institutional Mechanisms Shaping Adaptive Behavior

To understand adaptation in CEE, we must demonstrate not only that institutions matter, but also how they drive behavioral responses to climate risks. Institutions shape adaptive behavior through several channels that reduce cognitive burdens, stabilize expectations, and lower the perceived risks associated with long-term investments (North 1990; Grothmann and Patt 2005). Effective institutional frameworks streamline decision-making by providing clear signals about acceptable practices, reliable incentives, and predictable outcomes. In this sense,

adaptation-related behavior is not solely a function of individual preferences or risk perceptions but emerges from the interaction between cognitive processes and institutional environments.

One of the central mechanisms involves the role of default rules embedded in public programmed, regulatory frameworks, and financial instruments. Defaults act as behavioral anchors: when irrigation insurance is automatically included in agricultural support packages, or when climate-resilient infrastructure guidelines are standardized in building codes, individuals and firms tend to adopt these options without requiring additional motivation or extensive evaluation. This behavioral effect is particularly relevant in contexts of limited administrative capacity, where simplifying choices may significantly increase uptake of adaptive practices.

Institutions also shape social norms around adaptation. Advisory services, extension networks, and professional associations can diffuse information on recommended practices and generate reputational incentives for farmers or firms to comply with emerging standards. Social norms reinforce perceptions of what constitutes responsible behavior, reducing the uncertainty associated with investing in new technologies or altering production patterns. In environments where climate information is scarce or inconsistent, informal norms may be as influential as formal regulations in driving behavioral change.

Another mechanism relates to trust-based compliance, which is critical in post-socialist countries characterized by historically low trust in public administration. Trust influences how individuals interpret policy signals, assess institutional credibility, and decide whether public incentives are reliable enough to justify long-term adaptation investments. Where institutions demonstrate transparency, consistency, and support, compliance tends to increase. Conversely, institutional instability frequent policy reversals, administrative fragmentation, or inconsistent enforcement reduces trust and amplifies behavioral inertia, even when adaptation measures are economically beneficial.

These mechanisms create important feedback loops. Low absorption of EU adaptation funds reduces the visible effectiveness of public policy, which in turn weakens institutional credibility and diminishes trust in climate programs. As trust declines, willingness to participate in public schemes also decreases, leading to lower adoption of adaptive measures, weaker project pipelines, and further difficulties in absorbing funds. This self-reinforcing cycle helps explain why certain CEE countries exhibit large discrepancies between formal adaptation strategies and actual behavioral uptake of resilience measures. Institutional and behavioral deficiencies thus reinforce each other, creating persistent adaptation gaps that cannot be resolved solely through additional funding or regulatory adjustments.

Institutional and Behavioral Dimensions of Adaptation

Recent research has made it increasingly clear: when it comes to climate adaptation, weak institutions constitute major obstacles. In many post-socialist countries, fragmentation across administrative levels and a lack of policy continuity have consistently undermined the effectiveness of adaptation efforts (Bosello, Carraro, and De Cian 2013, pp. 2–4).

But the problem does not stop at governance structures. Even when technical solutions exist, they are not always embraced, and that has a lot to do with human behavior. Behavioral inertia among key actors, whether in government or industry, tends to persist. That inertia is made worse when there are no strong peer networks to learn from, or when there's a lack of visible "early adopters" to set an example (de Bruin, Dellink, and Tol 2009, pp. 65–68).

The reality is that adaptation isn't just a matter of economics or technology; it is also deeply rooted in how institutions function and how people think and act. Institutional economics reminds us that both formal rules (like regulations and strategies) and informal norms (like organizational culture or social expectations) play a major role in shaping how adaptive a system can be (North 1990, pp. 36–45). In the CEE region, key elements such as the quality of public administration, coordination across sectors, transparency in decision-making, and the extent to which climate policies are decentralized all influence outcomes (Bassi and Domínguez 2021, pp. 19–30).

At the same time, behavioral economics has been gaining traction as a tool to explain why people, including farmers, business owners, and even policymakers, sometimes hesitate to adapt, even when the economic case is strong. Factors like how individuals perceive climate risks, their reliance on mental shortcuts (heuristics), limited cognitive bandwidth, or just a preference for the status quo, all come into play (Grothmann and Patt 2005, pp. 201–205). Add to that the general uncertainty surrounding the scale and speed of climate change, combined with limited access to reliable information and a lack of trust in institutions, and it's easy to see why inaction often wins out (IPCC 2022, pp. 1798–1805).

All this points to one conclusion: we need a more integrated approach that brings together both institutional and behavioral perspectives. Only then can we fully grasp the diverse range of adaptive capacities across the CEE region and begin to break down the real-world barriers that hold back effective climate adaptation policies.

Methodology

Comparative Case Study Analysis

This study takes a comparative look at five CEE countries: Czechia, Hungary, Lithuania, Poland, and Romania. These countries were not chosen at random. They all share key features: EU membership, similar stages of economic development, and sectoral structures that leave them particularly exposed to the risks of climate change (Bassi and Domínguez 2021, pp. 8–9). What especially interests us here is how prepared their institutions are for adaptation, how coherent their national strategies really are, and whether existing support tools are actually delivering on the ground.

To do this, we use a mixed approach. On the one hand, we investigate official policy documents and planning frameworks. On the other hand, we look closely at macro-level and sector-specific data to understand the broader economic context. However, the story does not end there. We also include behavioral factors, like how people perceive climate risks, and how willing they are to take

adaptive action. That includes insights into how farmers and small business owners make decisions in the face of uncertainty (Grothmann and Patt 2005, p. 204).

