Ministry of Development Funds and Regional Policy
Republic of Poland

NDC2050
National
Development
Concept

ATTACHMENT III TO NDC 2050

METHODOLOGY FOR DEVELOPING NDC 2050

This document has been prepared based on the GOSPOSTRATEG-III/0032/2020 project entitled: Operationalising the Development Management System of Poland. Improving and introducing innovative and effective solutions into the socio-economic and spatial system as part of long-term development policy programming.

Warsaw 2025

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INTRODUCTION

The National Development Concept 2050 (hereinafter referred to as the Concept or NDC) is anchored in the Act on the Principles of Development Policy. According to the provisions of this Act, the national development concept includes, in particular: (1) conclusions from the analysis of development trends in the country; (2) conclusions from the analysis of global development trends and their potential impact on development trends in the country; (3) development scenarios and development challenges for the country in social, economic and spatial terms.

The Ministry of Development Funds and Regional Policy is responsible for coordinating the preparation of the NDC. The scientific basis and expert knowledge for this process were provided through the project "Operationalisation of the Polish Development Management System: Improvement and introduction of innovative and effective solutions to the socio-economic and spatial system within long-term development policy programming" (GOSPOSTRATEG-III/0032/2020), implemented by the Institute of Urban and Regional Development (IRMiR), the Institute of Environmental Protection – National Research Institute (IEP-NRI) and the Ministry of Development Funds and Regional Policy.

The project served to elaborate the key elements of the NDC, as required by the Act. The minimum scope of the national development concept defined in the Act allows for flexible selection of research methods and tools suited to:

- identifying global, European and national development trends,
- developing a vision for the country in 2050,
- building development scenarios for the country until 2050,
- diagnosing and territorialising Poland's development challenges.

Development trends are defined as directions of change that exert, or will in the future exert, a significant influence on the social, economic, environmental and spatial conditions of national development. The 2050 Vision of Poland represents the desired image of the country once it has addressed its development challenges. Development scenarios are models describing potential pathways for the country's development until 2050, outlining routes towards achieving the 2050 Vision of Poland while taking into account conditions arising from different external scenarios. Development challenges refer to issues requiring action within public policies up to 2050. They are understood as responses to the effects of trends in society, the economy, the environment and space. These responses aim either to resolve problems or to leverage opportunities for Poland's development arising from these trends.

The results of the project's work were applied in drafting the individual components of the Concept.

Work on the National Development Concept was based on available data, while the proposed research methods can also be applied in the preparation of other documents.

The methods used at the individual stages of the work are described below. At the end of this annex, a diagram summarises the methods applied and the results achieved.

IDENTIFYING GLOBAL, EUROPEAN AND NATIONAL DEVELOPMENT TRENDS

Socio-economic development trends

Identification and analysis of global trends was carried out based on a review of the literature (particularly global foresight reports), a public hearing organised by the Ministry of Development Funds and Regional Policy in 2021, and an examination of international and domestic databases. To assess the external conditions for Poland's development, a modified version of the PEST and STEEPVL analyses, which have been in use for years, was applied. The new approach (STEEPS) considers six dimensions: social (S), technological (T), economic (E), environmental (E), political (P), and spatial (S). Key phenomena shaping the global future were identified within these areas.

Expert methods were used to evaluate external trends and their impact on Poland, including a survey of 399 academic experts. This assessment allowed for the formulation of hypotheses regarding the potential impact of these trends on Poland by 2050.

The diagnosis and analysis of national socio-economic trends focused on changes occurring in Poland, taking into account the European context and Poland's position within the European Union. Using selected indicators, national trends were analysed and the ways in which Poland fits into global trends were assessed, along with potential changes in the country by 2050 – in terms of social, economic, environmental, spatial, and political-institutional dimensions.

