Climate justice in urban adaptation planning: A case study of Hamburg's response to unequal climate impacts

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Preface

The German names for relevant documents and institutions are kept for clarity and ease of reference. The interview protocols can be found in a separate document.

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Carsten Kwaku Ofori Schütt

Summary

Climate crisis' impacts are felt more and more around the globe. The quality of the impacts and the capacity to adapt to climate hazards are not equally distributed. The most widely acknowledged and described injustice is between countries the wealthy Global North as the most polluting ones and the Global South as the most affected. These differences can also be observed on a smaller scale, e.g. within cities. The inequity between responsibility and exposure and possibility to adapt to the impacts are described as climate injustice. The idea and notion to rectify it is called climate justice. This study examines how Hamburg is addressing the uneven impacts of the climate crisis, particularly on vulnerable communities with its municipal plans and programmes as well as how they can be improved.

The problem is investigated by using four steps:

1. Identification and description of three climate related hazards on Hamburg by using Geographical information systems (GIS), analysing documents and reviewing literature. A focus is then set on the most vulnerable district in terms of social vulnerability and exposure to climate impacts.

2. Investigating what vulnerable groups are affected and how they intersect with the areas at risk using GIS and interviews.

3. Assessing what different municipal institutions plan and implement to adapt to the climate hazards by analysing their published documents and through interviews with the planners.

4. Analysing the relevant documents for adaptation planning through an analytical framework that draws from climate justice and intersectional theory. The analysis of the document s is supported by interviews with planners and affected people.

The analysis shows that Hamburg is already experiencing climate-related hazards: temperatures which have never been measured before, people dying because of heat, increasing heavy precipitation events that flood streets and houses. The rising sea-level is an issue but because of the protection measures in place it just becomes a threat in event of storm surges that reach the design-water level. The city is acknowledging that all the identified climate-related hazards are tasks that need to be addressed at least in parts by urban planning measures. Plans are created and measures taken to adapt to the changing circumstances, but most of the measures like upgrading the dykes are not adequate to the scale of the challenges. The dykes' protection level is increased just enough for the most optimistic scenario which is very unlikely to reach. In the investigated institutions and programmes relevant for Hamburg-Mitte that focus on planning and implementing climate adaptation measures, social factors are not considered in identifying sites for interventions and choosing measures, when vulnerable groups profit it is by chance not by design. This confirms that recognising differential capabilities and access is necessary for decision-making processes to be fair that then can produce fair outcomes. Otherwise acts of omission occur which create unjust outcomes by not taking different starting points into account.

Some responses to the climate crises are considered to mainly be the personal responsibility of the affected people like protection one's property from flooding

through heavy precipitation and adaptation to heat. Appealing only to personal responsibility neglects the different capacity to adapt.

For marginalised groups other issues than climate-related impacts can be more pressing, which together with participation processes that do not take different personal circumstances in account prevent people from participating in planning processes.

There is also no comprehensive strategy or document focussing on climate adaptation neither for Hamburg-Mitte nor for the whole city. On the other side of planning, Hamburg's urban development programme, RISE, that is intended to improve the lives of the most disadvantaged and should include climate adaptation lacks substantial measures. In practice some measures that can be considered as adaptation measures are taken. Notable efforts to recognise differential capabilities and reduce barriers could only be observed in the RISE programme. An improved cooperation between RISE and other institutions would benefit the ideal of intersectional climate just adaptation measures.

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Abbreviation index

BUKEA	Behörde für Umwelt, Klima, Energie und Agrarwirtschaft
GIS	Geographic Information Systems
GVK	Gemeinsamer Verbundkatalog
IKK	Integriertes Klimaschutzkonzept
RISA	RegenInfraStrukturAnpassung
RISE	Rahmenprogramms Integrierte Stadtteilentwicklung
TIB	Technische Informationsbibliothek

