



Socially-just adaptation to heat-related impacts of climate change on health:

An assessment of the Bremen (DE) Heat Action Plan

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ACCREEU (Assessing Climate Change Risk in Europe) is a Horizon Europe research project that aims to advance the knowledge on the economics of climate change and adaptation, working with stakeholders using a co-creation approach.

This case study examined the costs, benefits and social justice dimensions of adaptation to the heat-related impacts of climate change on health in the Federal State of Bremen (DE).

The research was supervised by partners Ecologic Institute (DE) and BC3 (ES) and co-developed with the Ministry for Environment, Climate and Science of the Free Hanseatic City of Bremen – Directorate for Climate Adaptation (Landeszentrale Klimaanpassung), in coordination with Ministry for Health, Women and Consumer Protection of the Hanseatic City of Bremen and the Health Authority (“Gesundheitsamt”).

1 Decision context

This case study focuses on the State of Bremen (pop. 684,000) which comprises the cities of Bremen (pop. 570,00) and Bremerhaven (114,000). The State of Bremen faces socioeconomic disparities, indicated by relatively high unemployment and poverty rates in parts of the city (Senatorin für Soziales, Jugend, Integration und Sport, 2021). In addition, Bremen has the highest share of migrants of all German Bundesländer (Federal States) and a relatively low life expectancy, ranking 14 out of 16 Federal States (Bund-Länder Demografie Portal, 2025). At the same time, Bremen is, as many other regions, confronted with increasing temperatures and prolonged heat spells, which are expected to become more severe in the future (Senatorin für Umwelt, Klima und Wissenschaft, 2024).

In 2018, the State of Bremen adopted a Climate Adaptation Strategy, which was revised with a new Strategy published in July 2025. In 2024, a specific Heat Action Plan (HAP) was also adopted, setting out further measures to protect the State's inhabitants to better meet the heat-related climate impacts.

The Ministry for Environment, Climate and Science is responsible for planning and monitoring, developing and implementing the state-level Adaptation Strategy, mapping of climate impacts including areas with higher social vulnerability or heat stress. The Ministry also led the design and development phase for the HAP. Responsibilities for measures are distributed across relevant actors in the administration with some roles allocated to the Health Ministry.

Key policy questions for the Federal State of Bremen are to understand how heat impacts are distributed i.e. to understand which areas are affected by heat and how, and to understand how this transects with differential vulnerabilities within different groups in the population. This leads us to the following specific policy questions:

- 1) What are the economic and financial implications of climate risks for the health sector?
- 2) What are the differential effects and social justice dimensions of adaptation options for different groups?
- 3) What are the costs and co-benefits of socially-just adaptation options?

2 Current and future risk

Although adaptation to heat has been improving, heat events remain an important threat to human health in Germany. The years 2018-2020 were significant in this regard, with 2018 being the second hottest year since 1881 and registering 8700 heat-related deaths (Winklmayr et al. 2022). Regionally, in the period 1881-2023, average annual temperatures in the State of Bremen have increased by 1.6°C (DWD 2024). There has also been a notable increase in the number of hot days ($T_{max} \geq 30 \text{ °C}$) from the period 1971-2000 (23 days in Bremen, 14 days in Bremerhaven) to the period 1991-2020 (30 days in Bremen, 21 days in Bremerhaven) (Senatorin für Umwelt, Klima und Wissenschaft, 2024). This trend is expected to continue and for individual hot days to be associated with prolonged periods of heat. In Bremen daytime temperatures tend to be higher than in Bremerhaven, while warmer nighttime temperatures affect Bremerhaven more strongly than Bremen (Senatorin für Umwelt, Klima und Wissenschaft, 2024).

During years with extreme heat, as witnessed in 1994, there was an observable regional difference in the number of tropical nights ($T_{min} > 20 \text{ °C}$). In 1994, 10 tropical nights were registered in Bremerhaven while only one was registered in neighbouring Bremen (DWD 2013; DWD 2016).

By the end of the century (2071-2100) there is an expected increase of between +0.6°C and +6°C in average summer temperatures for the north German metropolitan region of Bremen-Oldenburg (of which the Bremen region is part) as compared to 1961-1990 levels (Norddeutscher Klimaatlas).¹ With regards to other temperature-related changes in this region, there is presently only low-level agreement between different climate models. The range for the mean number of summer days ($T_{max} \geq 25 \text{ °C}$) varies between -1 and +40 days, while both the mean number of hot days ($T_{max} \geq 30 \text{ °C}$) and number of tropical nights ($T_{min} > 20 \text{ °C}$) range from 0 - 27 days.

¹ The North German Climate Atlas uses A1B ARPEGE RM 5.1 to show possible mean change, but there are other scenarios and RCPs that can be applied for other results <https://www.norddeutscher-klimaatlas.de/klimaatlas/2071-2100/sommer/durchschnittliche-temperatur/metropolregion-bremen-oldenburg/mittlereanderung.html>

3 Identifying adaptation options

The Bremen Heat Action Plan (HAP) (see Section 1 above) identifies adaptation measures that fall into five categories: A) Structure and coordination; B) Risk communication, information and awareness-raising; C) Extreme event management; D) Climate-adapted urban development; and E) Measures for Monitoring and Evaluation. Categories A and E are primarily administrative, while measures in categories B-D are focused on the implementation of practical adaptation measures.

A full overview of the measures is visible in the assessment on page 16. Among the specific measures included in the Heat Action Plan are a number of grey, green and soft interventions. These include for example:

Grey

- Cooling in health sector infrastructure / buildings
- Identification of potential rooms that provide cooling
- Drinking water provision either through wells or through water bottles, esp. for vulnerable groups in focus areas
- Provide seasonal shading

Green

- Nature-based transformation of public spaces (long-term)
- Planting and maintenance of city trees and green spaces
- Provide seasonal shading options through trees

Soft

- Heat information / awareness-raising of vulnerable groups
- Creation of an online portal on heat
- Training of staff in social facilities
- Exchange and networking on climate adaptation at state level
- Communication regarding options for cooling

4 Methodology for assessment of adaptation options

The assessment methodology for the Bremen case study consists of two main parts, each answering different elements of policy questions identified in Section 1 **Decision Context**.