Figure 1. Research procedure scheme for trend analysis in the context of NDC

Source: Dziemianowicz 2023

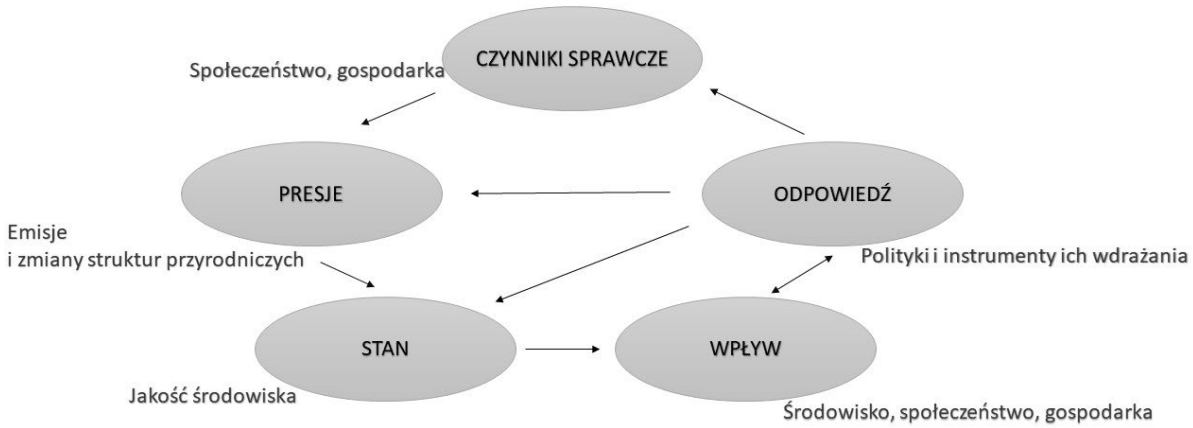
Wybór megatrendów i kluczowych trendów	Selection of megatrends and key trends
Analiza	Analysis
Wstępne wnioski dla Polski w kontekście KRK 2050	Preliminary conclusions for Poland in the context of the NDC 2050
Kontekst europejski	European context
Specyfika Polski	Specific features of Poland
Światowe trendy społeczno-gospodarcze	Global socio-economic trends
Krajowe trendy społeczno-gospodarcze	National socio-economic trends
Światowe trendy środowiskowe	Global environmental trends
Krajowe trendy środowiskowe	National environmental trends

Environmental development trends

The diagnosis of global, European, and national environmental trends was conducted using analytical methods. The DPSIR model (Driving Forces – Pressures – State – Impact – Response) was applied to identify and characterise environmental trends, allowing for an integrated, multi-dimensional, and evidence-based assessment of the environment for public policymaking purposes. The analysis took into account various characteristics describing the pressures exerted on the environment due to land and natural resource use, emissions into the environment, as well as the condition of individual environmental components.

The research methods included content analysis and statistical analysis. A review and analysis of selected information sources on environmental changes were conducted. The characteristics of national environmental trends were developed based on the analysis of historical, statistical, and spatial data using selected indicators. These analyses enabled the identification of major environmental trends that significantly impact society and the economy at global, European, and national levels. The potential effects of these trends were identified and assessed regarding their impact on Poland's development.

Figure 2. DPSIR model



Source: Hajto et al. 2023 [1].

CZYNNIKI SPRAWCZE	CAUSAL FACTORS
PRESJE	PRESSURES
ODPOWIEDŹ	RESPONSE
STAN	CONDITION
WPŁYW	IMPACT
Społeczeństwo, gospodarka	Society, economy
Emisje i zmiany struktur przyrodniczych	Emissions and changes in natural structures
Jakość środowiska	Environmental quality
Polityki i instrumenty ich wdrażania	Policies and instruments for their implementation
Środowisko, społeczeństwo, gospodarka	Environment, society, economy

[1] Hajto M. et al. 2023. Environmental trends in the context of the National Development Concept 2050. Global and European trends. IEP-NRI. Warsaw.

The results of the work on identifying global, European and national socio-economic and environmental trends have been published in four monographs:

1. *Socio-economic megatrends in the context of the National Development Concept 2050. Global trends,*
2. *Socio-economic megatrends in the context of the National Development Concept 2050. European and national trends,*
3. *Environmental trends in the context of the National Development Concept 2050. Global and European trends, Environmental trends in the context of the National Development Concept 2050. National trends.*

All reports are available on the project website: https://krk2050.pl/baza-wiedzy/opracowania/

Main features of the vision:

- It is a snapshot of an idealized image of Poland in 2050, having overcome all threats and leveraged emerging development opportunities.
- It served as the starting point for the preparation of development scenarios and the identification of challenges for Poland in its development processes.
- It is divided into five key thematic areas:
  - Society – describes ideal socio-demographic conditions.
  - Economy – defines the optimal state of the country's economy.
  - Environment – considers the challenges and goals related to the protection of nature and natural resources.
  - Space – pertains to the spatial organization of the country.
  - Institutions – describes the desired state of public and administrative institutions.
- It is the result of a consultation process involving the project team, representatives from the marshal's offices, local government units, and ministry representatives. Consequently, the vision is the outcome of extensive discussions and incorporates a variety of perspectives.