German terms

Behörde für Umwelt, Klima, Energie und Agrarwirtschaft (BUKEA)	Ministry for the Environment, Climate, Energy and Agriculture
Bezirk	District
Bezirksamt	District administration
Bezirksseniorenbeirat	District's Senior citizens advisory board
Bezirksversammlung	District's parliament
Bundesland, pl. Bundesländer	Federal state (region)
Deutschen Anpassungsstrategie an den Klimawandel	German Adaptation Strategy
Hamburgisches Klimaschutzgesetz	Hamburg's Climate Protection Law
Integriertes Klimaschutzkonzept (IKK)	Integrated Climate Protection Concept
Klimabeirat	Climate Advisory Board
Klimaplan	Climate Plan
Merkblatt nachhaltiges Anpassungsmanagement	Guideline on Sustainable Adaptation Management
Rahmenprogramm Integrierte Stadtteilentwicklung (RISE)	Framework programme for integrated district development
RegenInfraStrukturAnpassung	Rain InfraStructure Adaptation
Stabsstelle Klimafolgenanpassung/RISA	Central office for climate adaptation

1. Problem analysis

The inevitable consequences of the climate crisis need to be mitigated as much as possible, alongside adaptation measures that need to be adequate for the different impacts on humans around the globe, to preserve livelihoods as well as possible. The amount of greenhouse gases that have already been emitted into the atmosphere has led to severe consequences worldwide, affecting almost every aspect of human life (Lee et al., 2023).

How the changed climate impacts societies and individual humans is strongly dependent on their location and political circumstances. The most widely acknowledged and described injustice is between countries of the Global North as the most polluting ones and the Global South as the most affected. This research is important and useful for describing and understanding the mechanisms leading to injustice in exposure to climate risks on a global scale but neglects the differences on a smaller scale, for example, within cities, where the majority of people live (Swanson, 2021; United Nations, 2019). A variety of research has shown that, also within urban areas, "socially and economically disadvantaged people suffer disproportionately from climate impacts" (Swanson, 2021, p. 289).

Urban planning is the discipline that is concerned with managing the built environment according to the 'public interest', improving citizens' living conditions and it is used to tackle the societal challenges that have been acknowledged in current politics (Albers & Wékel, 2017; Gunder et al., 2018a). Urban planning originated from improving the living conditions of disadvantaged urban population groups. Originally, the discipline has mainly focused on technical aspects, but tools and theories have evolved over time, and the current approaches are more complex and consider many factors that are relevant to the aim. Conceptions of the climate crisis have been mostly a technical problem for a long time, but the discussions change to view the issues as a more complex societal wicked problem (International Climate Justice Network, 2002; Lebrija Castillo, 2023). Considering these pressing threats to a safe and healthy life for many humans around the world, planning needs to be one of the main disciplines to cope with the current and expected problems. Adapting to the impacts of the climate crisis is a societal task, and planning plays a significant role in it.

The climate crisis exacerbates the already existing inequalities through three channels. Disadvantaged people are more likely to be exposed to harmful effects of climate change. They are more susceptible to damage caused by a changed climate and have a decreased ability to cope with and recover from the damage they experience (Swanson, 2021).

The growing amount of research focussing on and identifying these vulnerable groups shows that "the level of vulnerability to climate change results from a range of sociodemographic, economic, historic, and political factors, all of which operate at multiple scales" (Yang et al., 2021, p. 3). The demographic variables that have shown to make people more vulnerable to climate crisis' impacts are "age, gender, (dis)ability, ethnicity, education, and health" (Swanson, 2021, p. 289).

Actual vulnerability to climate-related risks or hazards depends on the environment. In the urban context, it is strongly influenced by the built environment, which can exacerbate or reduce the impacts of the anthropogenically changed climate. The extent to which man-induced climate change influences urban citizens is also man-made. The distribution of social or monetary costs related to climate action policies is also arbitrary. Whether an increase of costs is mainly shouldered by disadvantaged groups or by people with a high socio-economic status is decided by implemented policies and not dictated by natural sciences. The same is

true for benefits of climate action and adaptation policies (Adger & Kelly, 1999; Barnett, 2006; International Climate Justice Network, 2002).