Data Sources: Eurostat, World Bank, OECD, National Adaptation Strategies

The quantitative side of this study draws on a range of trusted sources. We used data from Eurostat, covering aspects such as greenhouse gas emissions, the role of agriculture in national economies, and investment patterns. From the OECD, we used indicators related to public policy and governance quality, while the World Bank provided regional insights on climate risks and adaptation-related investments. Finally, we also looked at country-specific strategic documents, such as National Adaptation Plans (NAPs) and National Energy and Climate Plans (NECPs) (European Commission 2020, pp. 6–13).

To ensure we did not rely too heavily on just one type of evidence, we used a triangulation approach. That means we combined hard data with a closer look at policy content, institutional arrangements, and expert commentary, drawing on scientific publications and technical reports to put the numbers into proper context (IPCC 2022, pp. 1755–1790).

Given the limited availability of harmonized behavioral datasets across the region, the study required a transparent operationalization of behavioral constructs derived from adaptation theory. In particular, two key behavioral dimensions risk perception and institutional trust could not be directly measured using standardized cross-country indicators. To address this gap and ensure analytical consistency, these concepts were approximated through observable behavioral proxies and partially available survey evidence. Table 1 summarizes how these constructs were translated into measurable indicators, the rationale behind the chosen substitutes, and the data sources that support their inclusion in the comparative framework.

Table 1. Operationalization of behavioral indicators: risk perception and institutional trust

Concept	Direct measure available?	Substitute indicator(s) used	Source / Notes
Risk perception	No comparable cross-country data available for all CEE states	– Agricultural insurance uptake – Irrigation adoption rates – SME adoption of renewable technologies	Eurostat (n.d.); OECD (2017); World Bank (2022). Substitutes used due to absence of harmonized perception surveys at national level.
Institutional trust	No comparable survey data across all countries; available only for selected years or sectors	– OECD behavioral surveys (2017) for selected CEE countries – National case studies and sectoral reports (where available)	OECD (2017); national expert reports; policy assessments. Used cautiously due to partial coverage and methodological heterogeneity.

Source: own compilation based on Eurostat n.d.; OECD 2017; World Bank 2022; and national case studies.

To ensure transparency and analytical consistency, Table 2 maps each research question (RQ) to its corresponding datasets and policy frameworks. This study utilizes these sources to construct a Resilience Index (RI) a composite measure of adaptive capacity.

The RI integrates four equally weighted dimensions, each normalized on a 0–1 scale via min–max transformation:

1. Institutional preparedness: The integration and implementation of National Adaptation Strategy (NAS), National Energy and Climate Plan (NECP), and National Adaptation Plan (NAP).
2. Financial capacity: The absorption of EU funds (RDP, LIFE, and RRF).
3. Sectoral vulnerability: Relative economic losses in agriculture and energy.
4. Behavioral uptake: Adoption rates for insurance, irrigation, and renewable technologies.

Following established benchmarks for composite adaptation indices (Fankhauser and Burton 2011; European Environment Agency 2021; World Bank 2022), each country's score is calculated as the arithmetic mean of these four pillars.

Table 2. Data sources, indicators, and policy documents used in the analysis

Research Question (RQ)	Indicators / Criteria	Primary Data Sources	Policy / Document Sources
RQ1. National adaptation strategies	Existence of NAS; integration with sectoral strategies; level of implementation (national/regional/local)	–	National Adaptation Strategies (NAPs), National Energy and Climate Plans (NECPs), Ministry of Climate reports
RQ2. Role of EU funds and public policies	Absorption rates of RDP, LIFE, RRF; allocation efficiency; structure of adaptation expenditures	Eurostat (env_ac_fnd), European Commission country reports, European Court of Auditors (2022)	Recovery and Resilience Facility (RRF), EU Cohesion Policy docs
RQ3. Divergence and convergence in adaptation performance	Share of agriculture in GDP; flood-prone land area; energy efficiency; Climate Resilience Index; projected GDP losses	Eurostat (agri_indicators), World Bank Climate Risk DataBank, OECD Green Growth Indicators, IPCC AR6	–
RQ4. Behavioral and psychological factors	Adoption rates of adaptive practices (irrigation, renewable energy, insurance uptake); survey-based evidence on risk perception	OECD (2017), World Bank (2022), case studies and expert reports	Grothmann and Patt (2005), national behavioral surveys (where available)

Source: own study based on Eurostat n.d., OECD 2021, World Bank 2022, European Environment Agency 2023, IPCC 2023, and national policy documents.

The Resilience Index for each country was then calculated as the arithmetic mean of the four dimensions. Higher values indicate greater adaptive capacity and resilience.

$$RI_c = \frac{1}{n}\sum_{i=1}^{n} x_{ci},$$

where:
RI_c – Resilience Index for country c,
x_{ci} – normalized value of indicator i for country c,
n – total number of indicators (four dimensions).

While Table 1 summarizes the datasets and policy documents applied in the study, it does not clarify how the theoretical frameworks were translated into empirical indicators. To bridge this gap, Table 3 maps the key dimensions of institutional and behavioral theories onto the specific indicators and data sources used in the comparative analysis. This operationalization clarifies how theoretical assumptions informed the empirical design and how each research question is linked to measurable variables.

Table 3. Operationalization of theoretical frameworks

Theoretical concept	Operational indicator / data source	Empirical link (RQ)
Institutional capacity	OECD governance indicators; Eurostat on fund absorption; NECP/NAP review	RQ1, RQ2
Policy consistency	Presence of adaptation indicators in national/regional strategies	RQ1
Vertical integration	References to regional/local implementation in NAS/NECP	RQ1
Adoption of adaptive practices (behavioral)	Irrigation, renewable energy, insurance uptake (Eurostat, World Bank, OECD)	RQ4
Risk perception/trust (behavioral)	Grothmann and Patt (2005), OECD surveys (2017), World Bank (2022)	RQ4

Source: own study.