Since the document was developed in a non-linear manner (see Fig. 2 in the NDC), it is challenging to reflect this process in a systematic document with a table of contents and page numbering that overlap the stages of work on the individual components. The team developing the NDC decided on the current order, which largely mirrors the sequence of work on individual stages: trends, vision, scenarios, challenges. Diagnosing phenomena and identifying trends allowed us to understand what is happening around us and what will happen in the future (see Megatrends and Attachment 1 – Trends).

The nature of the document and the strategic foresight elements used in its development required the preparation of the vision before the scenarios and main challenges were identified. It also acts as a long-term guide, which is why it was placed immediately after the graphics illustrating the megatrends – to direct the audience's attention to the desired image of Poland. The scenarios show possible paths to achieving the vision, taking into account Poland's external conditions (each scenario considers a different combination of environmental factors described on page 7 – see "Development of scenarios for the country's development until 2050").

PREPARING SCENARIOS FOR THE COUNTRY'S DEVELOPMENT UNTIL 2050

Methodological assumptions for scenario preparation:

- The scenarios are variant in nature and are developed through both an analytical and participatory process.
- The starting point is a fixed set of qualitative factors (variables) that influence the situation in various ways or lead to extreme approaches in public policy in response to identified trends.
- Each variant takes into account the following dimensions: social, economic, spatial, environmental, and institutional.
- The aim of the process is to present paths to achieving the 2050 Vision of Poland, to the extent that its implementation is possible in the specific scenarios.
- The paths are not – and should not be – a simple extrapolation of decisions or programs already in place in the socio-political life of the state.
- Regardless of the conditions set by the environmental scenario, some interventions – particularly in key areas with clear desired outcomes, such as the environment – may be similar across different scenarios. If a given action repeats across environmental scenarios, it is a valuable indication that we are dealing with an action largely resistant to changing environmental conditions (thus, worth implementing regardless of the scenario).
- Not all actions are "future-proof." Therefore, in many cases, development scenarios present alternative actions to achieve the same goal (stemming from the 2050 Vision of Poland) under different conditions imposed by environmental scenarios.
- The country's development scenarios are not a standalone strategic document, but rather an integral part of the process of preparing Poland for future challenges. Therefore, the pathways to achieving the Vision are formulated in a way that suggests the direction of intervention, without limiting the possibility of refining objectives and actions in subsequent stages of the process.
- The paths proposed by the participants in the process to reach the 2050 Vision of Poland are not the only possible ones. They are treated as a starting point for further reflection and the search for more effective, efficient, and future-proof alternatives that will effectively minimize risks and capitalize on opportunities arising from the changing environment.

Stages of scenario development:

1. Preparation of environmental scenarios for Poland,
2. Preparation of development scenarios for the country.

The environmental scenarios have been developed using a method known as the two-dimensional impact matrix (2×2), which:

- Is particularly useful for testing long-term scenarios (thus fitting within the NDC time horizon).
- Allows policies (visions) to be tested across multiple factors (thus fulfilling the need to analyze social, economic, spatial, environmental, and institutional dimensions).
- Utilizes the knowledge of a diverse group of experts and entities.
- Is effective – enabling diverse scenarios to be developed quickly.
- Is transparent – allowing the process through which scenarios were selected to be easily traced.

The factors for the matrix, i.e., the framework factors for changes in Poland's environment, were selected based on the results of trend analysis. The selection of these factors was based on the following criteria:

- The factor significantly impacts the possibility or manner of implementing the Vision;
- The factor is characterized by high uncertainty (i.e., it is not possible to clearly determine how the factor in question will evolve by 2050);
- The factors are relatively independent (i.e., a change in one factor does not directly influence a change in another).

