Urban Planning
2025 • Volume 10 • Article 10277
https://doi.org/10.17645/up.10277

cogitatio

ARTICLE

Open Access Journal

Baltic Spas in the Face of Climate Change: In Search of Resilience

Anna Golędzinowska and Maciej Ganczarek

Faculty of Architecture, Gdańsk University of Technology, Poland

Correspondence: Anna Golędzinowska (anna.goledzinowska@pg.edu.pl)

Submitted: 4 March 2025 **Accepted:** 7 August 2025 **Published:** 22 October 2025

Issue: This article is part of the issue "Smart and Resilient Infrastructure in the Wake of Climate Change" edited by Dillip Kumar Das (University of KwaZulu-Natal) and Varuvel Devadas (Indian Institute of Technology Roorkee), fully open access at https://doi.org/10.17645/up.i432

Abstract

In the context of urban centres exposed to climate change, spas represent a distinct and vulnerable cluster. Their sensitivity stems both from the health profile of spa visitors—often more susceptible to adverse weather—and from their reliance on local natural resources that justified their original therapeutic designation. These vulnerabilities are increasingly exacerbated by climate-related risks such as sea level rise (SLR), extreme weather, and environmental degradation. This article assesses the resilience of Polish Baltic spa towns to climate threats and proposes recommendations for future adaptation policies. Addressing a gap in the literature, the study integrates spatial, environmental, legal, and socio-economic dimensions into a local-scale assessment of small and medium-sized coastal spas. These towns vary in their spatial position within the settlement system, from metropolitan peripheries to isolated localities. A multi-criteria case study approach is applied, using indicators related to development prospects, spatial identity, and exposure to flooding and SLR. Spatial simulations (1-m and 5-m SLR scenarios) are used to identify risks to core spa infrastructure and supporting assets. Existing climate adaptation policies are also reviewed to assess institutional readiness and inform context-sensitive resilience strategies.

Keywords

Baltic Sea; climate adaptation; climate change; resilience; spa centres; spa towns

1. Introduction

Health resorts gained popularity in Europe during the Enlightenment era (Dargacz, 2020), initially developing inland around mineral springs, especially within the temperate climate zone (Kask & Raagmaa, 2010). Coastal spa tourism, based on the therapeutic benefits of sea bathing and maritime climate, emerged later, in 18th-century England, followed by Germany and the Prussian Baltic coast in the early 19th century (Dargacz, 2020).

This article assesses the resilience of Polish Baltic spa towns in the face of climate change and proposes recommendations for future adaptation policies. The analysis focuses on small and medium-sized coastal towns, each with distinct functional roles—ranging from metropolitan nodes to peripheral localities. The following research questions guide this study: To what extent are Polish coastal spas vulnerable to climate risks, particularly sea level rise (SLR) and extreme weather? And how might the spatial, functional, and institutional characteristics of these resorts support or hinder their resilience?

Spa zoning regulations and environmental quality criteria are typically more attainable in less urbanised settings. This creates opportunities to develop niche strategies in medical tourism, which is particularly relevant considering Europe's ageing population (GUS, 2024) and increasing health consciousness (Smith & Puczkó, 2015). However, small-town camaraderie brings structural limitations: constrained public finances and reduced flexibility in the face of economic shocks, compared to larger multifunctional centres.

In contrast to the collapse of British health resorts in the 1960s and 1970s (Kask & Raagmaa, 2010), Polish spas remained viable due to state-funded health access and restrictions on foreign travel during the socialist era. However, following the political transformation of the 1990s, outdated infrastructure and limited competitiveness became pressing challenges (Bachvarov, 2006; Dryglas & Smith, 2023). Efforts to modernise were undertaken through private investment, either via privatisation or public-private partnerships. In many cases, public protests halted full privatisation, preserving key spa functions. The offer was supplemented by private wellness facilities, yet serious gaps remain—particularly in upgrading ageing municipal infrastructures.

Present-day challenges include high costs of modernisation, excessive noise, air pollution (Gorczyca, 2024; Wirszyc-Sitkowska & Mędrzak, 2017), and inadequate healthcare service standards (Wirszyc-Sitkowska & Krawczyk, 2019). These factors collectively threaten the formal spa designation of many towns.

Climate change exacerbates these pressures. Beyond affecting people and infrastructure, it directly threatens the natural resources underpinning this spa's status. Coastal spas are particularly vulnerable to SLR and coastal erosion (IPCC, 2023; Meier et al., 2022). Spatial exposure to flooding and salinisation calls into question the long-term viability of some spa zones. In this context, evaluating the continued relevance of the spa function—and the implementation of effective preventive and corrective measures—becomes imperative.

2. Conceptual Framework

2.1. Socio-Ecological Resilience

In the context of the climate crisis, the concept of urban resilience has evolved significantly. Initially rooted in ecosystem theory (Holling, 1973), it now extends to the resilience of complex urban systems (Meerow et al., 2016). Unlike traditional risk management, resilience management addresses the uncertainties of large, integrated systems and future climate-related threats (Linkov et al., 2014). Communities form interconnected social–ecological systems, with resilience shaped by the ecosystems they inhabit (Adger, 2000; Chapin et al., 2006; Walker & Salt, 2012).

Anthropogenic pressures generate feedback loops that can either destabilise (positive feedback) or stabilise (negative feedback) such systems (Liu et al., 2007). These dynamics are particularly relevant in spa towns,

where natural resources, cultural identity, and health functions intersect. As Goldstein et al. (2015) argue, urban resilience research must also consider symbolic and social meanings attributed to places by local communities. Adaptive capacity—the ability to mobilise resources for transformation—bridges ecological resilience with social benefits (Nelson et al., 2007).

2.2. Spatial Identity and Location Context

Spa towns typically exist either as standalone health destinations or as part of larger recreational agglomerations. In the former, the spa defines the settlement's core function; in the latter, it contributes to a broader tourist or urban system (Pencakowska, 1978; Węcławowicz-Bilska, 2008). Due to the concentration of development and attractiveness of the Baltic coast, all analysed coastal spas fall into the agglomeration or conurbation category, making spatial identity relevant not only to the spa itself but to the entire urban belt.

Spas are characterised by distinct spatial structures, including public spaces that are rich in greenery—particularly the historic "cure parks" (Langer, 2020). Many spas retain protected monumental trees (Meller & Bernat, 2019) and other conservation areas near their central zones (CRFOP, 2024). In seaside towns, spatial form is further shaped by the presence of the sea, with promenades and piers reflecting the therapeutic appeal of marine air and bathing (Foley, 2016). Architectural elements and urban furnishings also express regional identity, although these are increasingly threatened by poor spatial planning (Bal, 2009; Bal & Czalczyńska-Podolska, 2020).

2.3. Trends

Understanding resilience in coastal resorts requires recognising evolving in-demand trends. In the 19th century, spas served the elite (Dargacz, 2020), but after World War II, social security and welfare policies made spa treatments broadly accessible (Diekmann et al., 2020). Today, there is increasing demand for wellness infrastructure that goes beyond resource-based therapies (Bočkus et al., 2024).

Spa and wellness tourism is expanding in Eastern Europe, with Poland already positioned in this niche (Yonov, 2024). Though the Covid-19 pandemic caused a temporary decline, by 2022, client numbers had rebounded to 2019 levels. Spa hospitals now serve both insured and commercial clients, with the latter group—particularly seniors—steadily growing (Urbas, 2023). A German study indicated a strong preference among seniors for seaside spas (Diller et al., 2023), suggesting Polish coastal resorts may attract similar interest. According to Dryglas and Różycki (2016), both commercial and public clients value natural resources, but non-commercial users especially appreciate contact with nature. Demand is increasingly driven by a desire to restore mental wellbeing (cf. De Vries et al., 2013; Dzhambov et al., 2021; Wang et al., 2019), a trend reinforced during the pandemic (Global Wellness Institute, 2021; Venter et al., 2021).

2.4. Impact of Climate Change

Climate change impacts on coastal regions can be assessed from two temporal perspectives: current phenomena and future projections. Along the Polish Baltic coast, the observed effects are already significant. Sea levels have been rising by 3–4 mm per year since 1995, with faster increases in the east (Tomczyk & Bednorz, 2022). Although the frequency of storms has not changed markedly, storm surges have intensified

due to higher sea levels, accelerating coastal retreat and threatening spa infrastructure (Soomere, 2024; Styszyńska et al., 2018).

Other hydrometeorological extremes affecting the region include high and low sea levels, windstorms, extreme waves, heavy rainfall, ice ridging, drought, and sea-effect snow (Rutgersson et al., 2021). Air and sea surface temperatures are also increasing, particularly in winter and spring. These trends contribute to harmful algal (cyanobacteria) blooms, which can release toxins and degrade bathing water quality, posing health risks and undermining spa attractiveness (Błaszczyk et al., 2021; Ibelings et al., 2016; Kownacka et al., 2021; Munkes et al., 2021).

Rising summer temperatures also increase heat stress, particularly for vulnerable groups such as the elderly and people with cardiac conditions (Błażejczyk & Kunert, 2011; Matthies & Menne, 2009). However, fluctuations in temperature, humidity, and wind limit the predictability of this risk (Kuchcik et al., 2021). The sea breeze and surrounding greenery in coastal resorts help mitigate heat stress effects (Dailidė et al., 2022; Wong et al., 2021).

Warming also affects snow cover duration and Baltic Sea ice extent (Styszyńska et al., 2018), contributing to hydrological drought and threatening ecosystems like peatlands and urban greenery (Choat et al., 2018; Minick et al., 2019). Although coastal medicinal water intakes are generally safe due to their depth (Davie, 2019; Polish Geological Institute – National Research Institute, 2024), long-term protection remains necessary.

Looking ahead, SLR is one of the most certain consequences of climate change. Even under low-emission scenarios, thermal inertia ensures a continued rise. In a high-emission SSP5–8.5 scenario, global sea levels could rise by 0.63–1.01 m by 2100, with 2 m possible under a 1.5 °C warming and over 5 m under 2 °C (IPCC, 2023). The regional SLR will likely reach about 87% of the global mean, though local factors—e.g., land subsidence, coastal morphology—create variation and uncertainty (Cazenave & Cozannet, 2014; Griggs & Trenhaile, 1994; Meier et al., 2022).

Additional projections include more frequent summer droughts in the southern Baltic basin and long-term ecosystem restructuring driven by rising sea temperatures (Meier et al., 2022; Neumann, 2010).

2.5. Formal Conditions for Spa Resilience

The resilience of Polish spa towns is shaped by formal conditions grounded in national legislation and spatial policy. According to the Act of 28 July 2005 on spa treatment, spa status requires the presence of natural resources with proven therapeutic value—specifically mineral waters and a climate with documented health benefits (Sejm of the Republic of Poland, 2005, Art. 34). While urban transformation is allowed, any changes compromising the spa's core functions or natural assets may lead to the loss of this official status.

A key spatial resilience tool is the system of spa protection zones, which integrates therapeutic, environmental, and planning standards (Art. 38). The law defines three zones:

- Zone A: ≥ 65% green space, including treatment facilities;
- Zone B: ≥ 50% green space, allowing limited services and housing;

- Zone C: ≥ 45% biologically active space, focusing on landscape and climate protection.