- 1) A qualitative social justice assessment of the Heat Action Plan focusing on the consideration of vulnerable groups in the plan's measures (Policy question 2)
- 2) A qualitative cost-benefit analysis (CBA) of socially-just adaptation options (Policy questions 1 and 3)

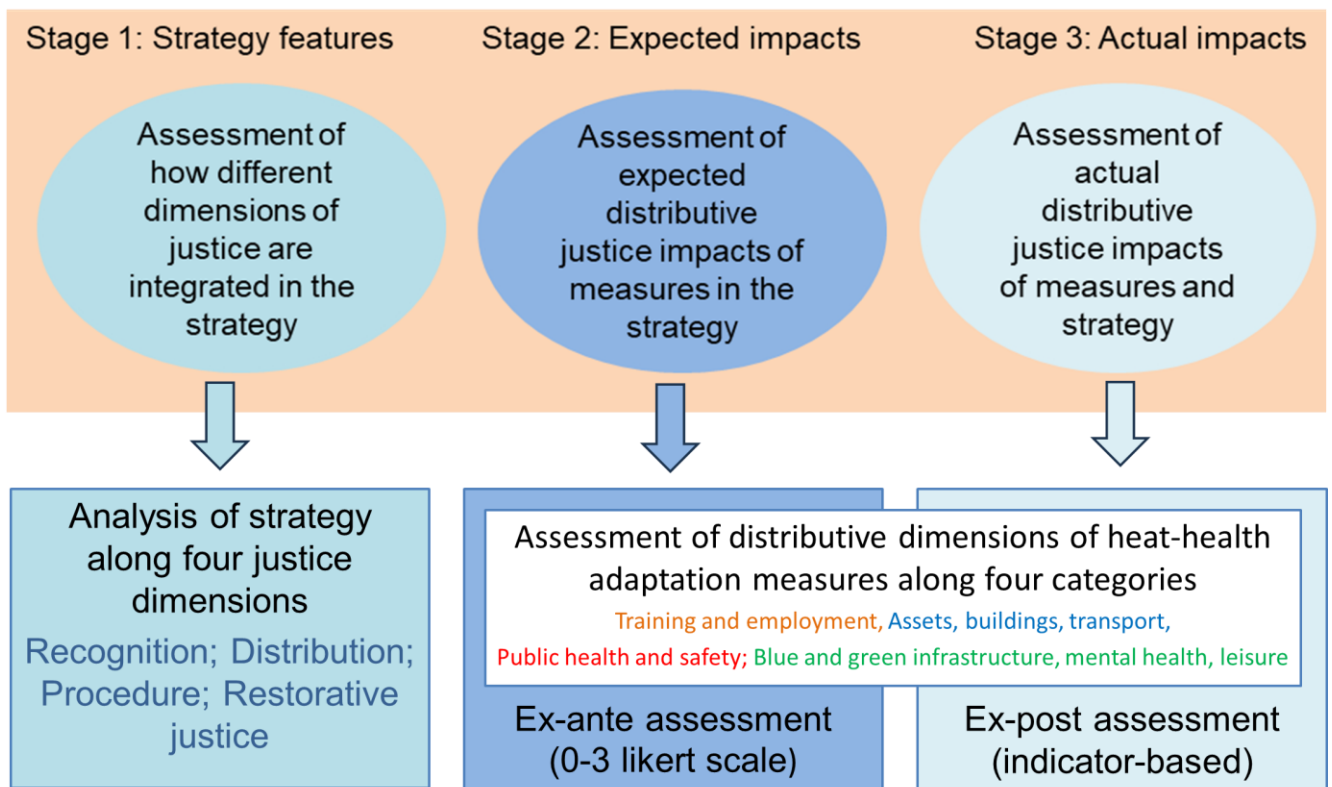
These two components were taken together to consider the economic costs of risks of heat to the health sector and how these risks and their costs are distributed across society and what the benefits of a more socially just form of adaptation could be.



4.1 Social justice assessment

The qualitative social justice assessment focuses on policy question 2) What are the differential effects and social justice dimensions of adaptation options for different groups? The assessment is based on three recent frameworks developed for the evaluation of the justice dimensions of climate adaptation policies (Juhola et al., 2022; Heyen 2023; Brousseau et al., 2024). The assessment comprises three major steps (see Figure 1). The evaluation criteria and scoring system were developed by the case study team in close collaboration with the local lead stakeholder. The evaluation of the strategy and measures were conducted by three members of the project team, first individually and then through discussion to reach consensus. The evaluation approach was then discussed with the local lead stakeholder in Bremen.

Figure 1 Conceptual framework for social justice assessment



Step 1

In a first step, different dimensions of justice (recognition, distribution, participation and restorative justice) are assessed for their level of integration in the policy. For each of these dimensions, specific features have been identified (see Table 1).

Table 1 Dimensions considered in strategy assessment (Step 1)

1. Recognition
1.1 There is a process for identifying vulnerable groups
1.2 Consideration of climate impacts on marginalised and/or vulnerable groups
1.3 Consideration of differential adaptation needs of marginalised and/or vulnerable groups
1.4 Consideration of impacts of adaptation interventions on marginalised and/or vulnerable groups
1.5 Consideration of impacts of societal structures and existing injustices on marginalised and/or vulnerable groups
2. Distribution
2.1 There is a process to map and assess the distribution of risks from climate impacts
2.2 There is a process that assesses the distribution of benefits from adaptation across the population
2.3 There is a process that assesses how positive or negative effects of the strategy are spatially distributed
2.4 There is a process that assesses of how positive or negative effects of the strategy are temporally distributed
3. Participation
3.1 The creation of the strategy involved participation of relevant stakeholders (e.g. expert groups, private actors) during different phases of the process
3.2 The creation of the strategy involved participation of the general public during different phases of the process
3.3 The strategy has a structured plan for participation in the implementation
3.4 The strategy has a structured plan for participation of vulnerable and marginalised groups in the implementation
3.5 The adaptation strategy has a participatory process for monitoring, evaluation and learning (MEL)
4. Restorative justice
4.1 The strategy acknowledges and addresses the roots of marginalisation and vulnerability
4.2 The strategy acknowledges the need to compensate for the diverging impacts of climate change

Step 2

In a second step, the measures of the strategies/plans are examined more closely ex-ante, focusing on their expected distributive justice impacts (Table 2).