The selected factors were assessed in terms of their impact on the ability and manner of implementing the adopted vision and the degree of uncertainty. The assessment was carried out using a survey (completed by nineteen experts), which enabled the selection of two factors:

- The degree of automation and robotization of work (technological factor);
- The dominant value system in global society (political/social factor).

These factors were used to construct the framework for the environmental scenarios (Fig. 3).

Figure 3. Two-dimensional impact matrix (2×2) for constructing environmental scenarios

	Moderate degree of automation (approximately 30–35% of occupations in 2022 have been automated globally)	High degree of automation (approximately 65-70% of occupations in 2022 have been automated globally)
Global society is characterised by openness towards other nations and cultures (citizens of the world).	**Scenario 1** **Poland in a world favouring further globalisation**	**Scenario 2** **Poland in a world of intensive use of technology and slow atomisation of society**
Attitudes that are closed to other nations and cultures dominate in global society	**Scenario 3** **Poland in a world of broken supply chains and shortages**	**Scenario 4** **Poland in a world of drastic technological, economic and social divergence**

Source: own work

The scenarios were developed based on an analysis of trends and their potential impacts, using participatory methods.

A preliminary outline of the environmental scenario, based on the trend analysis, was the subject of a workshop with representatives from the public, economic, and social sectors. The first round of the workshop aimed to develop guidelines for four scenarios for Poland's environment, providing a comprehensive view of the country's external conditions in the future. Representatives from various fields were invited to participate in the workshop to ensure the broadest possible range of perspectives. The result of the workshop was the creation of four "dispatches from the future," which were then refined and supplemented during a series of moderated design workshops. The goal was to develop scenarios that would be:

- Internally consistent, yet distinct from each other;
- Probable (agreed in terms of likelihood);
- Desirable (agreed upon regarding the degree of difficulty in implementing the 2050 Vision for Poland).

Four scenarios for Poland's environment were the subject of the second round of workshops. These workshops, attended by a broad range of public, economic, and social sector representatives, aimed to:

- Identify the consequences of the environmental scenarios for Poland (opportunities and threats to implementing the Vision);
- Highlight Poland's strengths and weaknesses in the context of avoiding threats and exploiting opportunities;
- Define courses of action (methods, policies) for implementing the Vision under each specific scenario;
- Create four development scenarios for Poland by 2050 based on the outcomes of the above work.

The scenarios developed during the workshops with representatives from the public, economic, and social sectors were refined and supplemented, taking into account the results of the trend analysis. The work was carried out as part of a series of moderated workshops by the project team, during which great care was taken to ensure the

internal consistency of the scenarios, their alignment with the surrounding scenarios, and their relevance to a wide range of issues raised in the 2050 Vision for Poland. The process ultimately led to the creation of four development scenarios for

1. Poland in a world embracing further globalisation
2. Poland in a world of intensive use of technology and gradual atomisation of society
3. Poland in a world of broken supply chains and shortages
4. Poland in a world of drastic technological, economic and social divergence

IDENTIFYING POLAND'S DEVELOPMENT CHALLENGES

The process of identifying Poland's development challenges and developing key conclusions for public policies (i.e., the directions of action that need to be taken in the long term by public policies in order to address the identified challenges) was multi-stage. In line with the project's assumptions, the process was participatory in nature. A key methodological assumption was ensuring the broad involvement of external experts, including representatives from the scientific community, local governments, non-governmental organizations, and the business sector. Focus group studies (two rounds) and workshop methods (two workshop meetings) were used. Additionally, a study of social needs was conducted in line with the citizen science methodology, allowing the unique experiences and knowledge of citizens to be considered and engaging them in the research process.

The focus studies aimed to identify Poland's development challenges in the thematic areas of the National Development Concept (NDC) — environment, society, economy, and space — as well as the key challenges for the country's development. The study was based on synthetic descriptions of development trends and their potential impact on Poland's development, prepared using the identification and characterisation of global, European, and national trends. The first round of the focus study resulted in the identification of Poland's development challenges until 2050 in each thematic area: environment, society, economy, and space (four lists of development challenges). These lists were revised in subsequent studies and during project team workshops, and they were used in the next phase of the research.