These zones highlight areas of vulnerability while providing an institutional framework for adaptive capacity through mandated green space preservation.

This legal framework is supported by national and regional climate adaptation strategies, including the Strategic adaptation plan for sectors and areas vulnerable to climate change by 2020 with the prospects until 2030 (Ministry of Environment, 2013), flood risk management plans, drought management plans, retention and water management programmes, and the Maritime Spatial Plan (Council of Ministers, 2021). Under the Water Framework Directive (Commission of the European Communities, 2000), Poland delineates flood risk areas (ARFs) every six years, factoring in climate impacts (Sejm of the Republic of Poland, 2017).

Municipal responsibility for flood and climate risk management has evolved through the Crisis Management Act (Sejm of the Republic of Poland, 2007) and more directly via the Water Law (Sejm of the Republic of Poland, 2017). A major change came with the Act of 27 November 2024, which mandates climate adaptation plans (CAPs) for all towns over 20,000 residents by 2028 (Sejm of the Republic of Poland, 2024, Art. 96a), with updates every six years.

Among coastal spas, this requirement applies to Sopot, Świnoujście, and Koszalin, though several smaller towns have voluntarily begun developing a CAP with EU and national support.

Despite this framework, small and medium-sized coastal spas remain under-analysed in climate adaptation literature. Their dual vulnerability—social (patient demographics) and environmental (SLR, eutrophication, microclimate loss)—is rarely addressed through integrated, local-scale assessments that combine zoning, spatial structure, and risk modelling.

3. Methodology and Scope of the Study

The study used a multi-criteria analysis approach combining spatial, environmental, and socio-economic factors to assess the resilience of selected Baltic Sea resorts in the context of climate change. Following the literature review and analysis of the legal conditions described above, case studies were conducted. The research focuses on centres that currently have official spa status under Polish law: Świnoujście, Kamień Pomorski, Kołobrzeg, Dąbki, Ustka, and Sopot. The factors considered can be divided into three groups: development prospects, internal spatial specificity, and risk exposure.

Each case study is introduced with a description of its location within the region (based on scientific literature, strategic documents, and the authors' own research) and a presentation of the demographic situation showing the population of the town in 2023 and its change over the decade—the data comes from the Local Data Bank of the Central Statistical Office (GUS, 2024). The exception here is Dąbki, for which, due to its lack of municipality status, data were available for 2021, but the description was supplemented with a comparison for the municipality analogous to other cases.

Next, based primarily on a monographic publication by Węcławowicz-Bilska (2021), the historical context of the health resort is presented, supplemented with data on accommodation in tourist facilities and their

seasonality, as well as changes in these figures over a decade (GUS, 2024). Against this background, the number and change in the number of places in health resort facilities (GUS, 2024) are also shown.

The description is accompanied by information on the type of medicinal mineral and the ownership status of the health resort complex (Ministry of Health, 2024).

The above information is supplemented with data on current threats to the status of the health resorts, which come from health resort reports prepared for individual health resorts.

The case studies also include a spatial analysis showing the projected threats to the basic and key complementary elements of the spatial structure of health resorts coming from the sea.

The group of basic components includes the locations of medicinal mineral deposits and health resort protection zones (A, B, and C)—spatial data for both were obtained from the Polish Geological Institute – National Research Institute (2024). Key complementary elements are phenomena whose occurrence is not required by the status of a health resort, but other forms of protection confirm their special significance for the identity of the health resort. These include:

- Areas covered by forms of nature protection—spatial data obtained from the Central Register of Forms of Nature Protection maintained by the General Directorate for Environmental Protection (2024);
- Heritage conservation areas—spatial data obtained from the Zabytek.pl portal maintained by the National Heritage Institute (NID, 2024).

The spatial analysis covered three areas: (a) the extent of ARF; (b) a scenario of a 1-m SLR (SLR 1 m); and (c) a scenario of a 5-m SLR (SLR 5 m).

The ARF boundaries were derived from the National Defence Information System (ISOK) and were determined according to the following criteria: hydrography; topography; land use; description of historical floods; assessment of the potential negative effects of future floods; and forecast of long-term changes, in particular the impact of climate change on the occurrence of floods—based on the percentage change in Q90 flow intensity in the RCP 4.5 and RCP 8.5 scenarios for 2050 (Państwowe Gospodarstwo Wodne Wody Polskie, 2018).

Two further scenarios were based on the high-emission SSP5–8.5 scenario IPCC: SLR 1 until around 2100 and SLR 5 in the case of a 2 °C temperature increase.

Due to uncertainty about the progress of mitigation measures and the dynamics of the phenomenon, the authors did not specify a specific time horizon; the scenarios illustrate the direction of the phenomenon's development within the local area. The scope of the simulation covers a buffer zone of 500 m from the border of the health resort area (i.e., outside the health resort).

The study also examined the presence and scope of the CAPs in each municipality, assessing their compatibility with the resilience needs of the health resorts.

The results of the case studies, supplemented by the issues discussed horizontally in the introduction and conceptual framework, were used to formulate conclusions.

4. Case Studies

As mentioned, the following case studies cover all Polish coastal towns with spa status, which represent a wide range of development conditions. To begin with, a summary of the basic data is provided (Table 1), along with a presentation of their population size (Figure 1) and its changes (Figure 2) against the backdrop of the settlement structure.

Table 1. Basic information about the spas that were surveyed.

	Świnoujście	Kamień Pomorski	Kolobrzeg	Dąbki	Ustka	Sopot
Population (2023)	38,904	8,291	43,426	308 (2021)	13,722	31,903
Port	+	+	+	–	+	–
Number of places in spas (2023)	1,237	614	6,692	1,311 (Commune)	374	647
Number of peloid deposits	1	1	1	1	0	0
Number of medicinal (brine) water deposits	3	1	5	0	1	1
Number of spa faculties	10	11	5	6	7	6

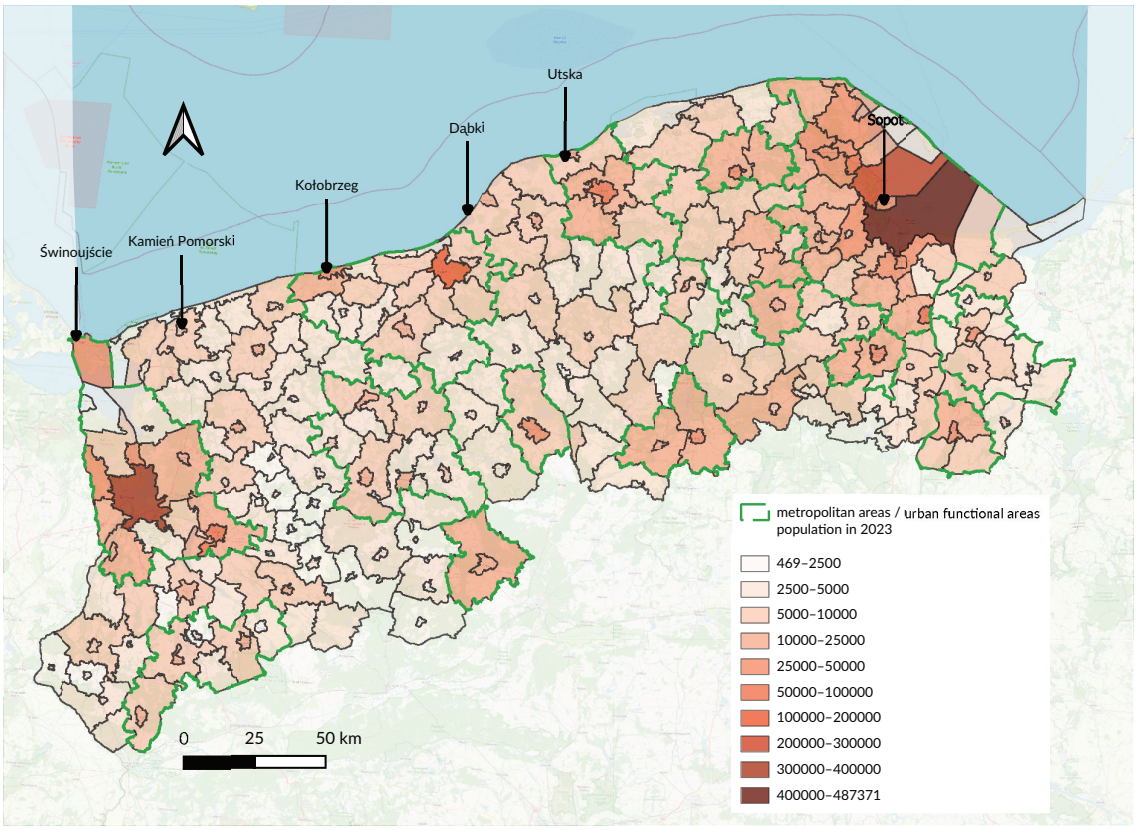


Figure 1. Seaside spa resorts against the backdrop of the settlement network of northern Poland (population as of 2023). Source: Based on data from GUS (2024); OpenStreetMap.

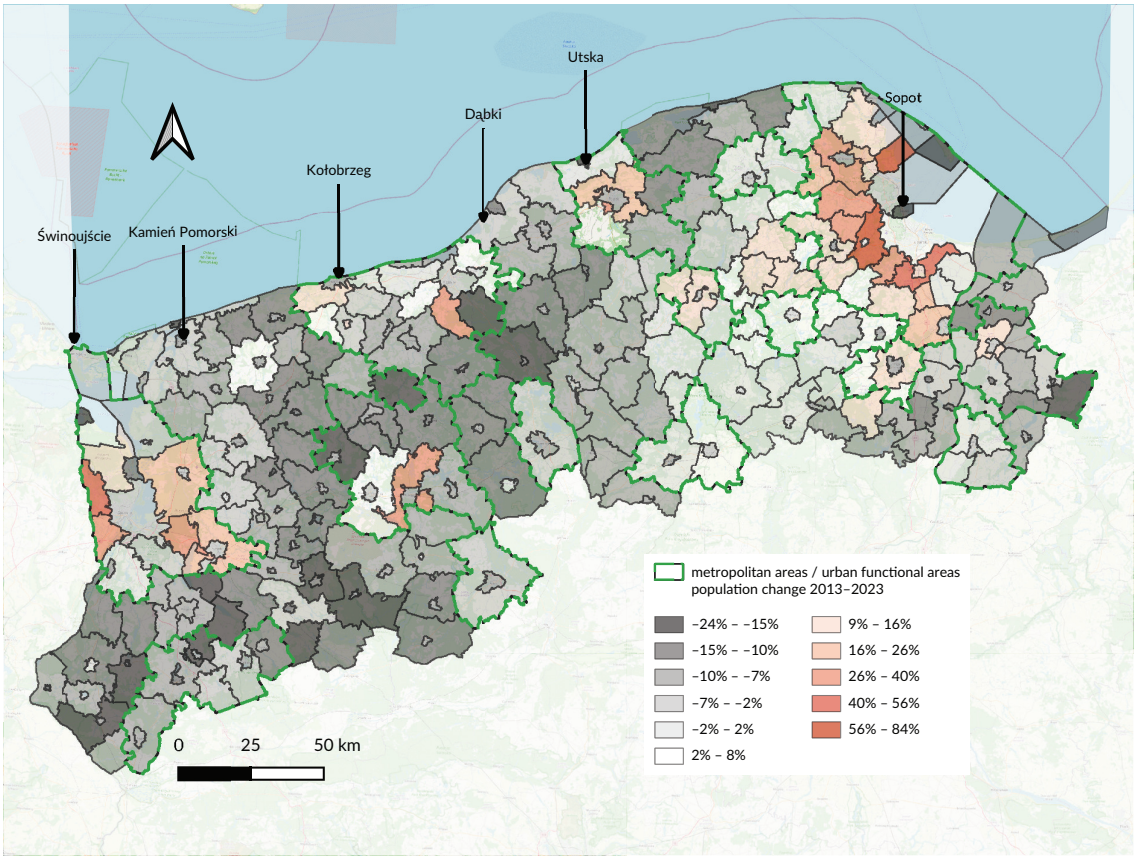


Figure 2. Seaside spas against the backdrop of the settlement network of northern Poland (population change between 2013 and 2023). Source: Based on data from GUS (2024); OpenStreetMap.