Table 2 Framework for ex-ante distributive justice assessment of measures (Step 2)

Name of measure:		
Total score (out of 8):		
Distributive justice impact	Evaluation scale	Score
1. Training and employment Measure enhances capacities of workforce to support marginalised / vulnerable groups or supports these groups directly	0: Not addressed / not relevant 1: General description: Describes in general how capacities of workforce will be increased to address marginalisation / vulnerability 2: Detailed description: Describes in detail how employment/training will be implemented to reduce marginalisation / vulnerability, such as funding, activities and target groups	
2. Assets, buildings, transport Measure enhances access of marginalised / vulnerable groups to housing and other community buildings, public transport infrastructure equipped to deal with climate impacts	0: Not addressed / not relevant 1: General description: Describes in general how public access to climate resilient buildings and transport will be enhanced 2: Detailed description: Describes detailed actions to enhance vulnerable / marginalised groups' access to climate resilient buildings and transport through specific funding, activities and targeted objects and locations.	
3. Public health and safety Measure enhances access of marginalised / vulnerable groups to public health resources and emergency support before, during, and after extreme events	0: Not addressed / not relevant 1: General description: Describes in general how public access to public health resources and emergency support will be enhanced 2: Detailed description: Describes detailed actions to enhance vulnerable / marginalised groups' access to public health resources and emergency support through specific funding, activities and targeted objects and locations.	
4. Blue and green infrastructure, mental health, leisure Measure enhances access of marginalised / vulnerable groups to public blue and green infrastructure (parks, canopy coverage, water) and/or enhances access to health infrastructure to compensate for mental stress and provides access to leisure activities	0: Not addressed / not relevant 1: General description: Describes in general how public access to green and mental health infrastructure and leisure activities will be enhanced. 2: Detailed description: Describes detailed actions to enhance vulnerable / marginalised groups' access to green and mental health infrastructure and leisure activities through specific funding, activities and targeted objects and locations.	

Step 3

In a third and final step, actual distributive impacts can be assessed ex-post implementation, using process and outcome-based indicators. A framework for evaluation is suggested (Table 3) but for timing reasons, this will not be assessed in the lifetime of the ACCREU project.

Table 3 Framework for monitoring and evaluation of distributive impacts of measures (Step 3)

Impact on distributive justice	Indicators to measure progress towards impact	Score and rationale
1. Training and employment Measure enhances capacities of workforce to support marginalised / vulnerable groups or supports these groups directly		
2. Assets, buildings, transport Measure enhances access of marginalised / vulnerable groups to housing and other community buildings, public transport infrastructure equipped to deal with climate impacts		
3. Public health and safety Measure enhances access of marginalised / vulnerable groups to public health resources and emergency support before, during, and after extreme events		
4. Blue and green infrastructure, mental health, leisure Measure enhances access of marginalised / vulnerable groups to public blue and green infrastructure (parks, canopy coverage, water) and/or enhances access to health infrastructure to compensate for mental stress and provides access to leisure activities		

4.2 Assessment of costs and benefits

The assessment of costs and benefits seeks to answer policy question 1) What are the economic and financial implications of climate risks for the health sector? and policy question 3) What are the costs and co-benefits of socially-just adaptation options? Based on the work developed in WP2, we have an estimate at the NUTS 3 scale of the costs of climate change in terms of heat-related mortality and morbidity. These data are available for a combination of RCPs and SSPs (see deliverable 2.3). Furthermore, the costs of adaptation measures foreseen in the above-mentioned planning instruments will be estimated. Based on the literature, an estimate of the potential effectiveness of these measures will be made, allowing us to calculate the avoided costs.

Research shows that the willingness to pay for climate policies increases when the co-benefits of climate policies are taken into account (e.g. Rodríguez-Entrena et al., 2014). The literature in this area has grown considerably in recent years in the context of climate

change adaptation (Sainz de Murieta, 2020), including in the health sector (e.g. Sharifi et al., 2021). Accounting for these benefits can promote the legitimacy of these policies (Krook Riekkola et al., 2011) and could be a powerful tool to overcome climate scepticism or lack of concern (Bain et al., 2016). For this reason, the assessment includes a qualitative assessment of co-benefits of climate change adaptation. We also explore the potential costs of adaptation options in health services, to which the literature has paid little attention so far.

5 Results

5.1 Social justice assessment

The Bremen HAP consists of a main document and 30 ‘Fiches’, one per planned measure. In the first step, the social justice assessment was conducted for the HAP main document, looking at the intentions of the strategy as a whole. The results are presented in Table 4.

Table 4 Social justice assessment of the overall aspects of the Bremen Heat Action Plan (Step 1)

1. RECOGNITION		
Strategy feature	Evaluation scale	Score and rationale
1.1 There is a process for identifying vulnerable groups	0: No process 1: Marginalised and/or vulnerable groups are identified 2: There is an existing assessment process that will be adapted. 3: The assessment of marginalised and/or vulnerable groups is clear and connected to adaptation planning and monitoring	3 – The assessment and results are shown in the HAP. Definitions are defined and clearly followed and based on this vulnerable groups are indicated.
1.2 Consideration of climate impacts on marginalised and/or vulnerable groups	0: The strategy does not identify marginalised and/or vulnerable groups 1: The strategy identifies a link between climate impacts and marginalised and/or vulnerable groups 2: The strategy identifies that marginalised and/or vulnerable groups are disproportionately affected by climate change 3: The strategy identifies how marginalised and/or vulnerable groups are disproportionately affected by climate change	3 – The assessment of heat impacts on vulnerable groups are shown in the HAP. Definitions are defined and clearly followed and based on this, vulnerable groups are indicated. In the maps also the intensity of heat days, night temperatures is linked to different criteria, such as age, socio-economic indicators, etc.