Good climate adaptation planning is focussing on the most affected and vulnerable people and areas to have the maximum effect and use a combination of climate projections and socio-economic change to better adjust the measures to the problems rooting in societal conditions and climate risks (Greiving & Fleischhauer, 2022). "Positive and negative effects of socio-environmental processes are highly unevenly distributed across the city" (Bulkeley et al., 2014, p. 33)

Research has shown that in climate adaptation responses, cities in the Global North and especially Europe rarely take marginalised groups into account, neglecting the inequity experienced by marginalised groups in generally wealthier societies (Araos et al., 2021). A review of the current urban adaptation policies has shown the need for investigating "whether climate change adaptation planning at various scales adequately considers the needs and priorities of disadvantaged populations, both in terms of process and outcomes" (Swanson, 2021, p. 294).

For the case that is being researched in this study, it is unknown to what extent climate justice is visible through publicly available data and recognised by institutions in adaptation planning programmes and practices.

1.1. Problem formulation

With my research I aim to answer the following research questions:

How is Hamburg addressing the uneven impacts of the climate crisis, particularly on marginalised communities, and how can climate-just planning improve equitable and effective climate adaptation in the city?

- How have climate-related hazards impacted Hamburg in the past and what are the anticipated future impacts, particularly in the city's most vulnerable district?
- What are the vulnerable groups to climate-related hazards and how do they intersect with climate hazard risk areas in Hamburg's most vulnerable district?
- How are different municipal institutions planning and implementing climate adaptation measures in Hamburg's most vulnerable district to adapt to climate-related hazards?
- To what extent do relevant documents for Hamburg's climate adaptation planning align with the principles of distributive, procedural, and recognition intersectional justice?

1.2. Delimitation of the project

This study does not explore the climate impacts on Hamburg in every detail, but instead focuses on prominent climate-related hazards. Assuming that climate injustice is a structural problem in urban adaptation planning, inequities can be found here, and it is most important to look at certain, observable, and predictable impacts. Climate impacts on Hamburg are investigated using already existing data and focussing on climate hazards which have been previously identified. The climate hazards impacts are certain and well understood. Other climate impacts for which no reliable projections and data are available are not taken into account to avoid speculation.

The focus on one district in the project's analysis is done because the districts have a clearly defined border and responsibility and create their own integrated climate protection concepts and a thorough investigation of all districts would go beyond the scope of this thesis. Investigating the most vulnerable district still allows to identify climate justice issues.

The programmes and documents analysed in this project are limited to climate action plans and plans that aim to tackle social injustices following the idea of climate justice. Assuming that the municipality is the most relevant actor, different government institutions' plans and documents are analysed.

To be able to work data based in investigating injustices on a city-wide scale already existing reliable geospatial data is used. Therefore, the use and resolution of geospatial data is limited to the data made available by different public authorities.

1.3. Validation of the RQ

This study aims to uncover the extent of climate injustice that manifests itself towards intersectionally disadvantaged demographic groups in an affluent and risk-conscious city. A preliminary assessment of Hamburg's relevant climate action documents showed that they do not mention "climate justice" (Adwiraah et al., 2021; Bezirksamt Altona, 2019; Bezirksamt Eimsbüttel, 2022; *Hamburgisches Gesetz Zum Schutz Des Klimas*, 2020; *Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019; Demuth et al., 2020; Röttgers et al., 2023; Schröder et al., 2023; Stahl et al., 2017). Not mentioning climate justice hints at not recognising the climate crisis in this manner. A further investigation is therefor needed. Climate justice itself will be further elaborated on in 3.3.

There is consensus in climate adaptation research that considers social issues that "climate adaptation responses that do not incorporate equity considerations may worsen inequality and increase vulnerability" (Araos et al., 2021, p. 1454) and therefore, good climate adaptation policies should focus on the most affected and vulnerable people and areas for the measures to have the maximum effect. In Germany, climate action concepts that consider the socio-economic aspects of adaptation measures are rare. (Greiving & Fleischhauer, 2022). No comprehensive study has investigated the extra vulnerability to climate crisis impacts of marginalised groups in Hamburg. For adaptation policies in a city to effectively focus on these vulnerable people and areas, it is important to find out more about how climate hazards manifest and who they affect. This lays the foundation to assess existing and future climate adaptation plans in improving the living conditions of disadvantaged groups. Previous studies have stated that "it is productive and indeed necessary to examine how climate justice is being pursued at the urban scale" (Bulkeley et al., 2014, p. 39)