By linking institutional concepts like vertical integration, policy consistency to specific NECP/NAP metrics, this approach ensures that the theoretical and empirical strands of the study remain integrated rather than running in parallel. Where primary survey data were not unavailable, we triangulated secondary sources such as World Bank risk reports and expert case studies to approximate the role of behavioral barriers in shaping adaptation outcomes.

Analytical Framework

To ensure transparency and replicability, we explicitly linked each research question to measurable indicators and policy documents. Table 4 provides an overview of the datasets, criteria, and adaptation policies analyzed. This design goes beyond narrative summaries and anchors the analysis in verifiable data sources, including Eurostat, OECD, World Bank, IPCC, and national adaptation plans.

Table 4. Research questions, indicators, and data sources

Research Question	Criteria / Indicators	Policies / Documents Analyzed	Data Sources
RQ1. National adaptation strategies	Existence of NAS/NAP; integration of adaptation in NECP; references to sectoral measures	NAS, NECP	National ministries; EU Climate-ADAPT database

Research Question	Criteria / Indicators	Policies / Documents Analyzed	Data Sources
RQ2. EU and domestic financial instruments	Absorption rates of RDP, LIFE, RRF; share of climate-related investments in total public spending	EU operational programmed; RRPs	Eurostat (env_ac_...); European Court of Auditors (2022); World Bank (2022)
RQ3. Divergence in adaptation performance	Climate resilience index; GDP losses from climate events; sectoral vulnerability scores	EU Green Deal monitoring; EEA Climate Risk Atlas	Eurostat (n.d.); European Environment Agency (2021); OECD databases
RQ4. Behavioral and psychological factors	Insurance uptake; irrigation adoption; renewable energy adoption by SMEs; survey results on risk perception and trust	OECD behavioral reports; national surveys; case studies	Grothmann and Patt (2005); OECD (2017); World Bank (2022)

Note: NAS: National Adaptation Strategy; NECP: National Energy and Climate Plan; RRP: Recovery and Resilience Plans.
Source: own compilation based on the databases and policy documents cited above.

Limitations and Robustness Checks

This study relies primarily on secondary data sources, including Eurostat, OECD, World Bank, the European Environment Agency (EEA), and national adaptation documents such as NAS, NECP, and NAPs. A major limitation concerns the availability of primary behavioral data, particularly risk perception and institutional trust, which are not consistently measured across the CEE region (OECD 2017; European Environment Agency 2021). As a result, behavioral dimensions were operationalized through indirect proxies such as insurance uptake, irrigation adoption, and technology diffusion, which approximate but do not fully capture underlying psychological mechanisms (World Bank 2022). Similarly, institutional trust indicators were drawn from OECD behavioral surveys and national case studies, which differ in temporal coverage and methodological design (OECD 2017). While these substitutions allow for a comparative assessment across countries, they introduce measurement error and should be interpreted as indicative rather than definitive assessments of behavioral adaptation barriers (Grothmann and Patt 2005). This approach ensures comparability across countries, although it also entails several limitations. First, behavioral indicators are not consistently available across all CEE countries, which constrains the ability to test causal relationships between risk perception, trust, and actual adaptation uptake. Second, the RI and its underlying indicators should be viewed as a heuristic tool rather than a definitive measurement of adaptive capacity. The choice of equal weights and min–max normalization was guided by transparency and replicability; however, alternative weighting or aggregation methods could yield different results. Finally, given the reliance on official reports and datasets, the findings may reflect reporting biases or incomplete monitoring mechanisms. Despite these limitations, the framework offers added value by providing a transparent and systematic comparison of institutional and behavioral adaptation dimensions across the region.

Justification of Indicator Selection

The selection of indicators used to construct the RI follows a set of methodological principles designed to ensure cross-country comparability, analytical transparency, and alignment with established international frameworks. Because the study covers five CEE countries, the primary criterion for inclusion was the availability of consistent, high-quality data across all countries. This constraint excludes several potentially relevant dimensions such as detailed measures of social capital, institutional trust, or sector-specific behavioral metrics – that are only partially available or rely on non-harmonized national surveys. The indicators included in the RI therefore prioritize robustness and comparability over breadth, reflecting the empirical limitations noted in recent adaptation assessments (European Environment Agency 2021; World Bank 2022).

A second guiding principle was the need to avoid redundancy among variables. Several categories of indicators examined during the initial design phase were ultimately excluded due to strong conceptual or statistical overlap with other components. For example, human capital variables education levels, skills indicators, and digital preparedness are strongly correlated with broader measures of institutional capacity and governance quality (OECD 2022). Including both sets of indicators would overweight similar underlying characteristics and distort the composite index. Similarly, sector-specific vulnerability indicators for agriculture, energy, and water management were aggregated into a single vulnerability dimension to avoid overrepresentation of countries with larger agricultural sectors. This approach is consistent with composite-index methodology, which recommends minimizing double-counting and ensuring conceptual balance across dimensions (Fankhauser and Burton 2011; European Environment Agency 2021).

Finally, the selection of indicators was informed by established international resilience and adaptation indices to ensure conceptual alignment and facilitate comparability with prior research. The structure of the RI mirrors the logic of the EEA Climate Risk Assessment (European Environment Agency 2021), which emphasizes institutional readiness, financial capacity, and sectoral exposure as core determinants of climate resilience. Similarly, the World Bank's Climate Resilience Indicators (World Bank 2022) informed the inclusion of institutional and financial dimensions, while the incorporation of behavioral uptake reflects recent literature highlighting the need to integrate behavioral data into adaptation metrics (Grothmann and Patt 2005; OECD 2017). The resulting index balances theoretical relevance with empirical feasibility and provides a transparent, replicable framework appropriate for cross-country comparative analysis within the CEE region.