1.3 Consideration of differential adaptation needs of marginalised and/or vulnerable groups	<p>0: The strategy does not identify marginalised and/or vulnerable groups</p> <p>1: The strategy identifies that marginalised and/or vulnerable groups may have differential adaptation needs</p> <p>2: The strategy identifies what these differential needs are</p> <p>3: The strategy identifies measures to address the differential adaptation needs of marginalised and/or vulnerable groups</p>	<p>3 – The measures have the aim to address different vulnerable groups and their needs, e.g. specific measures for pregnant women, parents, babies, elderly, socially-isolated, people working outside, etc. (partially via multipliers, e.g. schools/teachers, doctors, social volunteers)</p>
1.4 Consideration of impacts of adaptation interventions on marginalised and/or vulnerable groups	<p>0: The strategy does not identify marginalised and/or vulnerable groups</p> <p>1: The strategy identifies that adaptation interventions can have negative impacts marginalised and/or vulnerable groups</p> <p>2: The strategy identifies what these negative impacts on marginalised and/or vulnerable groups are</p> <p>3: The strategy identifies how it will mitigate these negative impacts.</p>	<p>1–The HAP mentions in general that negative impacts of measures should be avoided.</p>
1.5 Consideration of impacts of societal structures and existing injustices on marginalised and/or vulnerable groups	<p>0: No acknowledgement</p> <p>1: The existence of structural injustices is mentioned in a general manner</p> <p>2: There are measures that tackle some structural injustices</p> <p>3: There is a detailed plan to consider the impacts of structural injustices on marginalised and/or vulnerable groups as part of the strategic approach to adaptation</p>	<p>1 – Structural injustices are mentioned. The measures focus mainly on information and behaviour during an heat event but do not address structural changes, such as heat insulation in buildings.</p>

2. DISTRIBUTION

Strategy feature	Evaluation scale	Score and rationale
2.1 There is a process to map and assess the distribution of risks from climate impacts	<p>0: No risk assessment process</p> <p>1: Process for risk assessment is part of the strategy but does not consider differential aspects</p> <p>2: Process for differential risk assessment is included</p> <p>3: Process for risk assessment is implemented, risks are prioritized and measures are identified to address differential distribution of risks</p>	<p>2 – A process for risk assessment is in place, definition of indicators and mapping has been implemented</p>
2.2 There is a process that assesses the distribution of benefits from adaptation across the population	<p>0: No process for assessing benefits</p> <p>1: Process for identifying benefits of adaptation measures in general</p> <p>2: Process for assessing distribution of benefits across the population is included</p> <p>3: Distribution of benefits across the population is understood in detail and informs measures to address inequalities</p>	<p>2 – Benefits are described for targeted groups in qualitative terms</p>

<p>2.3 There is a process that assesses how positive or negative effects of strategy are spatially distributed</p>	<p>0: No process to consider spatial effects of strategy 1: Spatial dimensions of adaptation are considered 2: Process for assessing the distribution of the strategy's effects across different spatial areas is included 3: Spatial distribution is mapped in detail e.g. according to proportional socio-structural, economic and socio-spatial criteria and is used to inform measures to address inequalities.</p>	<p>0 – Spatial effects are mentioned but no process is described for taking these effects into account</p>
<p>2.4 There is a process that assesses how positive or negative effects of strategy are temporally distributed</p>	<p>0: No process to consider temporal dimensions of strategy 1: Temporal dimensions of adaptation are considered 2: Process for assessing the different effects of the strategy for different generations is included 3: Temporal distribution is understood in detail and is used to inform measures to address the inter- and intragenerational dimensions of adaptation costs and benefits</p>	<p>1 – Temporal dimension is considered in general, e.g. via measures for children</p>

3. PARTICIPATION

Strategy feature	Evaluation scale	Score and rationale
<p>3.1 The creation of the strategy involved participation of relevant stakeholders (e.g. expert groups, private actors) during different phases of the process</p>	<p>0: No participation 1: The strategy process has involved information provision about adaptation (at least once during the process before the final output publication) 2: The strategy process has involved consultation. 3: The participation in the strategy process has been collaborative and continuous</p>	<p>2 – The strategy was developed with participation of relevant stakeholders from the social and health sectors. Several meetings aimed to include their knowledge and preferences in the process, in order to define the measures and to ensure consistency with ongoing activities.</p>
<p>3.2 The creation of the strategy involved participation of the general public during different phases of the process</p>	<p>0: No participation 1: The strategy process has involved information provision about adaptation (at least once during the process before the final output publication) 2: The strategy process has involved consultation. 3: The participation in the strategy process has been collaborative and continuous</p>	<p>1 – Several public presentations were held around the development of the HAP including the university, local councils and the parliament. The public was not involved in the development of the strategy. However, to a limited extent, their input may have been included via the inclusion of interest groups (see 3.1.)</p>

<p>3.3 The strategy has a structured plan for participation in its implementation</p>	<p>0: No participation in the plan for implementation 1: The implementation plan involves informing different stakeholders 2: The implementation plan involves stakeholder consultation 3: The implementation plan involves stakeholder participation in a collaborative and continuous manner</p>	<p>2 – The plan does not provide a structured plan for participation. However, it does refer to citizen participation in the description of several measures. While not yet incorporated in a structured way, the plan is for the Actors Network to be a key way to deliver on this point.</p>
<p>3.4 The strategy has a structured plan for participation of vulnerable and marginalised groups in the implementation</p>	<p>0: The adaptation strategy is implemented by public bodies without participation of vulnerable and marginalised groups 1: Marginalised and vulnerable groups are targeted by and informed about implementation activities in the adaptation strategy 2: Marginalised and vulnerable groups are invited to participate in adaptation activities 3: Marginalised and vulnerable groups are engaged directly and can take appropriate levels of responsibility for adaptation activities.</p>	<p>2 – The plan explicitly addressing vulnerable groups in its measures as recipients, e.g. through information campaigns. Vulnerable groups will be represented through the active participation of their representatives (health and social workers)-</p>
<p>3.5 The adaptation strategy has a participatory process for monitoring, evaluation and learning (MEL)</p>	<p>0: No plan 1: The strategy involves a plan for MEL but this is done by the authorities 2: The strategy involves a plan for MEL that includes external inputs and feedback from stakeholders 3: The strategy has a detailed plan for stakeholder involvement in MEL throughout its implementation.</p>	<p>2 – The strategy aims to develop a plan for MEL that includes external inputs and feedback from the Steuerungskreis (Steering group) and Akteursnetzwerk (actor network) as stakeholders. The Plan is, however, not yet available and will only be developed in the future.</p>

4. RESTORATIVE JUSTICE

Strategy feature	Evaluation scale	Score and rationale
4.1 The strategy acknowledges and addresses the roots of marginalisation and vulnerability	0: No acknowledgement of past harms or injustices 1: Past harms and injustices are mentioned 2: The impact of past harms on current experiences of marginalisation, vulnerability or injustice is recognised 3: Action is taken to repair and restore past harms through recognition or redistribution	0 – No acknowledgement of past harms or injustices
4.2 The strategy acknowledges the need to compensate for the diverging impacts of climate change	0: No acknowledgement 1: The strategy acknowledges a need for compensatory action on climate change impacts for certain individuals or communities 2: The strategy foresees procedures for defining compensatory action. 3: The strategy has a plan for addressing and compensating for the impacts of climate change	1 – In some of its measures, the strategy acknowledges a need to address social inequalities, however, without explicitly calling for compensatory actions.