Świnoujście is a border city-archipelago on the Świna Strait and the Baltic Sea, encompassing 44 islands, with most urban functions concentrated on three. It is part of the Szczecin Metropolitan Area and forms a segment of a cross-border spa-resort conurbation including Kamień Pomorski, Dziwnówek, Międzywodzie, Ahlbeck, and Heringsdorf (Węcławowicz-Bilska, 2021). The city had 38,904 residents in 2023—a decline of 5.96% over the past decade (GUS, 2024). Its economy is driven by the Szczecin–Świnoujście Port Complex, Poland's third-largest seaport (GUS, 2024).

Established as a resort in 1824 and a spa in 1895 following the discovery of brine and peloid resources, Świnoujście retains traces of its historical spa identity through the spatial layout and large historic parks, despite extensive wartime destruction (Węcławowicz-Bilska, 2021).

Świnoujście stands out among Polish coastal destinations for its year-round readiness. In 2023, 84.5% of accommodation places were operational year-round—8,965 year-round spots (+30.8% since 2013) versus 2,589 seasonal (+8.1%). Spa infrastructure includes 1,237 spa beds (+41.7% over the decade). The city holds three deposits of medicinal water and peloids. Zone A lies adjacent to the seashore. A 2010 privatisation attempt of the spa hospital was blocked by union and government resistance, resulting in a regional takeover.

A 2023 spa report identifies several threats to spa status. Non-climate-related risks include traffic noise (not in Zone A) and air pollution—e.g., benzo(a)pyrene from outdated heating systems and elevated ozone levels

linked to weather, transport, and regional pollution influx. Water quality also poses a risk: The Szczecin Lagoon is eutrophic, worsened by nutrient flows from the Oder River and local pollution sources (Municipality of Świnoujście, 2023).

Climate-related hazards include forest fires (due to extensive forest cover) and flooding, which affects parts of the city—minimally in Zone A. The 1-m SLR scenario would not endanger Zone A aside from beach loss, but parts of the harbour and southern Zone C (allotment gardens) would be inundated. A 5-m SLR would devastate the city (Figure 3).

ARFs overlap with recreational areas along the coast (including Natura 2000 sites), parts of all spa zones, and areas near medicinal water intakes (Figure 3). A CAP, adopted in 2023, focuses on thermal risk reduction through urban greening but omits SLR scenarios.

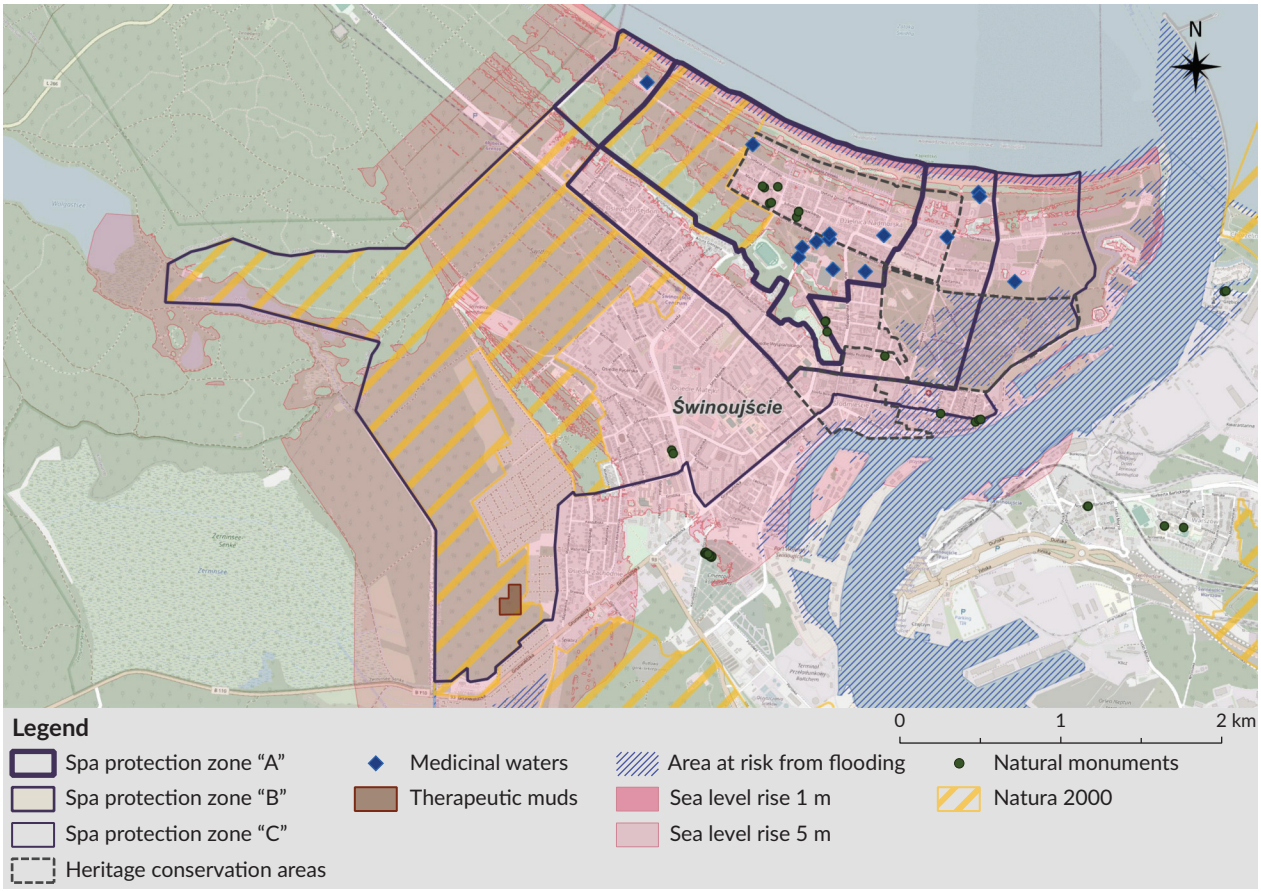


Figure 3. Simulation for Świnoujście.

Kamień Pomorski lies in the floodplain of the Dziwna Strait, which forms the Kamieński Lagoon. It is part of a cross-border spa-resort corridor extending towards the German Basin (Węcławowicz-Bilska, 2021), but is less connected to major urban centres than Świnoujście. In 2023, the town had 8,291 residents—a decline of 8.59% over the decade. The surrounding rural area (population 5,140) also saw a decline of 5.41% (GUS, 2024).

Although the town dates to the 12th century (Stępiński, 1975), its spa function emerged in the late 19th century. Following a 60% wartime destruction (Kwilecki, 1979), it retains average cultural value

(Węcławowicz-Bilska, 2021), with the Old Town—coinciding with Zone A—being its most historically significant area.

Kamień Pomorski's tourism offer is oriented towards year-round visitors. In 2023, 91.2% of accommodations were available year-round (685 places, +11.9% over the decade), while seasonal places reached 66 (+66.7%). The town had 614 spa beds in 2023—a 41% increase since 2013 (GUS, 2024).

Within the town limits are an exploited mud deposit and a medicinal water deposit, now mostly under private ownership since 2021.

Key threats to spa continuity include dispersed urban development and anthropopressure on ecologically sensitive areas. Fragmentation of ecological corridors and unchecked tourism in protected zones contribute to environmental degradation. Intensive agriculture also threatens groundwater quality through nutrient runoff. Much of Zone A lies in a flood risk area, where reduced river catchment capacity—due to urbanisation—exacerbates flooding (Municipality of Kamień Pomorski, 2018).

The spatial analysis confirms that both Zone A and large portions of the town fall within the ARF, including peatlands in Zone C. A January 2025 storm surge cut off Chrząszczewska Island in Zone C (Kraśnicki, 2025). A 1-m SLR closely matches current ARFs, while a 5-m SLR would likely destroy the town (Figure 4).