Adaptation Strategies and Institutions in CEE Countries

Overview of National Adaptation Strategies

All CEE countries analyzed in this study have adopted national adaptation strategies (NAS), largely in response to EU obligations United Nations Framework Convention on Climate Change (UNFCCC) reporting requirements, and access to climate-related funding (European Environment Agency 2021, pp. 23–27). Despite this shared policy architecture, the strategies differ considerably in structure, scope, and intended implementation pathways.

Lithuania integrates adaptation directly into spatial planning and land-use policy, particularly in coastal zone governance and responses to urban heat stress (Bassi and Domínguez 2021, pp. 14–20). Poland's "State Environmental Policy 2030" designates climate adaptation as one of three strategic pillars, prioritizing risk assessment, early warning systems, and cross-sectoral coordination (Ministry of Climate and Environment Republic of Poland 2020, pp. 11–18). Meanwhile, Czechia, Hungary, and Romania have updated NAS documents toward 2030 with a stronger sectoral focus on agriculture, water management, and urban adaptation.

However, across the region, a recurrent challenge is the weak vertical integration of NAS – national objectives often fail to translate into local implementation due to limited administrative capacity, unclear mandates, and insufficient technical support at regional levels (Biesbroek et al. 2013, p. 1122). Consistent with recent IPCC assessments, effective adaptation in CEE remains constrained by governance fragmentation, insufficient inter-ministerial coordination, and limited stakeholder engagement (IPCC 2022, pp. 921–928). These barriers reflect longstanding structural features of public administration in the region, including legacies of centralized governance and institutional instability.

The Role of EU Funds and Green Deal Mechanisms

EU funding mechanisms including the Cohesion Fund, Recovery and Resilience Facility (RRF), LIFE Programme, and instruments associated with the European Green Deal play a central role in enabling adaptation investments in CEE (European Union 2021, pp. 17–23). Although these mechanisms provide substantial financial support, their effectiveness varies significantly across countries.

The European Court of Auditors (2022, pp. 6–9) and the World Bank (2022, pp. 34–36) found that absorption rates for adaptation-related funding remain below the EU average. Key constraints include limited administrative capacity, complex procedures, fragmented responsibilities, and a shortage of well-prepared, fundable adaptation projects. Frequent changes in procurement rules, inter-agency coordination problems, and slow permitting processes further impede implementation.

Another recurrent issue is the tendency of national governments to treat adaptation as a secondary rather than primary policy priority (European Court of Auditors 2022, pp. 6–9). As a result, funding often prioritizes grey infrastructure such as roads, levees, and drainage systems over ecosystem-based solutions or behavioral interventions, which are less easily accommodated within standard cost-benefit frameworks.

There are, however, emerging examples of integrated approaches. Estonia and Slovenia have implemented LIFE-funded pilot projects that combine flood management with biodiversity co-benefits (OECD 2022, pp. 41–44). Recent RRF programming also shows greater alignment with EU climate objectives, including the 30% climate mainstreaming requirement. Turning this potential into sustained outcomes will nonetheless depend on domestic administrative reforms and the incorporation of adaptation into long-term development planning.

Comparative Analysis – Macroeconomic Aspects

Climate Vulnerability Indicators and Their Impact on GDP

Recent evidence points to a clear pattern: economies that are more diverse tend to weather climate shocks better than those that rely heavily on just one sector. In particular, regions dominated by monoculture farming, and especially those vulnerable to drought, often struggle the most (Kalkuhl and Wenz 2020).

Key indicators of climate vulnerability, like how often droughts occur, how much land is prone to flooding, the share of agriculture in national GDP, or how dependent a country is on fossil fuels, vary significantly across the region (European Environment Agency 2021, pp. 45–49). For instance, in Lithuania and Romania, agriculture makes up over 4% of GDP, putting those economies at higher risk when climate extremes hit. Hungary and Poland, on the other hand, face serious flood threats and have relatively low energy efficiency – both of which drive up the costs of adapting to climate change (World Bank 2022, pp. 15–18).

The impacts are no longer just projections; they're already being felt. Slower economic growth, falling agricultural yields, damaged infrastructure, and power system disruptions are becoming more frequent. And it could get worse. According to IPCC estimates, if effective adaptation policies are not put in place, the CEE region could see annual GDP losses of up to 1.5–2% by 2050 (IPCC 2022, pp. 1780).

Efficiency in Allocating Adaptation Funds

The way adaptation funds are allocated across CEE is still far from consistent. Czechia and Poland demonstrate relatively high administrative proficiency, having shown a consistent capacity to absorb and deploy EU funding effectively. By contrast, Lithuania and Romania face substantial challenges in implementing long-term projects, often characterized by low absorption rates (European Commission 2021, pp. 24–29).

Several structural impediments account for these disparities. Primarily, many countries lack robust, long-term systems to assess climate risks. When compounded by a prevalence of short-termism in policy planning, this results in misaligned investment flows that fail to reach high-priority sectors such as agriculture or flood prevention (Hallegatte et al. 2012, pp. 29–31).

Optimizing the use of adaptation funding requires more than access to good data. Local institutions also need the know-how to prioritize the right kinds of projects, especially regarding critical infrastructure, better water systems, or modernizing outdated energy grids. Without that institutional capacity, even well-designed funding mechanisms will fail to achieve their full potential.

Examples of Sectoral Adaptation (Agriculture, Energy, Infrastructure)

In the agricultural sector, climate adaptation is primarily manifested through modernized irrigation systems, stress-resilient crop varieties, and better access to weather and climate advice for farmers.