The HAP shows a clear awareness of the differential effects of heat for groups in the population. It identifies vulnerable groups and the effects of heat on these groups. Maps have been developed to show the distribution of heat impacts such as number of hot days or tropical nights, linked to different socio-economic indicators. These have identified the unequal distribution of climate risks for vulnerable populations. To this end, measures have been defined to target different vulnerable groups and their needs in relation to heat.

This includes specific measures for pregnant women, parents, babies, elderly, drug-users, the socially-isolated, people without housing and people working outside. This is done primarily in partnership with existing multipliers such as schools, social and health care facilities, neighbourhood outreach centres and volunteering initiatives. Despite identifying these vulnerabilities and strategies to support groups, the measures focus mainly on information campaigns to support adaptive behaviour during heat events. There is little to indicate that broader structural action is being taken to address these vulnerabilities at their root.

At the same time, this is in part because it is beyond the scope of a HAP; many of the root causes such as structural economic disadvantage cannot be tackled at the level of the state or municipality. While the distribution of risks has been mapped in detail, how the benefits of adaptation are distributed across the population is only briefly considered. Temporal dimensions, such as intergenerational effects of impacts or adaptation are not considered.

Concerning procedural justice, the strategy was developed with participation of relevant stakeholders from the social and health sectors. Several meetings aimed to include their knowledge and preferences in the process of defining measures and to connect with ongoing activities. However, general members of the public were not involved in the development of the strategy. Only where they belonged to a particular interest group or vulnerable group, were they included via third party representatives. The HAP primarily foresees interactions with the public through communication and awareness raising. Whether citizens will be invited to participate in the implementation of measures is unclear.

Nevertheless, there are processes planned for ongoing MEL to accompany the implementation of the HAP. These have not yet been established, but there will be a process of ongoing feedback through the *Steuerungskreis* (Steering group) and *Akteursnetzwerk* (actor network). Restorative justice is, as yet, a very niche area of justice considerations in climate adaptation strategies. While it has been included in the assessment framework for theoretical completeness, there are no indications that Bremen or any other of the strategies analysed for the ADT are considering this issue through, for example, compensatory measures.

The second step of the assessment examined the individual measures of the HAP for their expected distributive justice impacts.² Each measure was allocated a score of 0 (for no mention or relevance), 1 (for general reference) or 2 (with specific details) of how the measure considered distributional justice issues. Drawing on Heyen et al. 2023, we developed four clusters in which distributional justice concerns might be taken up: 1. Training and employment; 2. Assets, buildings and transport; 3. Public health and safety; and 4. Blue and green infrastructure, mental health and leisure.

The results (Table 5) reveal that scores in the third cluster on public health and safety (coloured dark purple) were around double the scores in the other categories. This means that while distributional justice issues were considered in other activity areas, the primary way in which marginalized and vulnerable groups are considered is in relation to public health resources and emergency support before, during, and after extreme events.

Less attention is paid in the consideration of these groups in urban planning, although for urban renewal projects, the participation of vulnerable groups is an integral part. This includes specific measures for pregnant women, parents, babies, elderly, drug-users, the socially-isolated, people without housing and people working outside. This is done primarily in partnership with existing multipliers such as schools, social and health care.

Looking at the five action areas identified by the Bremen government we see a focus on B) Risk communication, information and awareness-raising measures and C) Extreme event management measures. Activities to address distributional justice are less present in A) Internal management and organization; D) Measures for climate-adapted city planning; and E) Measures for Monitoring and Evaluation.

An overview of the evaluation is presented in Table 5, with high scoring areas highlighted in bold and purple. Individual high scores (where measures scored '2') are highlighted in dark blue. Particularly high scoring were measures that focused directly on vulnerable groups and developed targeted measures to support these groups through infrastructure such as cooling provision or undertaking capacity building of multipliers to inform and support these groups (e.g. measures C4, C5, C7, C8).

In Step 3 (Table 6), indicators are suggested for the monitoring, evaluation and learning around the distributive impact of the measures discussed in Step 2. These will not be used for assessment in the ACCREU project due to the longer timeframe in which the Bremen HAP will be implemented. However, some initial ideas are proposed and can be adapted according to individual measures and data availability

² All measures can be found in detail on pp 33-83 of the Bremen Heat Action Plan available in German at <https://www.klimaanpassung.bremen.de/sixcms/media.php/13/Hitzeaktionsplan.pdf>.

Table 5 Social justice assessment of individual measures in the Bremen Heat Action Plan (Step 2). Darker colours indicate higher scoring areas.