This research is closely aligned with the UN's Sustainable Development Goals (SDGs), namely Goals 11, 13, and 16. SDG 11, which focuses on creating inclusive, safe, resilient, and sustainable cities and human settlements, directly intersects with the study's exploration of how urban areas can effectively adapt to climate change while ensuring justice and equity for all residents. This research addresses the targets 11.3, 11.5, 11.7, and 11.b, which focus on aspects of improved urban planning, enhanced resilience and protection from disasters with attention to poor and vulnerable people, increased access to green spaces, and the integration of climate considerations into policies and strategies. Additionally, SDG 13, calling for urgent action to combat climate change and its impacts, serves as a core driver for the research project, examining deficits in adaptation measures and planning and how addressing climate-related challenges can be improved. Lastly, target 16.7 of SDG 16, focusing on promoting

inclusive and participatory decision-making, highlights the importance of incorporating justice considerations in climate adaptation planning processes. By addressing these specific SDGs and their targets, this study contributes to the broader global agenda of sustainable development and fosters the integration of climate justice principles into urban climate adaptation planning (*Transforming Our World: The 2030 Agenda for Sustainable*, 2015).

2. Research Design and Methodological Framework

2.1. Research Design

This chapter explains the research design and the methods used to answer the research questions. This study employs a mixed-methods approach to examine the exposedness to climate hazards and the current state of climate action plans through the lenses of climate justice and intersectionality. An overview of the research design is shown in Figure 1Fehler! Verweisquelle konnte nicht gefunden werden..