The identified development challenges were ranked from most to least important (from the perspective of Poland's development processes) as a result of their ranking in an online survey addressed to experts. A wide range of experts — including participants from the Delphi survey conducted during the trend identification phase — took part in the ranking process. As a result of the survey, analytical work, and project team workshops, short lists of development challenges for Poland were prepared in each of the thematic areas: environment, society, economy, and space (four lists of development challenges). These lists were the subject of the second round of focus group research, which aimed to identify key development challenges for each thematic area (i.e., environment, society, economy, and space) in two time perspectives — until 2030 and 2050 — and to create a list of cross-cutting (horizontal) challenges. During the project team's study and workshops, a synthetic list of Poland's development challenges across all thematic areas — environment, society, economy, and space — was compiled.

The objective of the expert and local government workshops was to identify and discuss potential public policy measures in response to the identified development challenges. The workshops developed recommendations for public policies (in the 2030 and 2050 perspectives) across the four thematic areas of the NDC — environment, society, economy, and space. There was also a discussion on the institutional changes necessary to address Poland's development challenges. The synthesis of the recommendations was prepared during moderated workshops held by the project team.

In total, more than 150 external experts were involved in the process of identifying Poland's development challenges until 2050. As a result of the work carried out, a final list of 76 challenges (divided into four thematic areas of the Concept) and a list of 15 key mega-development challenges were formulated. Experts identified approximately 200 courses of action to address these challenges.

The challenges and recommendations developed in this way formed the basis for the final version of the challenges presented in the main NDC document. These challenges are the result of work on trends, the vision, and scenarios.

PREPARING THE NDC TEXT

The results of the above-described work on the project were used in the development of the NDC project.

The key elements of the Concept – vision, scenarios, and challenges – were the subject of workshops involving various stakeholders, who have been consistently engaged from the beginning of the process, including representatives from regional governments, academic circles, NGOs, and students. Meetings with representatives of these communities helped to verify the work done so far, identify the key development challenges for the country, assess their spatial impacts, and discuss the 2050 Vision of Poland's development. The individual elements of the NDC (vision, scenarios, challenges) were also consulted with legislative process partners and key stakeholders – representatives of ministries and regional governments. In parallel, the project team worked on a graphic representation of selected issues included in the draft NDC text.

The diagram below outlines the individual tasks, methods adopted, and the results of the subsequent work aimed at developing the NDC project.

Etapy prac	Work stages
Metody	Methods
Rezultaty	Results
Identyfikacja trendów światowych, europejskich i krajowych w wymiarze społecznym, gospodarczym, środowiskowym i przestrzennym	Identification of global, European and national trends in social, economic, environmental and spatial dimensions
Opracowanie wizji rozwoju Polski do 2050 roku	Developmentof a vision for Poland's development by 2050
Opracowanie scenariuszy rozwoju kraju do 2050 roku	Developmentof scenarios for the country's development by 2050
Identyfikacja kluczowych wyzwań rozwojowych Polski do 2050 roku	Identification of key development challenges for Poland by 2050
Opracowanie kluczowych wniosków	Development of key conclusions
Opracowanie tekstu KRK2050	Draftingof the NDC2050 text
Wysłuchania publiczne	Public hearings

Metaanaliza literatury i analiza danych Metoda delficka Warsztaty zespołu projektowego	Meta-analysis of literature and data analysis Delphi method Project team workshops
Analiza wyzwań i kierunków działań Warsztaty zespołu projektowego	Analysis of challenges and policy directions Project team workshops
Analiza trendów, wyzwań i wizji Warsztaty zespołu projektowego Warsztaty z udziałem przedstawicieli sektora publicznego, gospodarczego i społecznego	Analysis of trends, challenges and the vision Project team workshops Workshops with representatives of the public, economic and social sectors
Badania fokusowe, warsztaty, ankieta z udziałem przedstawicieli różnych środowisk i różnych dziedzin Badania Citizen science Warsztaty zespołu projektowego	Focus groups, workshops, survey with representatives of various communities and different disciplines Citizen science research Project team workshops
Analiza polityk publicznych Warsztaty eksperckie Warsztaty samorządowe Warsztaty zespołu projektowego	Public policy analysis Expert workshops Local government workshops Project team workshops
Analiza trendów, scenariuszy, wyzwań i wniosków Warsztaty zespołu projektowego Warsztaty z udziałem przedstawicieli sektora publicznego, gospodarczego i społecznego Resortowe uzgodnienia bilateralne	Analysis of trends, scenarios, challenges and conclusions Project team workshops Workshops with representatives of the public, economic and social sectors Bilateral ministerial agreements
Charakterystyka trendów światowych, europejskich i krajowych Rozpoznane konsekwencje trendów dla rozwoju Polski	Overviewof global, European and national trends Identified consequences of trends for Poland's development
Wizja Polski w 2050 roku	Vision of Poland in 2050
Cztery scenariusze rozwoju kraju do 2050 roku	Four scenarios for the country's development by 2050
Katalog wyzwań rozwojowych Polski w perspektywie 2050 r. z uwzględnieniem perspektywy 2030 r.	Catalogue of Poland's development challenges with a horizon to 2050, including the 2030 perspective
Lista kluczowych wniosków	List of key conclusions
Koncepcja Rozwoju Kraju 2050 (projekt do konsultacji społecznych	National Development Concept 2050 (draft for public consultation)