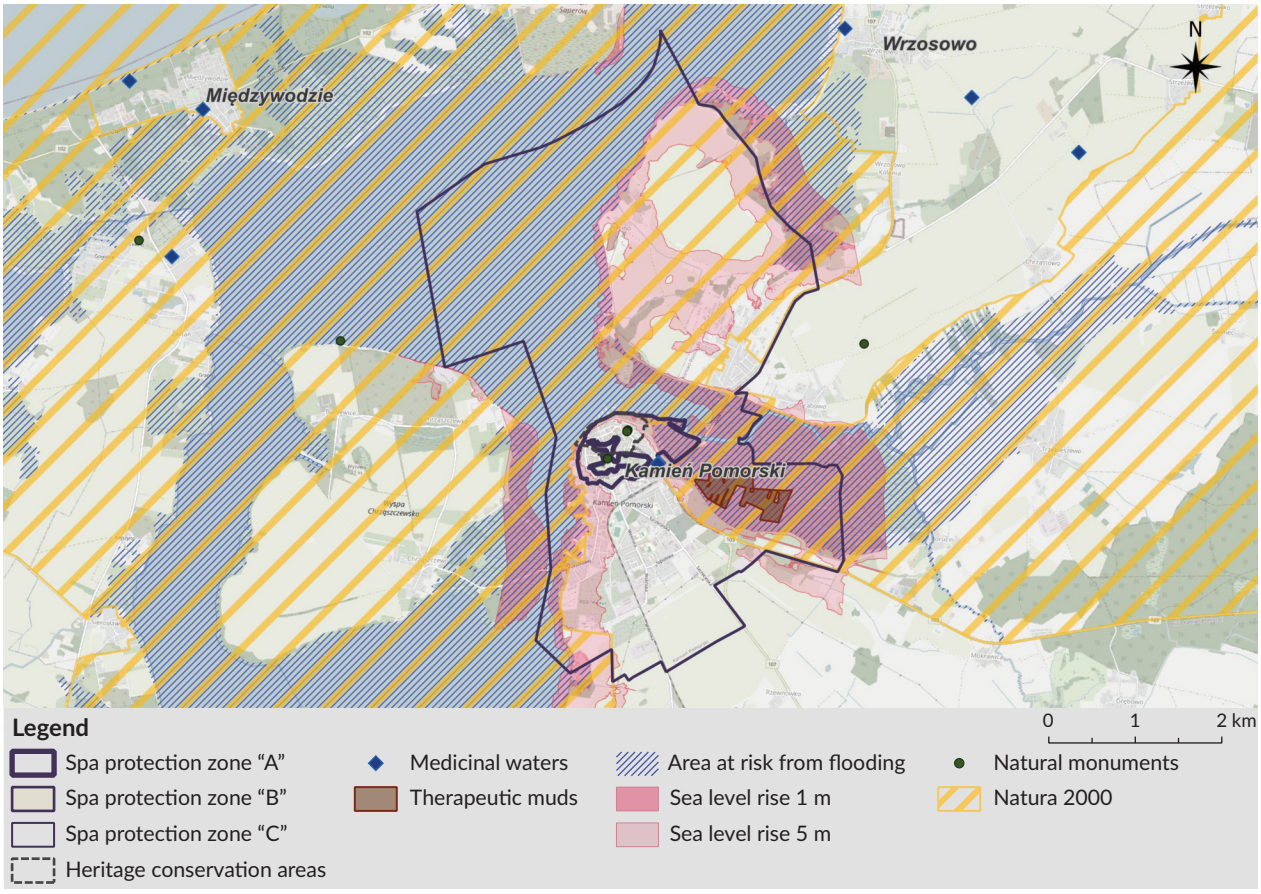


Figure 4. Simulation for Kamień Pomorski.

Kamień Pomorski lacks a citywide climate adaptation plan but began a pilot project in 2024—the Adaptation of the Urbanised Areas of the Municipality of Kamień Pomorski to Climate Change project—focussed on improving microclimates in key public spaces via blue-green infrastructure.

Kołobrzeg is part of the central southern Baltic spa and resort agglomeration and is functionally linked to nearby Koszalin. In 2023, it had 38,904 residents, a decline of 5.96% over the past decade (GUS, 2024).

While Kołobrzeg dates back to the Middle Ages, spa development began in the early 19th century. Due to wartime destruction, it is considered to have medium cultural value (Węcławowicz-Bilska, 2021). The city includes Natura 2000 sites, a protected landscape area, and monumental trees.

Kołobrzeg's tourism offer is strong year-round. In 2023, 84.5% of its accommodation was year-round (8,965 places, +30.8% over the decade), while its seasonal beds fell by 40.5% to 2,589. Spa capacity reached 6,692 beds in 2023—a 13% increase since 2013. The spa includes one peloid intake and five medicinal water deposits. Attempts to privatise the health resort were blocked, and it remains publicly managed (GUS, 2024).

Challenges to spa continuity include urbanisation pressure, air pollution during the heating season, and traffic noise in Zone A. Additionally, nutrient loads from the Parsęta River contribute to eutrophication (Municipality of Kołobrzeg, 2023).

The ARFs are concentrated near the Parsęta River and touch the eastern edge of Zone A, which includes valuable peatlands and marshes. These areas are relatively undeveloped and distant from key public spaces. A 1-m SLR would result in substantial flooding, particularly in eastern Zone A and along the river. A 5-m SLR scenario would nearly destroy the city, sparing only a small enclave in the historic centre (Figure 5).

Although Kołobrzeg lacks a CAP, the Smart City strategy adopted in 2021 includes plans for such a document and a retention scheme, though neither has yet been implemented (Municipality of Kołobrzeg, 2021).

Dąbki is a village in the Darłowo commune, with a population of 308 in 2021. The wider municipality had 7,596 residents in 2023, down 5.4% over the decade (GUS, 2024). Located far from major cities, Dąbki is part of a string of coastal spa and resort towns.

It is the youngest of the Polish seaside spas, having developed only in the late 20th and early 21st centuries (Węcławowicz-Bilska, 2021). Traces of local history remain in four preserved fishing huts. The town's defining feature is the narrow strip of land between the Baltic Sea and Lake Bukowo, where most of Zone C lies. The area includes Natura 2000 sites, a protected landscape area (covering Zones A and B), and a group of natural monuments near the spa.

Tourism in the Darłowo commune remains highly seasonal. In 2023, seasonal accommodation reached 4,532 beds (a 30.2% decrease over a decade), while year-round beds increased by 81.2% to 1,066. Spa capacity grew by 145%, reaching 1,311 beds (GUS, 2024).

The resort is publicly owned, with confirmed peloid therapeutic properties and recent investments from local and state budgets.

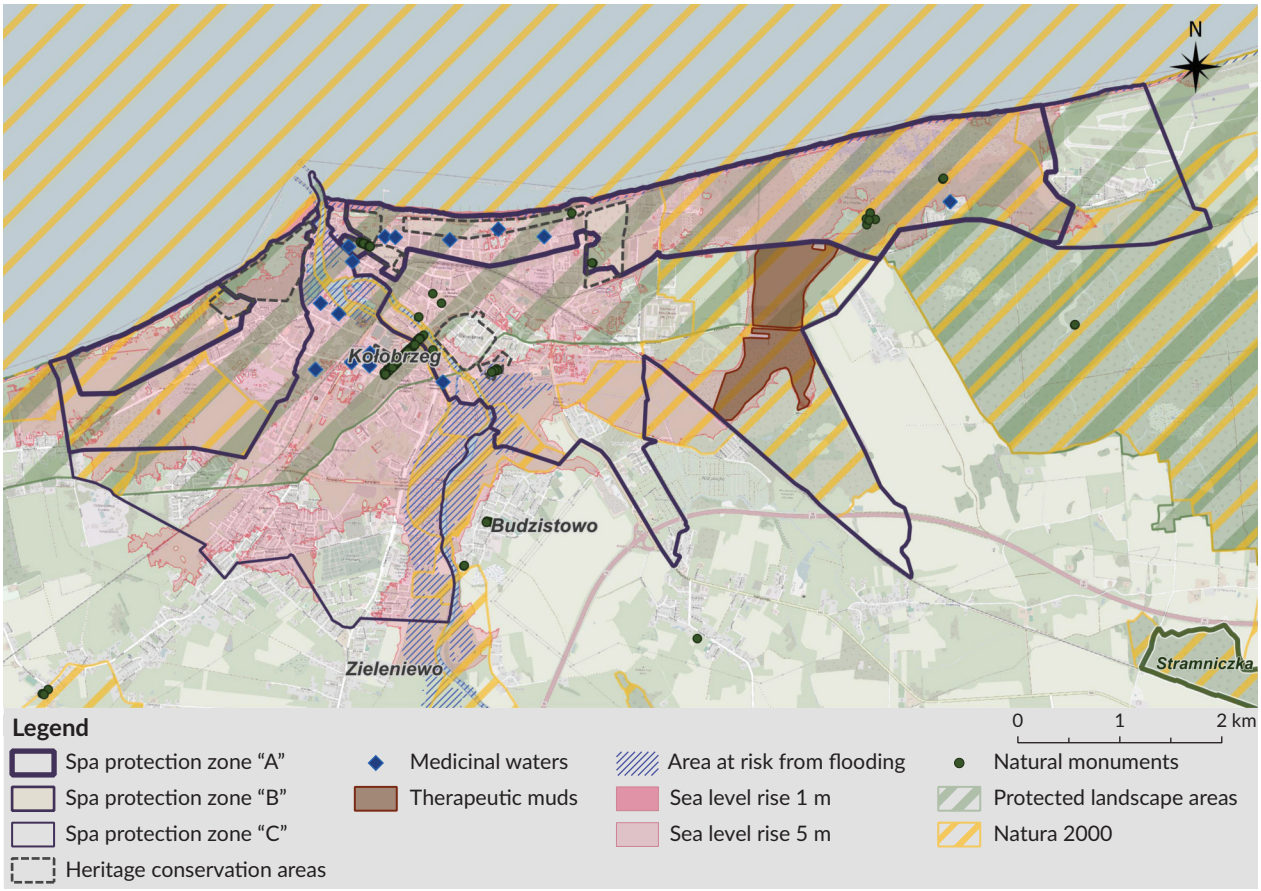


Figure 5. Simulation for Kołobrzeg.

The 2017 spa report highlights traffic noise in Zone A and air quality concerns. Dąbki is also highly vulnerable to flooding (Commune of Darłowo, 2017). Due to its low elevation between the sea and the lake, the ARF includes all of Zone A, most of Zone B, and large parts of Zone C—encompassing public spaces, spa facilities, and the mud deposit. Even with a 1-m SLR, much of the area would be submerged (Figure 6).

As of 2025, the Darłowo commune lacks a CAP.

In 2023, Ustka had 13,722 residents, a 15.6% decline over the decade. The surrounding rural municipality recorded a population of 8,026, with minimal growth (+0.12%; GUS, 2024). Ustka is part of the Słupsk Urban Functional Area, which had 160,588 residents in 2020, reflecting a 1.3% population decline since 2011 (Strategy 2022–2030). In addition to its spa, Ustka's economy is supported by a seaport and associated industries.

Spa development began in the early 20th century and accelerated post-1950s. The town is considered to have average cultural value (Węcławowicz-Bilska, 2021). Tourism remains highly seasonal: in 2023, seasonal places reached 5,327 (+8% over a decade), while year-round places rose by 34% to 2,933. In 2023, Ustka offered 374 spa beds—a 45% decline from 2013, with a 55% drop between 2019 and 2021.