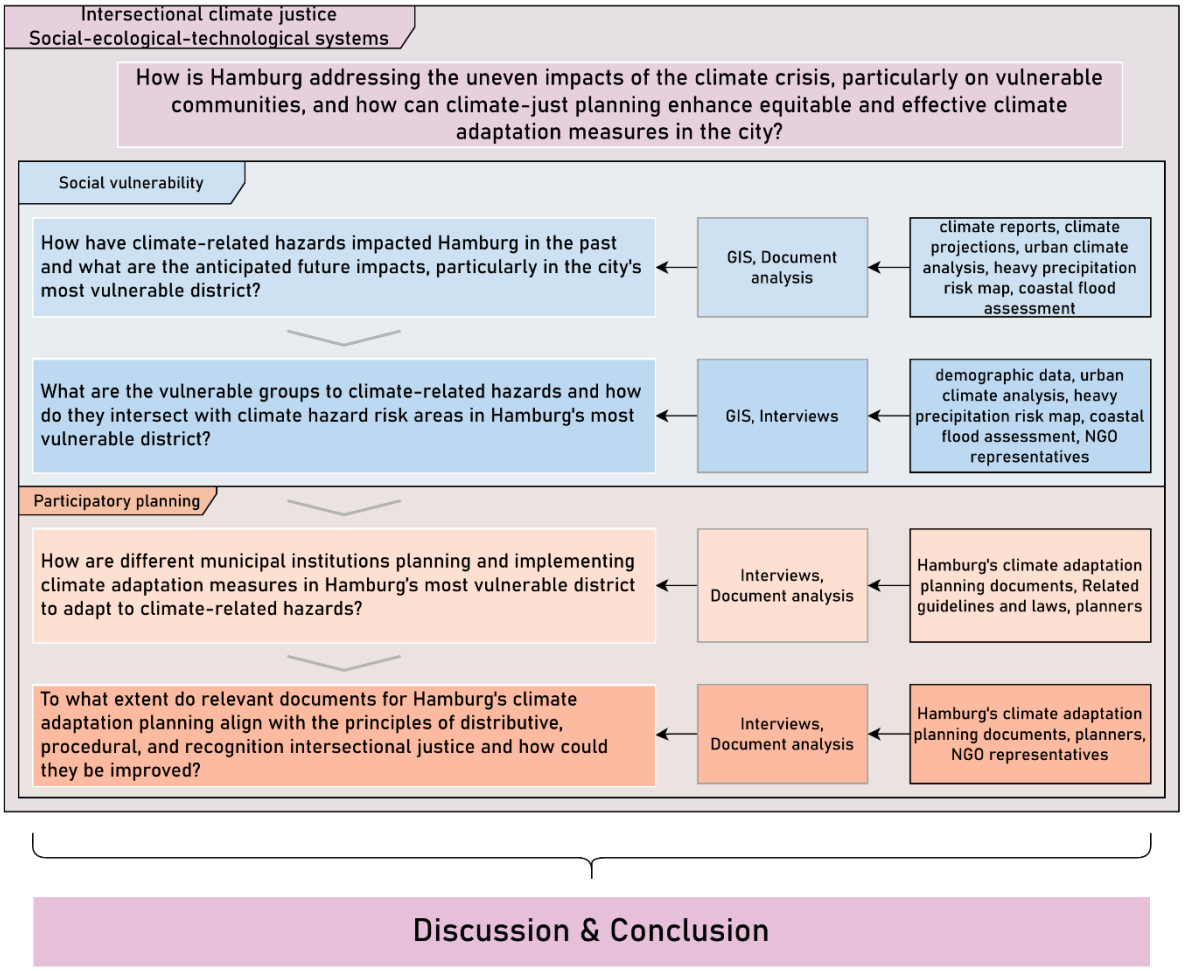

Figure 1 Research Design

This study is observing one city as a case study and then focusses on one of its districts to dig deeper. Point of departure is Hamburg's *Klimaplan*[1] issued by the city's government, it is outlining their perception of climate change, the most important climate impacts on Hamburg and the measures intended to tackle the implications. The identified most important climate impacts are taken from this document and further investigated by a literature review and the

[1] Climate plan; translation to German terms can be found on p. VI

use of geospatial information in geographic information systems (GIS). After the climate impacts on Hamburg and its effects on the most vulnerable citizens are explored by analysing documents and conducting interviews, the planned and implemented climate adaption in Hamburg's most vulnerable district is investigated using an analytical framework based on intersectionality and climate justice. In the end improvements to the planning practice are suggested based on the analysis and climate justice considerations.

Geospatial data is gathered from official records and used in GIS to identify areas with high levels of vulnerability to climate change impacts, such as flooding from storm surges and heavy rain as well as extreme heat. It is then analysed how these areas intersect with different demographics and in particular marginalized communities. Relevant government documents are analysed in terms of proposed measures and their consideration of vulnerable and marginalized groups and whether their mentioned measures support these groups.