In Poland, for example, the 2014–2020 Rural Development Programme (RDP) allocated funding toward water retention projects and agricultural training, measures designed to make farms more resilient in the long run (European Environment Agency 2021, pp. 60–63).

The energy sector has also seen movement in the right direction. Lithuania, for example, has expanded investments in decentralized renewables – specifically solar farms and local microgrids – and energy storage. These upgrades help reduce the risk of blackouts during extreme weather events (Bassi and Domínguez 2021, pp. 25–26).

Public infrastructure, including roads, railways, and energy systems, is gradually being adapted to cope with hotter temperatures and heavier rainfall. However, European Environment Agency (2021, pp. 60–63) and the World Bank (2022, p. 38) report that the pace of change remains insufficient relative to the scale of projected climate risks, with many investments still focused on short-term repairs rather than long-term resilience. While specific infrastructure projects in Romania and Hungary have received support from the LIFE programme and the European Investment Bank, such initiatives remain the exception rather than the rule (World Bank 2022, p. 38).

Empirical Results – Comparative Analysis

National Adaptation Strategies (RQ1)

The analysis of planning documents (NECPs, NAPs, national strategies) reveals that adaptation strategies in the examined countries differ both in scope and implementation. Czechia and Poland have achieved moderate levels of integration of adaptation measures into regional development policies, for example, by including adaptation indicators in regional planning documents. In contrast, Lithuania and Romania continue to treat adaptation largely as a separate environmental component, with weak links to transport, spatial planning, or health policies. Hungary demonstrates fragmented implementation and high dependence on individual institutions running adaptation projects.

Answer to RQ1: These findings indicate that while all CEE countries have formally adopted national strategies, their rollout is uneven. Czechia and Poland show stronger institutional coordination, whereas Lithuania and Romania lag behind, confirming the structural gaps identified in Section 5.

The Role of EU Funds and Public Policies (RQ2)

Analysis of Eurostat data and European Commission reports (European Union 2021) reveals significant disparities in the absorption of EU climate adaptation funds between 2014 and 2020:

- Poland absorbed 89% of allocated RDP and LIFE funds for adaptation projects.
- Czechia absorbed 84%, mainly due to efficient domestic procedures.
- Romania and Lithuania absorbed only 56% and 62%, respectively, due to a lack of ready projects and institutional constraints.
- Hungary absorbed 74%, with expenditures focused mostly on engineering solutions, while behavioral and educational aspects were underrepresented.

Answer to RQ2: These results demonstrate that while EU financial instruments significantly supported adaptation in Poland and Czechia, their impact remains limited in Romania and Lithuania because of institutional bottlenecks. Moreover, funding still prioritizes hard infrastructure, leaving ecosystem-based and behavioral measures underfunded.

An additional concern relates not only to the volume and absorption of funds but also to the quality of adaptation investments. Evidence from CEE countries suggests a persistent bias toward grey infrastructure such as levees, drainage systems, or road protection works which delivers short-term risk reduction but often lacks long-term transformational value and may even increase lock-in effects (Sovacool, Linnér, and Goodsite 2015; European Environment Agency 2021). By contrast, deep adaptation investments ecosystem-based solutions, water retention landscapes, soil regeneration, climate-resilient land-use planning, or decentralized energy systems remain underfunded despite their higher long-term benefits and alignment with the EU Adaptation Strategy 2023 update (European Commission 2023a). The predominance of grey projects reflects institutional incentives that favor visible, easily quantifiable outputs and existing sectoral capacities, whereas deep adaptation requires cross-sectoral coordination, behavioral engagement, and longer implementation horizons. As a result, the structure of expenditures continues to limit transformative outcomes, reinforcing short planning cycles and reducing the effectiveness of adaptation financing in the region.

Divergence and Convergence Across Countries (RQ3)

According to World Bank (2022) data for the period 2010–2020, sectoral vulnerability shifts are evident:

- Agricultural productivity in Poland and Czechia remained relatively stable despite increased drought frequency, indicating partial success of adaptation measures (e.g., water retention, crop changes).
- Romania and Lithuania experienced declines in agricultural productivity of 12% and 9%, respectively, in extremely dry years (2012, 2015, 2018), suggesting insufficient technological and infrastructural adaptation.
- Hungary recorded increased investment in decentralized renewable energy (e.g., photovoltaics), reducing power outages in regions covered by the "Local Energy 2030" program.

Climate resilience indicators also highlight divergence (Table 5). Poland (0.68) and Czechia (0.72) are the most resilient, while Romania (0.52) and Lithuania (0.56) are the least resilient. Hungary holds an intermediate position (0.60). Without adaptation, GDP losses by 2050 could reach between –1.2% and –2.1% annually, depending on the country.

Table 5. Indicators of Economic Resilience to Climate Change

Country	Climate Resilience Index	Projected GDP Loss by 2050 (No-Adaptation Scenario)
Czechia	0.72	− 1.2% annually
Hungary	0.60	− 1.7% annually

Country	Climate Resilience Index	Projected GDP Loss by 2050 (No-Adaptation Scenario)
Lithuania	0.56	−2.0% annually
Poland	0.68	−1.4% annually
Romania	0.52	−2.1% annually

Source: author's own calculations based on IPCC 2022; OECD 2022.

Answer to RQ3: The results suggest a relationship between institutional preparedness and macroeconomic resilience. In this study, institutional preparedness is defined as the existence and integration of adaptation strategies (NAS/NECP), the capacity to absorb EU funds (RDP, LIFE, RRF), and the degree of policy consistency across sectors. As shown in Table 5, Poland (score 0.72) and Lithuania (0.68) recorded higher preparedness levels, accompanied by relatively lower climate-related GDP losses (0.9% and 0.7% of GDP, respectively). By contrast, Romania, with a preparedness score of 0.41, experienced losses averaging 1.8% of GDP over 2000–2020 (European Environment Agency 2021; World Bank 2022). These findings indicate that stronger institutional frameworks tend to reduce the scale of macroeconomic climate-related losses, although the evidence should be interpreted as correlational rather than causal.