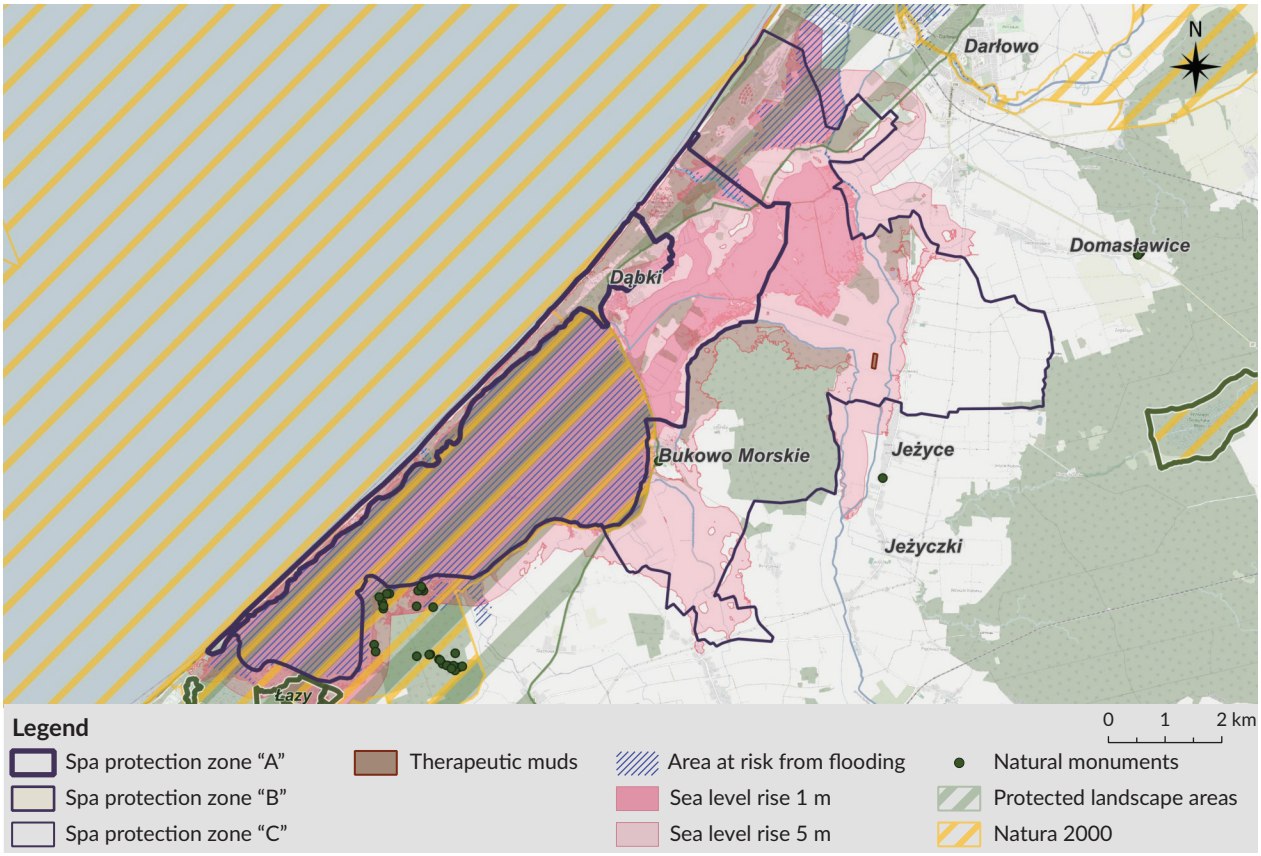


Figure 6. Simulation for Dąbki.

The primary spa resource is medicinal water. After partial privatisation in 2010, the spa has operated as a private entity with ongoing infrastructure investment.

Key threats include investment pressure and traffic noise, both affecting Zone A (Municipality of Ustka, 2008). ARF is concentrated along the coast, covering parts of all zones, including the promenade (Zone A) and harbour quays (Zone C). While a 1-m SLR affects only a narrow coastal strip (largely overlapping with ARF), widening the Słupia River estuary could flood ecologically valuable areas in Zone C. A 5-m SLR would inundate much of Zone C, reaching areas near the spa's water intake at the Zone A boundary (Figure 7).

Ustka adopted a CAP in 2020 (horizon: 2030), aimed at increasing the resilience to heavy rainfall, flooding, and drought. Measures include a monitoring system, emergency service planning, reconstruction of the harbour entrance, and the construction of open reservoirs.

Sopot lies within a major spa and resort corridor (Węcławowicz-Bilska, 2021) and, despite its small size, plays an outsized role due to its position in the Tri-City metropolitan area (Lorens & Golędzinowska, 2022). The spa established in the early 19th century was the catalyst for the city's development (Stankiewicz & Szermer, 1959) and holds high cultural value (NID, 2024; Węcławowicz-Bilska, 2021). Almost all of Zone A is protected as an area monument. Natural assets are extensive, including monumental trees (all zones), a nature reserve (Zone C), and part of the Tri-City Landscape Park (Zones A2 and C).

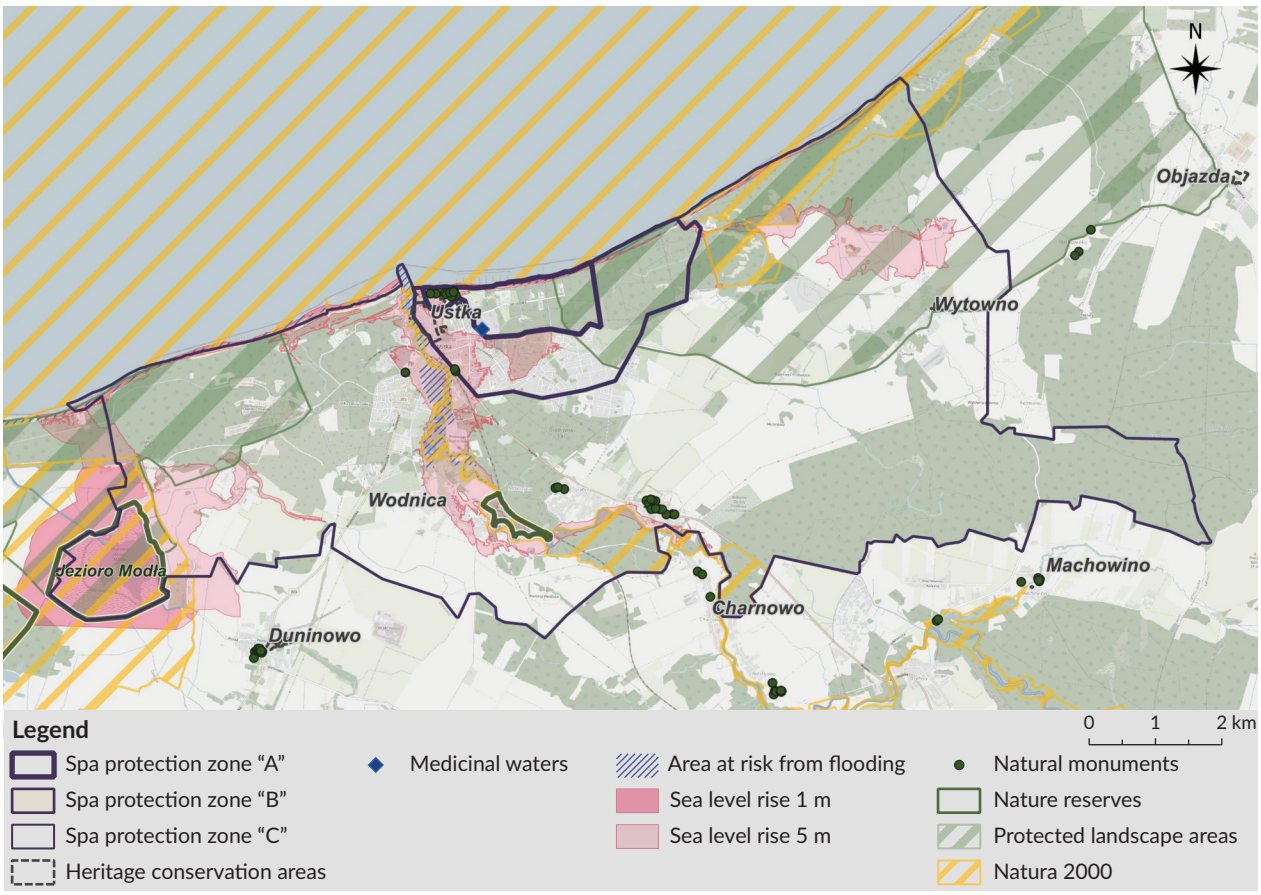


Figure 7. Simulation for Ustka.

In 2023, Sopot had 31,903 residents—a 15.8% population decline over the decade (GUS, 2024). In contrast, the broader metropolitan area, including Gdańsk (pop. >1.6 million), is growing (Obszar Metropolitalny Gdańsk-Gdynia-Sopot, 2024).

The city's tourism figures are difficult to assess directly due to the proximity of Gdańsk and Gdynia. In 2023, 75% of tourist beds were available year-round (4,837, +47.4% since 2013), while seasonal beds rose dramatically to 1,657 (a 1,690% increase from zero). The number of spa beds rose slightly to 647 (+2%; GUS, 2024).

The city has one medicinal water intake, located in Zone A1 by the coast, while Zone A2 lies in forested uplands. The health resort remains city-owned. Between 1997 and 2009, major upgrades were completed via a public–private partnership.

Key risks include traffic noise in Zone A1 (LEMITOR Ochrona Środowiska, 2022) and cyanobacterial blooms, exacerbated by summer warming and nutrient inflows (Błaszczyk et al., 2021; Municipality of Sopot, 2020). Although the storm risk is low, Sopot faces future SLR. A 1-m SLR would impact only the beach area, but a 5-m SLR would submerge Zone A1 and much of Zone B, including historic areas. Zone A2 would remain unaffected due to its elevation (Figure 8).

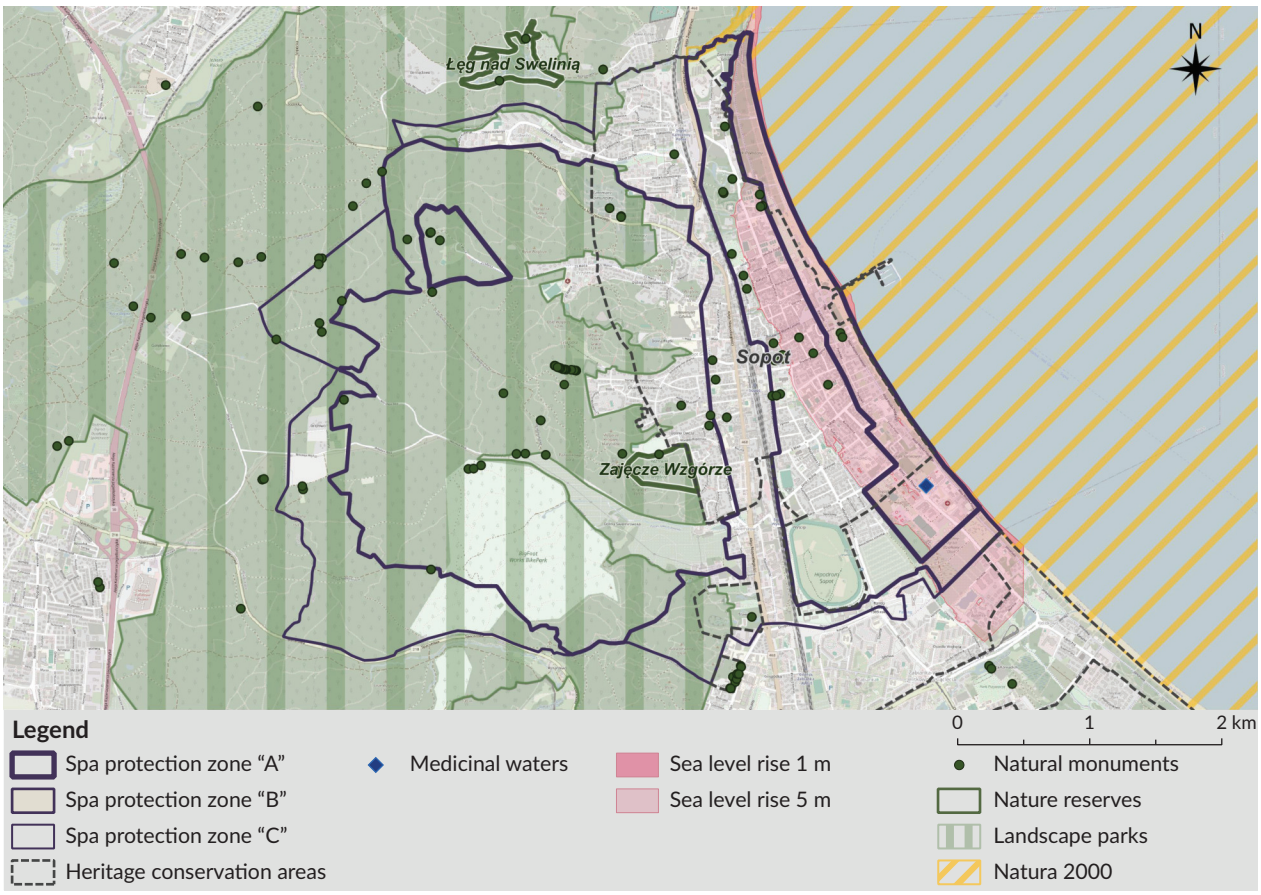


Figure 8. Simulation for Sopot.