METHODOLOGY FOR DEVELOPING TERRITORIAL VULNERABILITY AND RESILIENCE MAPS

Justification for the study

Socio-economic development processes clearly tend to vary across space. Recognizing the various dimensions and manifestations of these differences is not only important for cognitive (diagnostic) purposes but also has significant practical implications, particularly for development policy. While development policy concerns the entire country, certain measures or instruments are specifically focused on selected territories that need support to enhance their development potential or address various problems and adverse phenomena. Modern development policy is integrated and territorially oriented. The foundation for programming activities within this framework is a reliable diagnosis that allows for the identification of development challenges in the territorial dimension, in line with the evidence-based policy paradigm.

Given the above, as part of the work on the preparation of the National Development Concept 2050 (NDC 2050), territorial vulnerability maps have been developed for selected areas that require support to enhance their development potential or mitigate various problems and adverse phenomena. These territorial vulnerability maps correspond to specific thematic areas of NDC 2050 and are aligned with the groups of development challenges identified during earlier stages of the work. The maps illustrate the variation in vulnerability levels across Poland in environmental, social, and economic dimensions.

The development of territorial vulnerability and resilience maps had three main objectives: cognitive (diagnostic), methodological, and practical. The first objective was to portray the spatial distribution of Poland's vulnerability across the thematic areas of NDC 2050, specifically identifying and illustrating the territorial variation in the country's vulnerability to various environmental, social, and economic challenges. The study summarizes the diagnostic process of NDC 2050 and has identified areas within Poland that are particularly vulnerable in various development dimensions.

Moreover, the results show that the vulnerability levels of these areas vary not only territorially but also by the nature of the challenges they face. The same territory might be highly resilient in one dimension of development while very vulnerable in another. Understanding these differences and their territorial distribution is a crucial factor for planning and implementing public policies – not only development and regional policies but also sectoral ones.

The methodological objective of the study was achieved by testing different approaches to constructing synthetic indicators that reflect the scale of diversity in development challenges across the country. Based on these, the final method for developing the territorial vulnerability and resilience maps was selected. The goal was to choose a method that is as objective and verifiable as possible while also simple and repeatable, forming the basis for monitoring phenomena and processes that occur and evolve across the country.

The practical objective of the study was to establish a reliable foundation for an integrated, territorially targeted development policy for Poland. Over the long term, the results of this study can be used to plan and take action aimed at mitigating the potential negative effects of future challenges and threats in areas most vulnerable to them.

Selecting indicators

The study employed an indicator-based approach using statistical methods. For each dimension of territorial vulnerability (environmental, social, and economic), a synthetic indicator was constructed, based on a set of sub-indicators. These sub-indicators and corresponding measures were deliberately chosen. The aim was to select indicators that most effectively addressed the issues relevant to the specific areas of development challenges identified in the National Development Concept (NDC) 2050.

Three criteria were applied when selecting the measures:

Variability: The first criterion was the variability of individual measures within the set of analyzed territorial units (municipalities). To examine this, the coefficient of variation was used, which defines the ratio of the standard deviation to the arithmetic mean. In the further analysis, only measures showing variability (where the coefficient of variation exceeded 10%) were considered.

Spatial Distribution: The second criterion was the nature of the spatial distribution of the analyzed measures. The study focused on measures whose spatial distribution exhibited distinct territorial patterns across Poland.