Behavioral and Psychological Dimensions of Adaptation (RQ4)

Although most quantitative data reflect institutional and financial aspects, evidence from expert assessments and secondary sources highlights significant behavioral barriers. Farmers and SMEs often underinvest in adaptation even when it is economically justified. Evidence from Grothmann and Patt (2005, pp. 201–203) and the OECD (2017, pp. 32–35) shows that short planning horizons, risk underestimation, and low institutional trust are key behavioral barriers. Similar findings for CEE countries were highlighted by the World Bank (2022, pp. 22–24), which pointed to persistent cognitive and institutional constraints limiting the uptake of adaptive practices. For instance, in Romania and Hungary, financial support schemes were available, yet the adoption of adaptive practices remained limited.

Answer to RQ4: These results show that behavioral and psychological factors play a critical role in shaping adaptation outcomes. Even where financial and institutional support is present, cognitive biases and low institutional trust constrain effective adaptation, confirming the importance of integrating behavioral economics into policy design.

Cross-country comparisons further illustrate how behavioral dynamics interact with institutional settings. Poland's relatively high agricultural insurance uptake (approximately 45%) correlates with higher levels of institutional trust and more consistent enforcement mechanisms (OECD 2017; World Bank 2022). In contrast, Romania's very low level of insurance penetration (below 20%) reflects both persistent distrust in public institutions and weak policy enforcement. Lithuania shows comparatively high adoption rates of efficient irrigation technologies (over 30%), linked to targeted policy incentives and cooperative structures, while Hungary lags behind with adoption rates below 10%. These differences suggest that behavioral barriers in CEE are not purely psychological but are closely intertwined with institutional and cultural legacies. Post-communist

distrust of state institutions, limited participatory traditions, and the prevalence of "policy façade" mechanisms reduce willingness to engage in formal adaptation programs, even when economic incentives exist.

Sensitivity Analysis of the Resilience Index

To assess the robustness of the RI, a comparative sensitivity analysis was conducted using three alternative weighting schemes: (i) equal weights, (ii) Principal Component Analysis (PCA), and (iii) expert-based weights derived from adaptation literature (Fankhauser and Burton 2011; European Environment Agency 2021; World Bank 2022). The goal was to examine whether the relative ranking of countries remains stable regardless of weighting assumptions.

Table 6. Comparison of Resilience Index Scores Under Alternative Weighting Schemes

Country	Equal Weights	PCA Weights	Expert Weights
Czechia	0.72	0.74	0.71
Hungary	0.60	0.57	0.59
Lithuania	0.56	0.53	0.55
Poland	0.68	0.69	0.67
Romania	0.52	0.50	0.51

Source: author's own calculations based on data from Eurostat, OECD Green Growth Indicators, World Bank Climate Risk DataBank, and methodological guidelines from European Environment Agency 2021 and World Bank 2022.

The sensitivity analysis demonstrates that the relative ordering of countries remains largely stable across all three weighting methods, indicating that the RI is robust to alternative weighting assumptions. PCA-based weights produce slightly more dispersed scores, reflecting the stronger influence of financial absorption and institutional quality in the variance structure of the dataset. Expert weights create only minor deviations from the equal-weight baseline, reinforcing the conclusion that no single dimension dominates the index disproportionately. Overall, the consistency of country rankings across weighting schemes supports the methodological reliability of the composite index and strengthens confidence in the comparative interpretation of resilience levels in the CEE region.

Discussion

The comparative results show substantial variation across CEE countries in both climate risks and adaptive capacities. Table 2, which tracks the existence and quality of national adaptation strategies, confirms that while all examined states have formally adopted NASs or NECPs, their integration into sectoral policies remains uneven. For example, Lithuania's NAS embeds adaptation into spatial planning, whereas Romania's and Hungary's strategies lack consistent sectoral linkages. These findings confirm the relevance of institutional theories of adaptation, which stress that fragmented governance and limited policy consistency undermine long-term resilience (Biesbroek et al. 2013; Dupuis and Biesbroek 2013).

Despite the formal adoption of adaptation strategies across CEE, many countries in the region continue to exhibit what the literature terms "symbolic policy" or "policy façade" – strategic documents that signal alignment with EU expectations but lack the institutional depth, administrative capacity, or financial commitments needed for meaningful implementation (Dupuis and Biesbroek 2013; Jordan and Huitema 2014). Such symbolic adaptation is often rooted in the political incentives of governments that prioritize compliance on paper while avoiding distributive conflicts associated with substantive climate reforms. As a result, adaptation plans appear comprehensive, yet remain weakly embedded in sectoral policies, underfunded or inconsistently enforced, undermining their credibility and practical impact (Sovacool, Linnér, and Goodsite 2015; European Environment Agency 2021).

A further explanation lies in the role of sectoral veto players – actors with sufficient political, economic, or bureaucratic power to block, delay, or dilute adaptation measures that threaten entrenched interests (Tsebelis 2002; Meadowcroft 2011). In several CEE countries, agricultural lobbies, energy incumbents, forestry agencies, and regional authorities resist reforms that require behavioral change, investment shifts, or regulatory tightening. These actors often benefit from existing subsidy structures, weak enforcement, or legacy infrastructure, thereby creating institutional inertia that slows adaptation progress (Adger, Arnell, and Tompkins 2005; Biesbroek et al. 2013). The influence of veto players reinforces implementation gaps, limits transformative adaptation, and contributes to the persistent divergence between formal strategies and actual resilience outcomes across the region.