Sopot's CAP (horizon: 2030) includes both organisational and infrastructural measures: dune reinforcement, climate monitoring, service coordination, and planning document updates. Notably, it is the only spa to consider decommissioning infrastructure in future risk zones.

In summary, certain characteristics, such as population loss, are horizontal for all the studied centres, even though there is significant variation in several other factors, including development prospects, internal specificity, and identified threat areas. The following table lists the most important features for each centre (Table 2).

Table 2. Summary of the case studies.

Spa locality	Key conditions		Exposure risk (ARF/SLR)	CAP
	Development prospects	Internal spatial specificity		
Świnoujście	strong port economy metropolitan area	historic spa parks, multiple brine/mud deposits poor air quality moderate cultural and natural values	moderate ARF risk minor flooding in Zone A (SLR 1m) catastrophic SLR 5m scenario	adopted (2023), lacks SLR response
Kamień Pomorski	small town; some private investment moderate tourism growth	Old Town overlaps with Zone A moderate cultural and natural values	extensive ARF and SLR 1m exposure (esp. Zones A & C) high risk of ecosystem fragmentation catastrophic SLR 5m scenario	partial, via blue-green infrastructure project
Kołobrzeg	high year-round tourism functional urban area	extensive spa infrastructure poor air quality moderate cultural and high natural values	ARF risk near the Parsęta River mud deposit at risk with SLR 1m catastrophic SLR 5m scenario	Smart City strategy (2022), no CAP yet
Dąbki	peripheral; high seasonal fluctuation significant increase in spa beds	unique spit-land setting between sea and lake poor air quality low cultural but high natural values	Zone A almost fully within ARF heavy flood risk even with SLR 1m catastrophic SLR 5m scenario	no CAP; high priority for protection
Ustka	moderate development of tourist and spa function functional urban area	spa facility under private ownership noise moderate cultural and natural values	ARF overlaps key spa zones SLR 1m threatens coastal facilities severe SLR 5m scenario	adopted (2020) with a long-term focus
Sopot	highly valued spa and wellness tourism metropolitan area	dual Zone A structure includes resilient forested areas (Zone A2) noise high cultural and natural values	ARF minimal SLR 1m minor effect on beach severe SLR 5m scenario (A2 stays intact)	comprehensive CAP to 2030 includes SLR and decommissioning scenarios

5. Discussion

The results of the analyses contribute to a broader body of research on the resilience of local communities and urban systems under pressure from climate change and other anthropogenic factors. In this context, coastal spas demonstrate a degree of infrastructural and functional resilience, particularly in their ability to maintain both core and ancillary spa services (Konecka-Szydłowska, 2018). This discussion critically reflects on these findings, especially regarding the specific climate-related challenges faced by spas and their potential adaptation strategies.

Although the scientific consensus on climate change is strong, projections regarding localised long-term impacts remain uncertain due to the complexity of climatic interactions (Meier et al., 2022; Styszyńska et al., 2018; Zscheischler et al., 2018). Some studies suggest that certain regions of Europe may experience fewer adverse weather days, potentially enhancing tourism and lengthening the spa season (Djordjevic et al., 2016; Rosselló-Nadal, 2014). However, given the vulnerability of natural spa assets and infrastructure, this scenario requires cautious interpretation.

Importantly, the study confirms that environmental quality issues—independent of climate change—already threaten the status of health resorts. This underscores the importance of proactive adaptation, which can be framed through the lens of a triple dividend of resilience approach (Heubaum et al., 2022). This model highlights:

- First dividend: avoided climate-related losses;
- Second dividend: induced economic and development benefits;
- Third dividend: social and environmental gains from resilience-building—including the resolution of existing structural or environmental issues.

Notably, the second and third dividends occur regardless of whether projected climate impacts materialise, reinforcing the value of investing in adaptation.

To guide implementation, adaptation measures can be structured across three planning horizons (see Supplementary File):

- Up to 2034 (short-term);
- Up to 2050 (mid-term);
- Up to 2150 (long-term), with flexibility to extend the timeline as new information emerges.

Despite negative demographic trends—most pronounced in Sopot—the spa towns analysed retain a strong, well-established resort image that continues to attract both visitors and investors. In some cases, economic resilience is bolstered by structural advantages, such as large-scale port operations (e.g., Świnoujście) or proximity to metropolitan cores (Świnoujście, Sopot), which help buffer fluctuations in the tourism sector (Szymańska & Wiśniewska, 2022).

Importantly, local and regional actors have, in several instances, successfully resisted the privatisation of spa infrastructure. As a result, four of the six spas remain publicly owned, reinforcing community influence over

strategic assets. In all cases, the local tourism economy continues to benefit from cultural and natural values linked to spa specialisation. Strengthening resilience, therefore, requires not only protecting these assets but also empowering local authorities to lead coordinated adaptation efforts that include private stakeholders.

The CAPs currently in place prioritise issues such as flood control, stormwater retention, monitoring, and microclimate regulation, which is consistent with national guidelines and their shared 2030 time horizon (Ministry of Environment, 2017). Among them, Sopot's CAP stands out for adopting long-term, strategic goals: protecting and restoring coastal dunes, revising spatial plans, and prohibiting development in high-risk flood zones. Research suggests that coastal protection strategies aimed solely at land preservation often prove ineffective in the long term (Łabuz, 2013).

Despite their limitations, the current CAPs place appropriate emphasis on blue-green infrastructure, which is critical in spa towns where high proportions of green space contribute to microclimatic stability. However, many spa zones also contain extensive sealed surfaces (e.g., roads, harbour areas), reducing adaptive capacity. Increased urbanisation and rising temperatures may undermine the natural heat balance mechanism provided by sea breezes—once a major locational advantage (Xie et al., 2023).

Although the current 1-m SLR scenarios do not critically affect the core spa functions in most towns, they do pose risks to essential public infrastructure—promenades, waterfronts, and harbour basins. In contrast, a 5-m SLR would result in the wholesale transformation of water systems and ecosystems (IPCC, 2023; Meier et al., 2022), moving the issue beyond resilience and into the realm of transformability—the capacity to build a new system when the existing one becomes unsustainable (Walker et al., 2004).

6. Conclusions

When analysing the socio-economic determinants of spa resilience, it is important to emphasise that spa accommodation constitutes only a portion of the overall tourism base, with its significance varying by location. In four of the six cases studied, strong local and regional opposition successfully halted privatisation, ensuring continued public ownership of key spa assets. These centres benefit not only from cultural and natural heritage but also from their distinct spa specialisation. Local authorities thus have a dual responsibility: implementing adaptation strategies and coordinating broader resilience-building processes in collaboration with private actors.

This study confirms that all Polish Baltic spa towns are already experiencing environmental quality issues and face a range of climate-related risks. However, the scale and nature of these threats vary based on the location, degree of urbanisation, and local governance structures. While demand for spa services is rising, delays in infrastructure modernisation and environmental pressures necessitate corrective actions, many of which can double as climate adaptation measures.

The spa protection zone framework (Zones A, B, and C) offers a spatial basis for adaptation. Yet, enforcement and flexible management remain inconsistent or outdated. Future CAPs should prioritise preserving and enhancing spa and health-promoting functions—assets closely tied to local identity and less dependent on seasonal tourism. These also enable more efficient infrastructure use throughout the year.

The immediate planning priority is to ensure that local spatial development plans comprehensively cover spa areas and (a) prohibit development in flood-prone areas, (b) control chaotic urbanisation that erodes cultural identity and adaptive capacity, and (c) reserve land for alternative public uses and spa infrastructure.

This is particularly urgent for Dąbki; in the long term, all centres should establish spatial reserves—except for Sopot, which already benefits from the elevated and resilient A2 zone surrounded by protected forest.

In terms of organisational measures, efforts must target the reduction of eutrophication, both regionally and locally, to mitigate annual cyanobacteria blooms, while improving air quality and noise reduction should also be prioritised in Świnoujście, Kołobrzeg, Dąbki, Ustka, and Sopot.

This study provides an outline of the problem. Further research is needed at different scales. The first is the in-depth modelling of local phenomena for the development of specific centre policies. This group includes issues such as changes in the healing properties of the climate, changes in the microclimate, the vulnerability of green areas to hydrological drought, and the projected impact of storm surges on specific parts of a locality after SLR. Another scale involves analysing and forecasting phenomena at a regional level, e.g., the potential development of spa and health tourism over time, and analysing climate change trends. Finally, a further research issue is how to build the resilience of Baltic spas within the framework of national policies or the European Union cohesion policy, and to what extent.

Acknowledgments

Figures 3 through 8 were created by Krystian Leliwa based on the authors' methodology.

Funding

Publication of this article in open access was made possible through the institutional membership agreement between Gdańsk University of Technology – Faculty of Architecture and Cogitatio Press.

Conflict of Interests

The authors declare no conflict of interests.

LLMs Disclosure

ChatGPT and DeepL Write were used for linguistic editing, including shortening the text, and grammar checking. The authors reviewed and corrected the wording where necessary and take full responsibility for the published article.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

References

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, *24*(3), 347–364.

Bachvarov, M. (2006). Spas in Central-Eastern Europe between decline and revitalisation. In M. Smith & L. Onderwater (Eds.), *The transformation of tourism spaces ATLAS Reflections 2006* (pp. 43–51). ATLAS.

Bal, W. (2009). Tożsamość kulturowa kurortów nadmorskich. Przestrzeń inspirująca, wymagające dziedzictwo. *Przestrzeń i Forma*, *12*, 135–152.

Bal, W., & Czalczyńska-Podolska, M. (2020). The stages of the cultural landscape transformation of seaside resorts in Poland against the background of the evolving nature of tourism. *Land*, *9*(2), Article 55. https://doi.org/10.3390/land9020055

Błaszczyk, A., Kobos, J., & Mazur-Marzec, H. (2021). *Letnie zakwity cyjanobakterii w Zatoce Gdańskiej-zagrożenia i nadzieje*. Division of Marine Biotechnology, University of Gdańsk.