Measure number (brackets show corresponding measures in Bremen/ Bremerhaven)	Measure name	1. Training and employ- ment	2. Assets, buildings, transport	3. Public health and safety	4. Blue and green infra-structure, mental health, leisure	Overall score
A1	Coordination bureau	1	0	1	0	2
A2	Coordination group	0	0	0	0	0
A3	Heat Action Plan Stakeholder Network	1	1	1	0	3
B1	Warning and information plan	0	0	1	0	1
B2	Heat Portal for the Federal State of Bremen	0	0	1	1	2
B3	General awareness raising campaign	0	0	1	0	1
B4	Information and awareness raising for vulnerable groups	1	0	2	0	3
B5	Training and further education for professional groups working with vulnerable people	2	0	2	0	4
B6	Further training for family carers and voluntary support workers	2	0	2	0	4
B7	Heat protection for particularly exposed employees	2	0	2	0	4
C1	Distribution of heat alerts from the German weather service	0	0	1	0	1
C2	Heat protection plans for mobile healthcare services, stationary care facilities and hospitals	0	2	2	0	4
C3	Mobilisation and support for pediatric facilities and midwives	2	0	2	1	4
C4	Neighbourhood support pilot project (heat buddies, heat hotline)	2	1	2	1	6
C5	Preparation and communication about public cool spaces	0	2	2	2	6
C6	Call to action for GPs and pharmacists to check medication plans	1	0	2	0	3
C7	Provision for unhoused and substance-using citizens in public spaces	1	2	2	2	7
C8	Heat protection in school playgrounds and outdoor areas of nurseries	2	2	2	0	6
C9	Drinking water in public spaces	0	2	2	0	4
D1	Climate adapted management of green spaces (Bremen)	0	0	0	1	1
D2	Urban Trees Action concept 2.0 (Bremen)	0	0	0	1	1
(D6)	Urban Trees Action concept 2.0 (Bremen)	0	1	0	2	3
D3	Pilot, nature-based reconfiguration of public spaces (Bremen)	0	2	0	0	2
D4	Adaptation of public buildings (Bremen)	0	0	0	1	1
D5	Adapted management of green spaces in urban areas (Bremerhaven)	0	0	0	1	1
D6	Urban Trees Action concept 2.0 (Bremerhaven)	0	1	0	2	3
D7	Pilot, nature-based reconfiguration of public spaces (Bremerhaven)	0	2	0	0	2
D8	Concept for summer heat protection for public and social facilities (Bremerhaven)	0	0	0	0	0
D9	Climate adaptation of existing industrial zones (Bremerhaven)	0	0	2	0	2
E1	Monitoring of implementation of measures	0	0	0	0	0
E2	Monitoring of morbidity and mortality during heat periods	0	0	2	0	2
	Total	17	18	32	15	

Table 6 Suggested indicators for monitoring and evaluation of individual measures in the Bremen Heat Action Plan (Step 3) *HAP Bremen (indicator mentioned directly in the Heat Action Plan); EI (Ecologic Institute)

Impact on distributive justice	Aim / Definition / Category	Suggested proxy indicators	Source
1. Training and employment	Measure enhances capacities of workforce to support marginalised / vulnerable groups or supports these groups directly	Training and continuing education for professional groups who deal with vulnerable people: Percentage of employees reached through qualification measures	HAP Bremen (B.5)*
		Continuing education for family carers and volunteers: Number of at home carers and volunteers reached through qualification measures	HAP Bremen (B.6)
		Heat protection plans for health and care facilities: Creation of guidelines, proportion of facilities with a specific heat protection plan, monitoring of heat-related illness burden	HAP Bremen (C.2)
		Activation and support of paediatric practices and midwives: Proportion of participating practices and midwives, feedback/interviews with participating practices	HAP Bremen (C.3)
		Climate adaptation in existing industrial/commercial areas: Continuous updating of the industrial zones recorded with regard to the need for action and the measures implemented.	HAP Bremen (D.9)
2. Assets, buildings & transport	Measure enhances access of marginalised / vulnerable groups to housing and other community buildings, public transport infrastructure equipped to deal with climate impacts	Percentage of social buildings (housing, nurseries, elderly homes, shelters) with active or passive cooling or green infrastructure (green roofs, shading, ventilation) elements.	EI*
		Number of publicly accessible cooling centers (libraries, community halls, senior centers) per 10.000 residents.	EI
		Accessibility to cooling centers with public transport (e.g. stops close to cooling centers / average travel time for vulnerable groups).	EI
		Public transport (density)	EI
		Percentage of public transport fleet that is air conditioned	EI
		Provision for homeless, homeless and addicted/mentally ill people in public spaces: Frequency of use of the services	HAP Bremen (C.7)
		Concept for summer heat protection for public and social facilities: Percentage of heat resilient buildings.	HAP Bremen (D.8)
		Heat protection in school playgrounds and daycare centre playgrounds: proportion of facilities with shaded outdoor areas.	HAP Bremen (C.8)

Impact on distributive justice	Aim / Definition / Category	Suggested proxy indicators	Source
3. Public health and safety	Measure enhances access of marginalised / vulnerable groups to public health resources and emergency support before, during, and after extreme events	Proportion of residents reached by the early warning system	Tuomimaa et al. 2023
		Number of hospital beds per district per km ²	EI
		Number of physicians per district per km ²	EI
		Access to water/Water fountain concentrations (n=xx/% coverage)	EI
		Number of interactions between support workers and vulnerable groups in preparation for extreme heat events	EI
		Awareness of cooling spaces and of physical effects of heat	EI
		Downloads / distributed print outs of cooling spaces maps	EI
		Drinking water in public spaces: number of drinking fountains installed or participating shops as refill stations per km ²	HAP Bremen (C.9)

Impact on distributive justice	Aim / Definition / Category	Suggested proxy indicators	Source
4. Green Infrastructure & leisure	Measure enhances access of marginalised / vulnerable groups to public blue and green infrastructure (parks, canopy coverage, water) and/or enhances access to health infrastructure to compensate for mental stress and provides access to leisure activities	Green area per inhabitant in the city	Catalan Climate Adaptation Plan (S2)
		Availability and equitable distribution of blue-green space (Unit: map) availability of green space and indicators	EU 2021. "Evaluating the impact of NbS" (19.6)
		Accessibility to (public) green spaces (e.g. measure through distance of public transport stations from green spaces)	Böhme et al. 2023
		Urban tree index / Tree survival rate / Tree cover per capita	EI
		Time spent outdoors in summer months	EI
		Indoor and outdoor swimming pools, lakes, rivers and sea (right to health)	Catalan Climate Adaptation Plan (JC7)

5.2 Assessment of costs and benefits

Effectiveness of Heat Action Plans

In the absence of direct data on the implementation of the Heat-Health Action Plans (HHAP), we turned to the literature to obtain an estimate of the benefits that these plans can have in terms of avoided impacts, both in terms of mortality and morbidity.

Following the 2003 heatwave, which marked a turning point in Europe, HHAPs have increased significantly, and today there are numerous plans at national, regional, and even municipal levels (Martinez et al., 2019). However, Dwyer et al. (2022) argue that, considering the number of heat plans currently in place, the number of studies assessing their effectiveness in the literature remains relatively low. This is more so in relation to morbidity outcomes.