Although institutional and financial factors strongly influence adaptation outcomes, behavioral gaps remain a major barrier in CEE. Farmers, SMEs, and households often underinvest in adaptive measures even when they are economically viable. Short planning horizons, risk underestimation, and low trust in public institutions reduce the willingness to engage in long-term strategies. Empirical evidence from the OECD (2017), World Bank (2022), and national case studies shows that behavioral inertia persists even in the presence of financial support schemes.

Addressing these gaps requires more systematic integration of behavioral economics tools into public policy, such as nudging mechanisms, targeted information campaigns, and simplified administrative procedures. Without tackling cognitive and psychological constraints, institutional reforms and EU funding will continue to face limited uptake on the ground.

Table 3, which compares the absorption of EU funds, indicates that adaptation-related spending as a share of total EU transfers ranged from 11% in Poland to less than 5% in Romania between 2014 and 2020. The European Court of Auditors (2022) similarly documents persistent underutilization of LIFE and RDP funds in several CEE countries. These data highlight how institutional capacity constraints, such as limited administrative resources and high transaction costs, translate directly into lower financial absorption, constraining adaptation outcomes. The results, therefore, corroborate institutional economics perspectives that emphasize the role of implementation capacity and incentive structures in determining policy effectiveness.

Regarding resilience outcomes, Table 4 shows that climate-related GDP losses (2000–2020) were substantially higher in Romania (1.8% of GDP equivalent) and Hungary (1.5%) compared

to Poland (0.9%) and Lithuania (0.7%). Similarly, sectoral vulnerability indicators (European Environment Agency 2021) confirm that agriculture remains disproportionately exposed in Romania and Hungary, while energy sector risks dominate in Czechia and Poland. These divergences point to structural differences in exposure and sectoral composition, reinforcing the need for country-specific rather than templated adaptation strategies.

The behavioral dimension is captured in Table 7, which presents evidence on the uptake of adaptive practices. Insurance penetration among farmers is below 20% in Romania and Hungary, but exceeds 45% in Poland; adoption of efficient irrigation technologies is above 30% in Lithuania but below 10% in Hungary. These findings illustrate the behavioral barriers identified in the theoretical framework: short planning horizons, limited risk perception, and low institutional trust (Grothmann and Patt 2005; OECD 2017). The underinvestment by farmers and SMEs, even when EU funds were available, reinforces the argument that adaptation cannot be understood solely through institutional capacity; behavioral factors critically shape uptake.

Table 7. Comparison of national adaptation strategies in selected CEE countries

Country	Adaptation Objectives	Main Policy Instruments	Implementation Level	Funding Sources
Czechia	Flood protection, urban resilience	Sectoral strategies, risk management plans	National	EU funds, domestic resources
Hungary	Water adaptation, drought management	National adaptation strategy, LIFE projects	Regional	LIFE, Cohesion Fund, bilateral support
Lithuania	Spatial planning, local adaptation	NECP, local strategies, PPP in green infrastructure	Local and regional	EU funds, pilot PPP initiatives
Poland	Water retention, agricultural resilience, infrastructure	RDP, State Environmental Policy 2030, agricultural advisory	National and regional	EU funds (RDP, LIFE), national budget
Romania	Reducing vulnerability in agriculture and energy	Climate Strategy 2030, cooperation with IFIs	Limited regional coverage	EIB, World Bank, EU funds

Source: own study.

These findings also align with the theoretical frameworks outlined earlier. For instance, the observed difficulties in policy coordination and low absorption of EU funds validate North's (1990) arguments about institutional path dependence and the persistence of structural inefficiencies. Similarly, the underinvestment by farmers and SMEs, despite available support schemes, confirms the behavioral mechanisms described by Grothmann and Patt (2005), where risk perception biases and limited adaptive capacity hinder rational decision-making. Conversely, cases such as Lithuania's integration of adaptation into spatial planning suggest partial evidence against overly deterministic views of institutional inertia, showing that targeted policy design can overcome legacy barriers.

Taken together, the results demonstrate that adaptation in CEE is constrained by a dual challenge: institutional fragmentation and behavioral inertia. Institutional weaknesses limit the effectiveness of EU transfers and policy frameworks, while behavioral barriers reduce uptake at the micro level. Integrating both perspectives thus yields a more comprehensive explanation of the observed patterns.

From a policy perspective, the data underscore three priorities. First, improving administrative and technical capacity is essential to raise absorption rates of EU adaptation funds, particularly in Romania and Hungary. Second, targeted measures are needed to reduce sectoral vulnerabilities, especially in agriculture, through investment in irrigation and crop insurance. Third, policies should incorporate behavioral insights to address short planning horizons and low trust, for example, by designing simplified procedures, defaults, and risk communication strategies. These implications are consistent with recent recommendations by the IPCC (2022, pp. 921–928) and the European Environment Agency (2021, pp. 75–78), which emphasize the need to combine institutional strengthening with behavioral interventions.

Beyond the descriptive comparison, this study highlights a broader theoretical challenge. Institutional perspectives often assume that formal strategies and governance structures translate into effective adaptation. However, the results presented in Tables 2–4 suggest otherwise: countries with relatively comprehensive adaptation plans (e.g., Hungary, Romania) still experience high climate-related GDP losses, whereas countries with fewer formal documents but higher financial absorption and behavioral uptake (e.g., Poland, Lithuania) demonstrate stronger resilience outcomes. This discrepancy illustrates the risk of "policy façade" strategies that exist on paper but lack budgetary commitment, enforcement, or social legitimacy. By explicitly combining institutional and behavioral indicators into a single resilience index, this article contributes to bridging this gap and provides a framework for future research to test how formal preparedness aligns or fails to align with tangible adaptation outcomes in post-socialist contexts.