Błażejczyk, K., & Kunert, A. (2011). *Bioklimatyczne uwarunkowania rekreacji i turystyki w Polsce*. Instytut Geografii i Przestrzennego Zagospodarowania Im. Stanisława Leszczyckiego PAN. https://rcin.org.pl/igipz/Content/19801/PDF/WA51_39725_r2011-nr13_Monografie.pdf

Bočkus, D., Vento, E., & Komppula, R. (2024). Cross-national analysis of wellness tourism concepts, tourists motivations, and service preferences. In H. Konu & M. K. Smith (Eds.), *A research agenda for tourism and wellbeing* (pp. 157–176). Edward Elgar Publishing. https://doi.org/10.4337/9781803924342.00018

Cazenave, A., & Cozannet, G. L. (2014). Sea level rise and its coastal impacts. *Earth's Future*, *2*(2), 15–34. https://doi.org/10.1002/2013EF000188

Chapin, F. S., III, Robards, M. D., Huntington, H. P., Johnstone, J. F., Trainor, S. F., Kofinas, G. P., Ruess, R. W., Fresco, N., Natcher D. C., & Naylor, R. L. (2006). Directional changes in ecological communities and social-ecological systems: A framework for prediction based on Alaskan examples. *The American Naturalist*, *168*(S6), S36–S49.

Choat, B., Brodribb, T. J., Brodersen, C. R., Duursma, R. A., López, R., & Medlyn, B. E. (2018). Triggers of tree mortality under drought. *Nature*, *558*(7711), 531–539. https://doi.org/10.1038/s41586-018-0240-x

Commission of the European Communities. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Union*, L 327. https://eur-lex.europa.eu/eli/dir/2000/60/oj

Commune of Darłowo. (2017). *Operat uzdrowiska Dąbki*. Unpublished manuscript.

Council of Ministers. (2021). *Rozporządzenie Rady Ministrów z dnia 14 kwietnia 2021 r. w sprawie przyjęcia planu zagospodarowania przestrzennego polskich obszarów morskich* (Dz.U. 2021 poz. 935). https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20210000935

CRFOP. (2024). *Centralny rejestr form ochrony przyrody*. https://crfop.gdos.gov.pl/CRFOP

Dailidė, R., Dailidė, G., Razbadauskaitė-Venskė, I., Povilanskas, R., & Dailidienė, I. (2022). Sea-breeze front research based on remote sensing methods in coastal Baltic Sea climate: Case of Lithuania. *Journal of Marine Science and Engineering*, *10*(11), Article 1779. https://doi.org/10.3390/jmse10111779

Dargacz, J. (2020). *Od Sopotu po Stogi: Początki kąpielisk morskich w okolicach Gdańska (1800–1870)*. Muzeum Gdańska.

Davie, T. (2019). *Fundamentals of hydrology*. Routledge. https://doi.org/10.4324/9780203798942

De Vries, S., Van Dillen, S. M., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science & Medicine*, *94*, 26–33.

Diekmann, A., Smith, M. K., & Ceron, J. P. (2020). From welfare to wellness: European spas at the crossroads. In *Handbook of social tourism* (pp. 108–122). Edward Elgar Publishing. https://doi.org/10.4337/9781788112437.00020

Diller, C., Litmeyer, M. L., & Göbel, J. (2023). Spa towns in Germany. *Erdkunde*, *77*(2), 113–126. https://doi.org/10.3112/erdkunde.2023.02.02

Djordjevic, D. S., Secerov, V., Filipovic, D., Lukic, B., & Jeftic, M. R. (2016). The impact of climate change on the planning of mountain tourism development in Serbia: Case studies of Kopaonik and Zlatibor. *Fresenius Environmental Bulletin*, *25*(11), 5027–5034.

Dryglas, D., & Różycki, P. (2016). European spa resorts in the perception of non-commercial and commercial

patients and tourists: The case study of Poland. *e-Review of Tourism Research*, *13*(1/2). https://scispace.com/pdf/european-spa-resorts-in-the-perception-of-non-commercial-and-2sv9dhrup9.pdf

Dryglas, D., & Smith, M. K. (2023). A critical analysis of how Central European spas create health tourism experiencescapes. *Tourism Planning & Development*, *21*(5), 570–593. https://doi.org/10.1080/21568316.2023.2259357

Dzhambov, A. M., Lercher, P., Browning, M. H., Stoyanov, D., Petrova, N., Novakov, S., & Dimitrova, D. D. (2021). Does greenery experienced indoors and outdoors provide an escape and support mental health during the Covid-19 quarantine? *Environmental Research*, *196*, Article 110420. https://doi.org/10.1016/j.envres.2020.110420

Foley, R. (2016). *Healing waters: Therapeutic landscapes in historic and contemporary Ireland*. Routledge.

Global Wellness Institute. (2021). *The Global Wellness economy: Looking beyond COVID*. https://globalwellnessinstitute.org/wp-content/uploads/2021/11/GWI-WE-Monitor-2021_final-digital.pdf

Goldstein, B. E., Wessells, A. T., Lejano, R., & Butler, W. (2015). Narrating resilience: Transforming urban systems through collaborative storytelling. *Urban Studies*, *52*(7), 1285–1303.

Gorczyca, M. (2024). Jakość powietrza w uzdrowiskach-stałe przekraczanie norm zanieczyszczeń. *Kontrola Państwowa*, *69*(5), 67–81. https://doi.org/10.53122/ISSN.0452-5027/2024.1.32

Griggs, G. B., & Trenhaile, A. S. (1994). Coastal cliffs and platforms. In C. Woodroffe & R. W. G. Carter (Eds.), *Coastal evolution: Late quaternary shoreline morphodynamics* (pp. 425–450). Cambridge University Press.

GUS. (2024). *Local data bank*. https://bdl.stat.gov.pl/bdl/metadane/cechy/szukaj?slowo=tourism

Heubaum, H., Brandon, C., Tanner, T., Surminski, S., & Roezer, V. (2022). *The triple dividend of building climate resilience: Taking stock, moving forward*. World Resources Institute. https://doi.org/10.46830/wriwp.21.00154

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, *4*, 1–23.

Ibelings, B. W., Fastner, J., Bormans, M., & Visser, P. M. (2016). Cyanobacterial blooms. Ecology, prevention, mitigation and control: Editorial to a CYANOCOST Special Issue. *Aquatic Ecology*, *50*, 327–331. https://doi.org/10.1007/s10452-016-9595-y

IPCC. (2023). Summary for policymakers. In Core Writing Team, H. Lee, & J. Romero (Eds.), *AR6 Synthesis Report: Climate change 2023* (pp. 3–32). Cambridge University Press. https://doi.org/10.59327/IPCC/AR6-9789291691647.001

Kask, T., & Raagmaa, G. (2010). The spirit of place of West Estonian resorts. *Norsk Geografisk Tidsskrift/Norwegian Journal of Geography*, *64*(3), 162–171.

Konecka-Szydłowska, B. (2018). Rozwój małych miast powiatowych województwa wielkopolskiego w ujęciu koncepcji. *Space–Society–Economy*, *2018*(24), 27–44. http://doi.org/10.18778/1733-3180.24.02

Kownacka, J., Busch, S., Göbel, J., Gromisz, S., Hällfors, H., Höglander, H., Huseby, S., Jaanus, A., Jakobsen, H. H., Johansen, M., Johansson, M., Jurgensone, I., Liebeke, N., Kobos, J., Kraśniewski, W., Kremp, A., Lehtinen, S., Olenina, I., v. Weber, M., . . . Wasmund, N. (2021). *Cyanobacteria biomass 1990–2020*. HELCOM. https://helcom.fi/wp-content/uploads/2022/04/BSEFS-Cyanobacteria-biomass-1990-2020.pdf

Kraśnicki, A., Jr. (2025, January 12). Cofka w Zachodniopomorskiem uwięziła na wyspie ponad 200 osób. Takiej wody w regionie dawno nie widziano. *Gazeta Wyborcza*. https://szczecin.wyborcza.pl/szczecin/7,34939,31607632,cofka-w-zachodniopomorskim-uwiezila-na-wyspie-ponad-200-osob.html

Kuchcik, M., Błażejczyk, K., & Halaś, A. (2021). Long-term changes in hazardous heat and cold stress in humans: multi-city study in Poland. *International Journal of Biometeorology*, *65*(9), 1567–1578. https://doi.org/10.1007/s00484-020-02069-7

Kwilecki, S. (1979). Odbudowa zabytków Pomorza Zachodniego po drugiej wojnie światowej. *Ochrona Zabytków*, *1979*(4), 281–287.

Łabuz, T. (2013). *Sposoby ochrony brzegów morskich i ich wpływ na środowisko przyrodnicze polskiego wybrzeża Bałtyku: Raport*. Fundacja WWF Polska.

Langer, P. (2020). Groundwater mining in contemporary urban development for European spa towns. *Journal of Human, Earth, and Future*, *1*(1), 1–9. https://doi.org/10.28991/HEF-2020-01-01-01

LEMITOR Ochrona Środowiska. (2022). *Strategiczna mapa hałasu miasta Sopotu dla dróg, po których przejeżdża ponad 3 000 000 pojazdów rocznie*. https://bip.sopot.pl/api/files/49034

Linkov, I., Bridges, T., Creutzig, F., Decker, J., Fox-Lent, C., Kröger, W., Lambert, J. H., Levermann, A., Montreuil, B., Nathwani, J., Nyer, R., Renn, O., Scharte, B., Scheffler, A., Schreurs, M., & Thiel-Clemen, T. (2014). Changing the resilience paradigm. *Nature Climate Change*, *4*(6), 407–409. https://doi.org/10.1038/nclimate2227

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., Pell, A. N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C. L., Schneider, S. H., & Taylor, W. W. (2007). Complexity of coupled human and natural systems. *Science*, *317*(5844), 1513–1516. https://doi.org/10.1126/science.1144004

Lorens, P., & Golędzinowska, A. (2022). Developing polycentricity to shape resilient metropolitan structures: The case of the Gdansk–Gdynia–Sopot Metropolitan Area. *Urban Planning*, *7*(3), 159–171. https://doi.org/10.17645/up.v7i3.5502

Matthies, F., & Menne, B. (2009). Prevention and management of health hazards related to heatwaves. *International Journal of Circumpolar Health*, *68*(1), 8–12.