A study of the benefits of heat alerts in 20 US cities found no association with lower mortality, except for Philadelphia, where heat alerts were associated with 4.4% lower mortality rates (Weinberger et al., 2018). Mixed results were also found in a systematic literature review of HHAP evaluations (Dwyer et al., 2022). Among 11 evaluations of heat action plans assessed, only one reported an overall mortality reduction; two of three morbidity evaluations found reductions; and one multi-city study observed a protective effect in a single city only. Overall, positive signals are limited and context-specific.

In Spain, after the HHAP1 was introduced, the extreme-heat mortality fraction decreased (from 0.67% to 0.56%, a relative reduction of 16%), but this was offset by an increase in the moderate-heat mortality fraction (from 0.38% to 1.21%), so the total heat-attributable mortality increased. On plan-activation days, the attributable fraction was reduced. Interestingly, those provinces with more actions being implemented within their HAPs showed higher decreases in mortality attributable to extreme heat (Martínez-Solanas and Basagaña, 2019).

In Italy, de'Donato et al. (2018) found that among adults over 65 years, the heat-attributable mortality fraction for extreme temperatures fell from 6.3% to 4.1% across 23 cities (35% relative decline), after the introduction of the national HHAPs.

Feldbusch et al. (2025) analysed the effectiveness of the national heat and health warning system in 15 German cities using a difference-in-differences approach. After adjusting for city characteristics, heat alerts were associated with 15% lower all-cause mortality on alert days (RR = 0.85; 95% CI 0.75–0.97). When city characteristics were not considered, no protective effect was found (RR = 1.00; 0.98–1.01). City-level reductions were statistically significant in Berlin (RR = 0.95), Frankfurt (0.94), and Hamburg (0.95), while Bremen's estimate was not significant. On balance, we can say that the evidence of a reduction in mortality is stronger than the evidence for no effect or an opposite effect.

Estimating the benefits of Bremen's Heat Action Plan

We measure the benefits of the implementation of Bremen's HAP in terms of the reduction of health impacts (mortality and morbidity). Given the heterogeneity in the literature, we adopt a central effectiveness of 15% of Bremen's HAP for all-cause mortality, in line with the pooled protective effect found by Feldbusch et al. (2025), once city characteristics were considered. While they did not find a significant reduction for Bremen, it should be noted that they evaluated the national heat-health warning system rather than full regional or municipal HAPs. Secondly, the newly adopted HAP for Bremen was developed with a strong focus on the region's characteristics and vulnerabilities, so it is reasonable to assume this level of effectiveness as an ex-ante portfolio assumption.

To account for uncertainty, we also use lower and upper bounds of effectiveness. The lower bound is 5%, in line with Weinberger et al. (2018), and the upper bound is 30%, in line with the higher effectiveness estimates (e.g., de'Donato et al., 2018).

Bremen's HAP anticipates annual implementation reviews and post-summer health evaluations, and several structural measures have a multi-year setup. For this reason, we assume a maturity ramp that assumes a partial effect in 2025 (40%), near-full effect in 2026 (75%), and a full protective effect from 2027 to 2030. To estimate effects on morbidity, we follow the approach applied by Markandya et al. (2025) that relates heat-related mortality and morbidity based on data from Adelaide et al. (2022). Mortality data (for adults over 65) is taken from Loroño et al. (2025) and morbidity from Markandya et al. (2025). Finally, although Bremen's HAP includes specific measures (B7) to reduce health impacts and productivity losses experienced by workers particularly exposed to heat, we were unable to assess the economic effects as the impact has not yet been quantified.

The cost of Bremen's Heat Action Plan

As noted in Section 1, the measures in Bremen's HAP are divided into five fields of action: A) Structure and coordination; B) Risk communication, information and awareness-raising; C) Extreme event management; D) Climate-adapted urban development; and E) Measures for Monitoring and Evaluation.

We treat the Coordination bureau (A1) as a fixed annual programme cost, covering planning, oversight, and coordination (central estimate €250,000 within the HAP's €230,000–270,000 range). Therefore, these costs do not vary with the number of alerts/heat-wave days. Any activity-driven effort is costed under each relevant measure (e.g., outreach, training). A2–A3 tasks, in-kind staff time with only minor event expenses (room/catering), are assumed to be included in A1. Considering about 80% of the coordination costs are salary costs, we have assumed that nominal these will increase by 2.5% per year, which is likely a conservative assumption given recent wage growth trends in Germany.

For measures in group B, related to communications, information, and awareness, we made the following calculations. Costs are obtained using resource-based costing (Hunt et al., 2016): task hours times the Eurostat whole-economy hourly labour cost² for Germany in 2024 (€45/hour), plus non-labour items, estimated based on observed average market costs. The central annual budget sums to €120,000, which we find consistent with a communications-heavy package. We have assumed that the first year of implementation will incur additional expenses that will not be necessary in subsequent years, such as web design, training packs or information guides.

We budget Group C on considering consumption supplies (materials, printing, media/placements, small outsourced tasks, supplies/equipment), keeping internal staff time under A1.

Concerning structural measures linked to the adaptation strategy (Group D), we opted to consider the city's strategy-funded investments (e.g., greening, shading, building upgrades) as baseline and therefore exclude their full costs from the cost-benefit analysis of Bremen HAP to avoid double-counting.

We cost E-group measures using the same resource-based approach as above but assume that the bulk of monitoring/analytics hours are delivered by the A1 Coordination Centre and Group E's budget only covers minor office items associated with the monitoring process (e.g., software/data access if needed, annual review meetings, etc.). On this basis, the cost is €12,000/year for outsourced item costs. Table 7 shows the summary of the HAP costs.

Table 7. Cost of Bremen HAP, by areas of action.

Measures	2025	2026	2027	2028	2029	2030
Group A	250,000	255,000	260,100	265,302	270,608	276,020
Group B	120,000	96,000	96,000	96,000	96,000	96,000
Group C	174,500	147,500	147,500	147,500	147,500	147,500
Group D	-	-	-	-	-	-
Group E	12,000	12,000	12,000	12,000	12,000	12,000
HAP cost	556,500	510,500	515,600	520,802	526,108	531,520

Comparing costs and benefits

Over the analysis period, 2025-2030, the benefits are dominated by avoided mortality, which is valued using the value of a statistical life (VSL) of €1.3 million (Szewczyk et al., 2018). Avoided morbidity values are taken from Markandya et al. (2025), but they contribute a very small share (less than 1%) of monetised benefits. In the central scenario (considering an effectiveness of 15%), annual benefits range from €50–55 million, depending on the climate scenario considered, while programme costs total €510,000 – 556,000 per year.