Interdependence: The third criterion considered the degree of interdependence between the measures in the areas of territorial vulnerability and resilience. This was determined using Pearson's linear correlation coefficient. Highly interdependent measures (those with a correlation coefficient below -0.8 or above 0.8) were excluded to avoid distorting the synthetic indicator toward any single issue.

Based on these criteria, a final selection of measures was made from a wide catalogue of potential indicators, which served as the foundation for constructing the synthetic indicators for each dimension of territorial vulnerability.

The adopted sub-indicators and corresponding measures in the study are categorized as either stimulators or destimulators:

Stimulators are diagnostic variables where higher values indicate a more positive phenomenon (e.g., birth rate and entrepreneurship level).

Destimulators are characteristics where higher values indicate a more negative phenomenon (e.g., unemployment rate or extent of social assistance use).

For each of the dimensions of Poland's territorial vulnerability, seven sub-indicators were selected. The list of indicators and measures adopted in the study is provided at the end of the methodological description.

Territorial vulnerability Level

The territorial vulnerability was assessed at the municipal level, as municipalities are the most appropriate and reliable units for this purpose when analyzing the spatial diversity across Poland. Using municipalities as the level of analysis avoids the risk of masking or flattening significant territorial differences, as may occur at the county level.

For most of the measures, values were analyzed as of 2023. For the environmental vulnerability map, data as of 2021 were used. This was primarily due to the availability of comparable source data at the municipality level at the time of the study. The data used for constructing individual measures were sourced from publicly available statistical and administrative data, primarily from Statistics Poland, sourced from the Local Data Bank. This approach allows for consistent continuation of territorial vulnerability and resilience studies in the future.

In some cases, the source of information for certain indicators was derived from the results of research projects. The specific data sources for each of the individual indicators are listed at the end of the methodological description.

Research procedure

To construct the synthetic indicators of territorial vulnerability and resilience, Hellwig's taxonomic measure of development – a linear ordering method – was applied. This method ranks units according to their distance from a benchmark: the unit with the highest value (for stimulants) or the lowest (for destimulants). It has been widely used in analyses of territorial development disparities (see e.g. Bąk 2016; 2018; Hnatyszyn-Dzikowska, Polcyn 2015; Koszel, Bartkowiak 2018; Łogwiniuk 2011; Stec 2015).

The procedure comprised four steps:

Step 1. Normalisation (standardisation) of variables. Each measure was standardised by subtracting the mean (calculated for the dataset) and dividing by the standard deviation. This enabled comparison of variables expressed in different units. Typically, values ranged between -3.0 and 3.0, although in the case of strongly asymmetric distributions they could exceed these limits. Such values were capped at -3.0 or 3.0.

Step 2. Calculation of the Euclidean distance of each unit from the benchmark for each measure. The benchmark was defined as the unit with the highest value (for stimulants) or lowest (for destimulants).

Step 3. Calculation of aggregate variable values for each measure. These were defined as 1 minus the ratio of the unit's distance from the benchmark (from Step 2) to the so-called critical distance. Critical distance was calculated as the mean distance from the benchmark across all units in a measure plus twice the standard deviation. The resulting values typically ranged from 0.0 to 1.0.

Step 4. Calculation of the synthetic index. For each unit, the synthetic index was computed as the arithmetic mean of the aggregate variable values across all measures. It typically ranged from 0.0 to 1.0, with higher values indicating more favourable conditions. In the sensitivity maps, higher synthetic index values correspond to lower vulnerability to the analysed challenges.

For the typology of municipalities, units were grouped into five classes using the standard deviation method, with boundaries defined by half or full standard deviation intervals from the mean.

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Sub-indicators of territorial sensitivity in environmental terms