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Meier, H. M., Kniebusch, M., Dieterich, C., Gröger, M., Zorita, E., Elmgren, R., Myrberg, K., Ahola, M. P., Bartosova, A., Bonsdorff, E., Börgel, F., Capell, R., Carlén, I., Carlén, T., Christensen, O. B., Dierschke, V., Frauen, C., Frederiksen, M., Gaget, E., . . . Zhang, W. (2022). Climate change in the Baltic Sea region: A summary. *Earth System Dynamics*, *13*(1), 457–593. https://doi.org/10.5194/esd-13-457-2022

Meller, M., & Bernat, S. (2019). Drzewa pomnikowe na terenie uzdrowisk w Polsce. *Sylwan*, *163*(03), 258–264. https://doi.org/10.26202/sylwan.2018104

Minick, K. J., Mitra, B., Noormets, A., & King, J. S. (2019). Saltwater reduces potential CO 2 and CH 4 production in peat soils from a coastal freshwater forested wetland. *Biogeosciences*, *16*(23), 4671–4686. https://doi.org/10.5194/bg-16-4671-2019

Ministry of Environment. (2013). *Strategiczny plan adaptacji dla sektorów i obszarów wrażliwych na zmiany klimatu do roku 2020 z perspektywą do roku 2030* (SPA 2020). https://bip.mos.gov.pl/strategie-plany-programy/strategiczny-plan-adaptacji-2020

Ministry of Environment. (2017). *Podręcznik adaptacji dla miast. Wytyczne do przy gotowania miejskiego planu adaptacji do zmian klimatu*. http://projektymiejskie.pl/wpcontent/uploads/2021/09/podrecznik_adaptacji_dla_miast_20191126.pdf

Ministry of Health. (2024). *Rejestr uzdrowisk*. https://www.gov.pl/web/zdrowie/rejestr-uzdrowisk-i-obszarow-ochrony-uzdrowiskowej-wraz-z-kierunkami-leczniczymi

Municipality of Kamień Pomorski. (2018). *Operat uzdrowiska Kamień Pomorski*. Unpublished manuscript.

Municipality of Kołobrzeg. (2021). *Strategia Smart City miasta Kołobrzeg*. https://bip.um.kolobrzeg.pl/api/files/117528

Municipality of Kołobrzeg. (2023). *Operat uzdrowiska Kołobrzeg*. Unpublished manuscript.

Municipality of Sopot. (2020). *Operat uzdrowiska Sopot*. Unpublished manuscript.

Municipality of Świnoujście. (2023). *Operat uzdrowiska Świnoujście*. https://www.swinoujscie.pl/uploads/files/1/Operat_Uzdrowiskowy_Swinoujscie_listopad_2023_do_druku.pdf

Municipality of Ustka. (2008). *Operat uzdrowiska Ustka*. https://www.ustka.pl/uploads/files/RIE/1_O_Operat.pdf

Munkes, B., Löptien, U., & Dietze, H. (2021). Cyanobacteria blooms in the Baltic Sea: A review of models and facts. *Biogeosciences*, *18*(7), 2347–2378. https://doi.org/10.5194/bg-18-2347-2021

National Heritage Institute. (2024). *Map*. https://zabytek.pl/en/mapa?setlang=1

Nelson, D. R., Adger, W. N., & Brown, K. (2007). Adaptation to environmental change: Contributions of a resilience framework. *Annual Review of Environment and Resources*, *32*(1), 395–419. https://doi.org/10.1146/annurev.energy.32.051807.090348

Neumann, T. (2010). Climate-change effects on the Baltic Sea ecosystem: A model study. *Journal of Marine Systems*, *81*(3), 213–224.

Obszar Metropolitalny Gdańsk-Gdynia-Sopot. (2024, July 27). *Więcej mieszkańców w OMGGS*. https://www.metropoliagdansk.pl/metropolitalne-wiadomosci/wiecej-mieszkancow-w-omggs

Państwowe Gospodarstwo Wodne Wody Polskie. (2018). *Raport z przeglądu i aktualizacji wstępnej oceny ryzyka powodziowego*. https://powodz.gov.pl/powodz/aWORP/ostateczna%20wersja/RAPORT_WORP.pdf

Pencakowska, W. (1978). *Zdrojowska: Kształtowanie struktury przestrzennej w koncepcji zespołów rekreacyjnych*. Politechnika Krakowska.

Polish Geological Institute – National Research Institute. (2024). *The HYDRO Bank*. https://spd.pgi.gov.pl/PSH/Psh.html?locale=en

Rosselló-Nadal, J. (2014). How to evaluate the effects of climate change on tourism. *Tourism Management*, *42*, 334–340. https://doi.org/10.1016/j.tourman.2013.11.006

Rutgersson, A., Kjellström, E., Haapala, J., Stendel, M., Danilovich, I., Drews, M., Jylhä, K., Kujala, P., Larsén, X. G., Halsnæs, K., Lehtonen, I., Luomaranta, A., Nilsson, E., Olsson, T., Särkkä, J., Tuomi, L., . . . Wasmund, N. (2021). Natural hazards and extreme events in the Baltic Sea region. *Earth System Dynamics Discussions*, *2021*, 1–80. https://doi.org/10.5194/esd-13-251-2022

Sejm of the Republic of Poland. (2005). *Ustawa z dnia 28 lipca 2005 r. o lecznictwie uzdrowiskowym, uzdrowiskach i obszarach ochrony uzdrowiskowej oraz gminach uzdrowiskowych* (Dz. U. z 2024 r. poz. 1420, 1572). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20051671399/U/D20051399Lj.pdf

Sejm of the Republic of Poland. (2007). *Ustawa z dnia 26 kwietnia 2007 r. o zarządzaniu kryzysowym* (Dz. U. 2007 nr 89 poz. 590). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20070890590/U/D20070590Lj.pdf

Sejm of the Republic of Poland. (2017). *Ustawa z dnia 20 lipca 2017 r. Prawo wodne* (Dz. U. 2017 poz. 1566). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20170001566/U/D20171566Lj.pdf

Sejm of the Republic of Poland. (2024). *Ustawa z dnia 27 listopada 2024 r. o zmianie ustawy—Prawo ochrony środowiska oraz niektórych innych ustaw* (Dz. U. 2024 poz. 1940). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20240001940/T/D20241940L.pdf

Smith, M., & Puczkó, L. (2015). More than a special interest: Defining and determining the demand for health tourism. *Tourism Recreation Research*, *40*(2), 205–219. https://doi.org/10.1080/02508281.2015.1045364

Soomere, T. (2024). *Climate change and coastal processes in the Baltic Sea*. Oxford Research Encyclopedias. https://doi.org/10.1093/acrefore/9780190228620.013.897

Stankiewicz, J., & Szermer, B. (1959). *Gdańsk: Rozwój urbanistyczny i architektoniczny oraz powstanie zespołu; Gdańsk, Sopot, Gdynia*. Arkady.

Stępiński, W. (1975). *Kamień Pomorski w XII i XIII wieku* (Vol. 26). Państwowe Wydawnictwo Naukowe.

Styszyńska, A., Krośnicka, K., & Marsz, A. A. (2018). Contemporary climate changes and their impact on functioning of urban systems (on the example of Polish coastal zone). *Studia KPZK*, *187*, 51–80. http://psjd.icm.edu.pl/psjd/element/bwmeta1.element.oai-journals-pan-pl-110309/c/oai-journals-pan-pl-110309_full-text_06_20Styczy_C5_84ska__20Kro_C5_9Bnicka_20-_20Studia_20187.pdf-1

Szymańska, W., & Wiśniewska, A. (2022). Socio-economic development of coastal health resort communes in Poland. *Journal of Geography, Politics and Society*, *12*(2), 51–72. https://doi.org/10.26881/jpgs.2022.2.06

Tomczyk, A. M., & Bednorz, E. (2022). *Atlas klimatu Polski (1991–2020)*. Bogucki Wydawnictwo Naukowe.

Urbas, M. (2023, July 3-5). *Badanie zakładów lecznictwa uzdrowiskowego—Aktualny stan w kontekście zmian demograficzno-ekonomicznych* [Paper presentation]. MET2023, Warszawa, Poland.

Venter, Z. S., Barton, D. N., Gundersen, V., Figari, H., & Nowell, M. S. (2021). Back to nature: Norwegians sustain increased recreational use of urban green space months after the Covid-19 outbreak. *Landscape and Urban Planning*, *214*, Article 104175. https://doi.org/10.1016/j.landurbplan.2021.104175

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, *9*(2), Article 5. http://www.ecologyandsociety.org/vol9/iss2/art5

Walker, B., & Salt, D. (2012). *Resilience thinking: Sustaining ecosystems and people in a changing world*. Island Press.

Wang, R., Helbich, M., Yao, Y., Zhang, J., Liu, P., Yuan, Y., & Liu, Y. (2019). Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures. *Environmental Research*, *176*, Article 108535. https://doi.org/10.1016/j.envres.2019.108535

Węcławowicz-Bilska, E. (2008). *Uzdrowiska polskie: Zagadnienia programowo-przestrzenne*. Politechnika Krakowska im. Tadeusza Kościuszki.

Węcławowicz-Bilska, E. (2021). *Uzdrowiska, kąpieliska termalne i ośrodki spa*. Politechnika Krakowska im. Tadeusza Kościuszki.

Wirszyc-Sitkowska, K., & Krawczyk, S. (2019). Surowce w leczeniu uzdrowiskowym—Nadzór nad ich wykorzystywaniem i wykonywaniem zabiegów. *Kontrola Państwowa*, *64*(4), 99–109.

Wirszyc-Sitkowska, K., & Mędrzak, B. (2017). Uzdrowiska muszą bronić statusu–konieczne zmiany w systemie lecznictwa. *Kontrola Państwowa*, *62*(6), 68–81.

Wong, N. H., Tan, C. L., Kolokotsa, D. D., & Takebayashi, H. (2021). Greenery as a mitigation and adaptation strategy to urban heat. *Nature Reviews Earth & Environment*, *2*(3), 166–181. https://doi.org/10.1038/s43017-020-00129-5

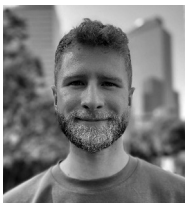
Xie, Y., Ishida, Y., Watanabe, H., & Mochida, A. (2023). Impacts of urban development between 2002 and 2022 on the effects of sea breezes in Sendai, Japan—Analyzing heat balance mechanism in urban space. *Atmosphere*, *14*(4), Article 677. https://doi.org/10.3390/atmos14040677

Yonov, I. (2024). Observations about tourism trends in Europe—From West to East. *KNOWLEDGE—International Journal*, *63*(1), 47–50.

Zscheischler, J., Westra, S., Van Den Hurk, B. J., Seneviratne, S. I., Ward, P. J., Pitman, A., AghaKouchak, A., Bresch, D. N., Leonard, M., Wahl, T., & Zhang, X. (2018). Future climate risk from compound events. *Nature Climate Change*, *8*(6), 469–477. https://doi.org/10.1038/s41558-018-0156-3

About the Authors

Anna Golędzinowska (PhD) is an architect-urbanist and assistant professor at the Faculty of Architecture of the Gdansk University of Technology. She has 20 years of experience working in regional and strategic planning, including the implementation of regional policy in the Pomorskie Voivodeship (Pomorskie region). Her research interests focus on multi-level spatial governance with a particular emphasis on the quality of public space, community engagement, resilience, and medium-sized towns.



Maciej Ganczarek holds a master's degree in spatial planning from the Faculty of Architecture at Gdańsk University of Technology, with a specialisation in integrated coastal zone management (as of 2021). His academic interests lie in the interdisciplinary analysis of the impacts of climate change on coastal cities as well as the impact of urban development on natural ecosystems and wildlife habitats.