Using a 3% discount rate and end-of-year timing, the present value of benefits is €268-300 million, and the present value of costs is €2.8 million. This yields a benefit-to-cost ratio (BCR) of 94-105. The results are robust to discounting (BCR remains essentially unchanged between 0 and 3%), and even with substantially lower effectiveness (e.g., one-third of the central scenario), the ratio remains well above 1.

When considering a maturity ramp where efficiency gradually increases from 40% in 2025 to 60% in 2026, 75% in 2027, before reaching 100% in 2028, the results vary slightly. Nevertheless, the programme continues to deliver substantial benefits between 2025 and 2030. Using this maturity curve and a discount rate of 3%, the present value of the benefits ranges from €209 million to €234 million, depending on the emissions scenario. The present value of costs remains at €2.9 million, resulting in an NPV of between €206 million and €231 million, and a cost-benefit ratio of between 73 and 82.

The outcome of the CBA carried out depends largely on the method used to calculate the value of a human life. Here, the value of a statistical life (VSL) of €1.3 million was used, which some might consider too high, despite higher values also being found in the literature (e.g., OECD, 2012; Alberini and Ščasný, 2024). Assuming a 15% effectiveness, this would mean avoiding 40-45 deaths per year thanks to the plan. Given that the plan incurs an annual cost of €529,500, this equates to an investment of €11,770-€12,900 per life saved

6 Barriers and conditions for implementation

The HAP takes clear account of the differential impacts on vulnerable groups and has integrated this as an important dimension of the strategy. However, whether adaptation measures will truly target and benefit these groups remains to be seen. This will depend on overcoming potential barriers listed below. There appear to be systems in place, particularly after the Covid-19 pandemic that can be mobilised to reach vulnerable groups in neighbourhoods. However, whether and how this can be deployed for heat and health remains to be seen and will depend on adequate funding and human resources. Furthermore, actions that provide wider benefits to the public but from which vulnerable groups can benefit such as increasing green infrastructure in public spaces relies on being able to recruit appropriately trained personnel to take care of the planting. Some of the initial barriers identified by the stakeholders in Bremen with regards to implementation are listed in Table 8.

Table 8 Measures in the HAP and their barriers to implementation

Measures	Barrier	Type of barrier
Communication campaigns	<ul style="list-style-type: none"> • Lack of long-term funding to implement strategies • Difficulties to reach specific vulnerable groups (e.g. due to technical barriers or cultural ones, limited accessibility via different media) • Lack of staff in social care and high workload of existing ones 	<ul style="list-style-type: none"> • Financial • Social and cultural • Human capital
Management of extreme events	<ul style="list-style-type: none"> • Lack of long-term funding to implement strategies • Lack of ability to induce behavioural change among vulnerable groups e.g. homeless people • Governance of cross-sectoral measures given sectoral organisation of Senate 	<ul style="list-style-type: none"> • Financial • Social and cultural • Governance
Long-term resilience building strategy for heat events	<ul style="list-style-type: none"> • Lack of long-term funding to implement strategies • Low support from relevant stakeholders in planning, implementation and maintenance of measures • Vulnerable groups not prioritised despite higher impacts • Lack of training time to skill up personnel or lack of trained personnel 	<ul style="list-style-type: none"> • Financial • Governance • Social and cultural • Human capital

7 Conclusions on socially just adaptation to heat impacts on health

The HAP was developed by the State Ministry for Environment, Climate and Science, which has also been in charge of developing the climate adaptation strategy (KAS) in parallel. The HAP takes a targeted approach to addressing the heat impacts of climate change for health. The HAP is interpreted as the policy through which the more ‘social’ components of the KAS are implemented and includes clear attempts to address the distributional and social justice dimensions of heat. This has included the strategic development with partners from across the regional administration, engaging with representatives from civil society organisations. However, it means that while somewhat mentioned, these issues are not dealt with in as much detail in broader adaptation activities being conducted through the KAS.

The assessment of the HAP indicates that there is some level of justice as recognition, procedure and distribution being considered in terms of impacts, but that restorative justice is rather ambitious for the sub-national level, being a criterion that would need longer consideration and or embedding at the national level. The focus of these actions is primarily on the distribution of heat impacts across the population who have already been identified as vulnerable rather than addressing the underlying causes of vulnerability. The HAP is intended to be the first of many iterations and will be monitored in an online portal to make progress transparent. A number of possible indicators have been proposed in this case study which could be used to specifically account for the social justice dimensions of the HAP.

The assessment of the distributional justice of the HAP measures conducted in Step 2 suggests that it is predominantly through risk communication and sensitisation of the population at large that distributional justice is accounted for. There is some promising consideration of differential needs of those who are physically vulnerable and/or marginalised owing to their socio-economic circumstances.

The HAP foresees soft adaptation measures that aim to inform and protect vulnerable and marginalised groups either directly or through support workers and representatives. There are also a range of green and grey measures, such as improving green areas and shading. However, the distributional dimensions of budget allocations for greening are not yet taken account of in a systematic way. Without this being factored in, investments may end up being captured by higher income groups and/or implemented in locations where the need for greening is not as high from a social or environmental perspective. The mapping that accompanies the HAP has been used to develop spatially differentiated planning of measures that account for distributional inequalities, which in the best-case scenario are expected to be taken up in public urban planning. In the private sector on the other hand there is no requirement to consider the differential impacts of urban development. This is thus a blind spot in understanding the full extent of the distributional effects of investment and planning decisions on climate adapted urban development.

As elsewhere, the economic benefits associated with health and heat protection measures in Bremen are expected to exceed a benefit-to-cost ratio well above 1, even where substantially lower effectiveness is accounted for. However, the measures of the HAP will not reach their full protective effect until the period 2027-30. At the same time, funding of adaptation measures is on a shorter-term, rolling basis. The lack of investment certainty can affect retention of human resources which have high startup costs for recruitment and training meaning that the efficiencies to be gained from retention of staff with appropriate skills and capacities may not be reached. Well-trained and locally engaged staff can support action that is sensitive to differential and complex needs and vulnerabilities in different locations. Long term planning and investment coupled with retention of staff with targeted skill sets is thus an important factor in delivering on socially just forms of adaptation.

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