No	Indicator	Measure name and explanation of selection	Nature of measure	Reference period	Source of data
W1	protected areas	share of legally protected areas in the total area – protected areas provide a range of ecosystem services that supportthe development of municipalities	stimulant	2021	Statistics Poland (Local Data Bank)
W2	ecological corridors	share of ecological corridor area in total area – ecological corridors are essential for ensuring environmental sustainability, including the preservation of protected areas	stimulant	2021	General Directorate for Environmental Protection (GDOŚ)
W3	drought risk	share of the municipality's area at risk of agricultural drought – drought risk limits agricultural development and negatively affects water availability for people and ecosystems	destimulant	2021	Drought Effect Counteracting Plan (PPSS)
W4	flood risk	share of the municipality's area at risk of flooding (once every 100 years) – flood risk affects the availability of land for various economic functions	destimulant	2021	Flood hazard maps (MZP)
W5	air quality	weighted annual average concentration of PM2.5 particulate matter [µg/m³] – air quality affects people's living conditions and health	destimulant	2021	Chief Inspectorate for Environmental Protection (GIOŚ)
W6	ecosystem sensitivity	share of ecosystems sensitive to anthropogenic pressure in the total area – ecosystems subjected to anthropogenic pressure may lose functions important for socio-economic development	destimulant	2021	Ministry of Climate and Environment (MKiŚ) (GRID)
W7	sealed surfaces	share of built-up area in total area – the share of sealed surfaces is an indicator of the degree of environmental transformation and provides information about the possible response of the area to the effects of climate change	destimulant	2018	CLC

Sub-indicators of territorial sensitivity in social terms

No	Indicator	Measure name and explanation of selection	Nature of measure	Reference period	Source of data
W1	natural population movement	average annual natural increase per 1,000 inhabitants – births and deaths are the basic indicators determining the population size in a given unit – the indicator allows for the identification of areas experiencing demographic decline	stimulant	2021–2023	Statistics Poland (Local Data Bank)
W2	population migration	average annual migration balance per 1,000 inhabitants – the difference between population outflow and inflow indicates the attractiveness of a given municipality as a place of residence	stimulant	2021–2023	Statistics Poland (Local Data Bank)
W3	demographic burden	number of people aged 65 and over per 100 people aged 0–14 – the demographic ageing index illustrates the intergenerational relationship and indicates the level of ageing in a municipality	destimulant	2023	Statistics Poland (Local Data Bank)
W4	scale of social problems (including poverty)	percentage of residents receiving social assistance benefits – this indicator shows the scale of social problems among the municipality's residents, including their financial situation and level of dependence on public assistance	destimulant	2022	Statistics Poland (Local Data Bank)
W5	scale of the unemployment problem	long-term unemployed per 100 persons of working age – this indicator specifies the number of persons who have been unemployed for more than 12 months, reflects the economic activity of residents and the situation on local labour markets	destimulant	2023	Statistics Poland (Local Data Bank)
W6	education of the population	percentage of residents aged 13 and over with higher education – the indicator shows the level of human capital of a given unit	stimulant	2021	Statistics Poland (CENSUS 2021)
W7	salary level	median gross salary – this indicator reflects the attractiveness of local labour markets. in social terms, this indicator reflects the income level of residents	stimulant	2024	Statistics Poland (Local Data Bank)

Sub-indicators of territorial sensitivity in economic terms

No	Indicator	Measure name and explanation of selection	Nature of measure	Reference period	Source of data
W1	level of entrepreneurship	economic entities entered in the REGON register per 1,000 inhabitants – a basic economic indicator showing the level of concentration of economic activity in a given unit	stimulant	2023	Statistics Poland (Local Data Bank)
W2	entrepreneurship structure	economic entities employing between 10 and 249 employees entered in the REGON register per 1,000 inhabitants – small and medium-sized enterprises constitute a significant part of the economy, as they generate nearly 50% of the country's GDP	stimulant	2023	Statistics Poland (Local Data Bank)
W3	foreign capital	commercial companies with foreign capital per 1,000 inhabitants – foreign capital reflects the level of investment attractiveness of a given unit	stimulant	2023	Statistics Poland (Local Data Bank)
W4	employment level	employed persons per 1,000 working-age population – economic activity rate of residents of a given municipality	stimulant	2023	Statistics Poland (Local Data Bank)
W5	circular economy	separately collected waste in relation to total waste – separate waste collection is an important element of the circular economy and, at the same time, the only available indicator reflecting the circular economy at the municipal level	stimulant	2023	Statistics Poland (Local Data Bank)
W6	condition of local governments	municipality's own revenue per capita – the level of own revenue indicates the municipality's development potential and the extent of its financial independence	stimulant	2023	Statistics Poland (Local Data Bank)
W7	energy transition	electric power of renewable energy installations per 10,000 inhabitants [MW] – illustrates the potential of RES-based installations	stimulant	2023	Energy Regulatory Office (URE)