Conclusions and Recommendations

The coordination of climate policies across different governance levels national, regional, and local remains one of the most persistent challenges in CEE. While vertical integration mechanisms, such as multilevel planning platforms or shared budgeting tools, can substantially improve adaptation outcomes, they remain largely missing or poorly institutionalized across the region.

Financing constraints are particularly acute in rural municipalities, which often lack both the fiscal autonomy and technical expertise to initiate climate-resilient infrastructure projects. Targeted fiscal transfers and regional climate investment funds may serve as viable policy innovations to overcome these bottlenecks. Embedding adaptation metrics into public investment appraisal procedures could also improve long-term resilience by aligning infrastructure and agricultural programs with broader climate goals.

The key findings and recommendations are summarized in Table 8, which links the research questions (RQ) directly to empirical results and policy implications.

Table 8. Research Questions, Findings, and Recommendations

Research Question (RQ)	Key Findings	Policy Recommendations
RQ1. National adaptation strategies	All examined countries have adopted national adaptation strategies, but implementation is fragmented. Poland and Czechia show stronger integration, while Romania and Lithuania lag behind.	Strengthen vertical integration; improve coordination between levels of government; enhance administrative capacity at regional and local scales.
RQ2. Role of EU funds and public policies	Large disparities in EU fund absorption: Poland (89%) and Czechia (84%) outperform Romania (56%) and Lithuania (62%). Funding often favors infrastructure over ecosystem-based or behavioral solutions.	Simplify administrative procedures; support project readiness; rebalance spending to include nature-based and behavioral approaches.
RQ3. Divergence and convergence in adaptation performance	Climate resilience indices show divergence: Czechia (0.72) and Poland (0.68) most resilient, Romania (0.52) and Lithuania (0.56) least resilient; GDP losses projected up to –2.1% annually without adaptation.	Standardize resilience metrics; target weaker countries with conditional EU support; integrate adaptation into core development strategies.
RQ4. Behavioral and psychological factors	Farmers and SMEs often underinvest in adaptation despite economic justification. Barriers include risk underestimation, short planning horizons, and low trust in institutions.	Incorporate behavioral insights into policy (nudges, default options, peer learning); strengthen participatory governance to build trust.

Source: own study.

A key conclusion is that only a comprehensive and integrated approach – addressing institutional, financial, and behavioral barriers simultaneously can enhance climate change adaptation in the CEE region. In practice, this means that:

- Lithuania and Romania need urgent institutional reinforcement, particularly in policy coordination, strategic planning, and the absorption of EU funds. In Romania, these structural challenges are compounded by behavioral barriers, suggesting the need for behavioral nudges to increase irrigation adoption and reforms of local procurement rules to improve project quality and reduce delays (Thaler and Sunstein 2008; OECD 2017).
- Czechia and Poland, while displaying relatively strong institutional frameworks, should prioritize the diversification of financing mechanisms, including public–private partnerships, climate insurance, and green bonds. In Poland, targeted instruments such as risk-sharing pools for farmers and trust-building pilots within advisory services could help address persistent behavioral and informational gaps (Beauchamp 2023; OECD 2023).
- Hungary demonstrates moderate deficits in both institutional and financial dimensions, indicating the need for parallel reforms. Given the political centralization of adaptation governance, a key priority is the depoliticization of adaptation funding and strengthening the autonomy of regional bodies to implement locally tailored adaptation measures (Tsebelis 2002; Meadowcroft 2011).

Future research should examine the long-term socio-economic impacts of climate adaptation in CEE, focusing on interactions between policies and demographic shifts, labor market changes, and urban–rural migration. Advanced modelling approaches (e.g., DSGE models) and cross-country panel data analyses could provide deeper insights into both macroeconomic effects and micro-level behavioral dynamics.

At the EU level, linking funding conditionality more directly to measurable outcomes and institutional reforms would incentivize stronger adaptation performance. National adaptation observatories, standardized metrics, and knowledge-exchange platforms could further help align national strategies with EU climate targets and the broader objectives of the Green Deal.

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Adaptacja do zmian klimatu i odporność gospodarcza w Europie Środkowo-Wschodniej: porównawcza analiza instytucjonalna i polityczna

Celem artykułu jest porównawcza analiza strategii adaptacji do zmian klimatu w wybranych krajach Europy Środkowo-Wschodniej (w Polsce, Czechach, na Węgrzech, w Rumunii, w krajach bałtyckich) oraz ocena ich wpływu na odporność gospodarczą. Szczególną uwagę poświęcono instytucjom publicznym, instrumentom finansowym oraz ramom regulacyjnym wspierającym proces adaptacji, ze szczególnym uwzględnieniem wykorzystania funduszy unijnych (w tym Zielonego Ładu i Funduszu Odbudowy). Analiza koncentruje się również na sektorze rolnictwa – jako jednym z najwrażliwszych na skutki zmian klimatycznych – oraz na mikroekonomicznych uwarunkowaniach decyzji adaptacyjnych podejmowanych przez gospodarstwa domowe i przedsiębiorstwa. Podejście badawcze łączy analizę instytucjonalną i polityczną z perspektywą ekonomii behawioralnej, wskazując na czynniki sprzyjające skuteczności adaptacji w regionie oraz ograniczające ją.

Słowa kluczowe: adaptacja do zmian klimatu, odporność gospodarcza, Europa Środkowo-Wschodnia, polityka klimatyczna, instytucje publiczne, ekonomia behawioralna, fundusze unijne, rolnictwo, analiza porównawcza, strategie adaptacyjne