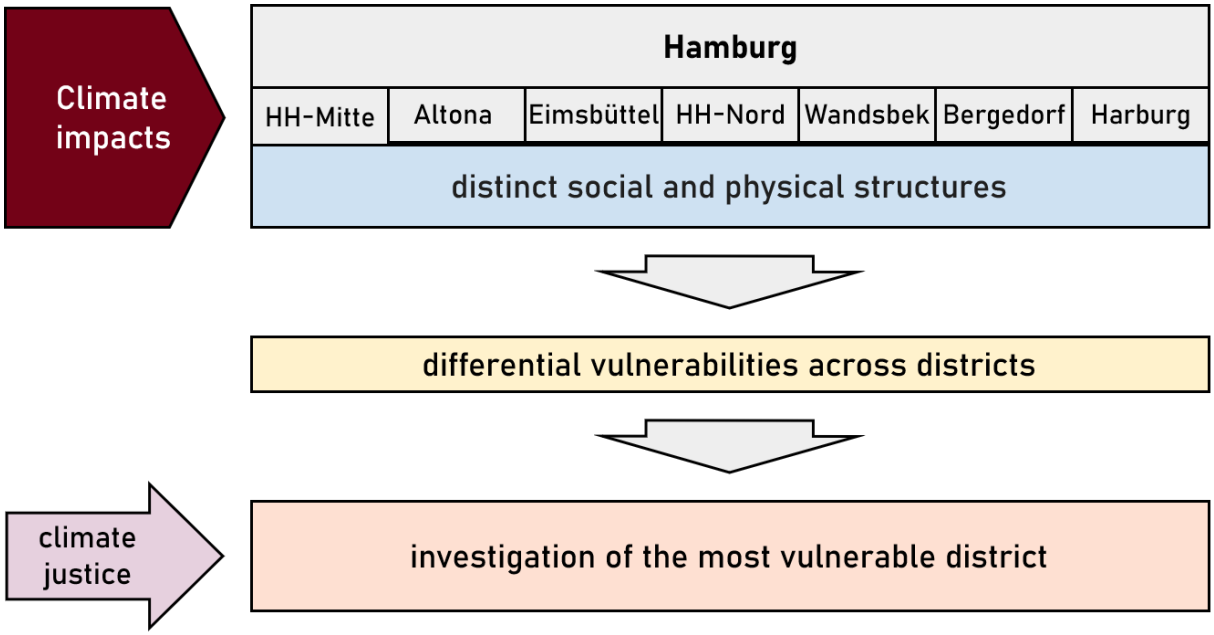

Figure 2 Case selection

Following the spatial analysis, the district with the highest ratio of people with low socio-economic status, and susceptibility to climate related risks is chosen to be investigated in more detail. For this purpose, semi-structured interviews with key stakeholders are conducted. The interview partners include the people in charge of creating the plans for district's climate adaptation measures and representatives from marginalised communities and advocacy groups mentioned in the planning documents. The planning authorities and their documents, and tasks are also considered.

2.2. Methodological framework

2.2.1. Utilisation of Geographic Information Systems

Geographic Information Systems are used to analyse, edit and visualize the relevant information to display and further analyse these results as well as help to identify relevant

interview partners. The use of GIS will enable the presentation of connections from different data sets which have not been seen before. In this study, GIS will be used to create maps that display the spatial distribution of areas prone to climate hazards and how they coincide with disadvantaged demographic groups.

Geospatial data is mainly gathered from different official sources. One relevant source is Hamburg's official geoinformation website: Geoportal Hamburg where most publicly recorded and created data concerning Hamburg is made available to the public. The data is downloaded, processed in QGIS and ArcMap to identify areas with high levels of vulnerability to climate crisis impacts, such as flooding and extreme heat, and analysed how these areas intersect with different demographics and in particular marginalized communities.

Geoportal Hamburg provides the geospatial data on risk areas due to flooding from storm surges or heavy rainfall. For information on the prevalence of the urban heat island effect in Hamburg an analysis by Hamburg's Ministry of Urban Development and Housing is used, called "Stadtklimaanalyse 2017". The analysis took into account the natural environment and the city's built environment and simulated different scenarios highlighting the temperature differences within the city. Heat hotspot areas are defined as areas with top 25% of temperatures and relevant areas to be affected by flooding through heavy rain is depth above 10 cm.

Demographic data based on Hamburg's quarters is obtained from Statistikamt Nord and included in the spatial analysis. Information about the spatial distribution of different social classes within Hamburg is taken from another analysis of Hamburg's Ministry of Urban Development and Housing, called "Sozialmonitoring". Different demographics are used to create a combined status to indicate the social status of neighbourhoods. These indicators include immigrant youth, children of single parents, people receiving asylum seekers payments as well as children, adults and elderly receiving unemployment benefits (Pohlan et al., 2010).

Following the concepts of climate justice and intersectionality, Hamburg's most vulnerable district for the in-depth analysis is identified by combining the considered climate hazards with the social status of the district's population. The district with the biggest population with a very low social status is chosen that also fits the following criteria. The district:

- has residential areas that show the highest temperature in the urban climate analysis due to the urban heat island effect.
- is considered to be at risk in a storm surge event with the affected areas being residential and covering more than 5 % of its overall area.
- has residential areas which are prone to flooding in heavy rain events.

In the district, facilities that accommodate vulnerable groups are further investigated. Geo-data about climate hazards and locations of kindergartens, retirement homes and homeless people. They are identified by gathering the locations of the facilities from public sources including Geoportal Hamburg and hamburg.de's Branchenbuch. The positions of all institutions in the district were geocoded and geo-referenced and afterwards connected with the building's shapes as displayed on open street map. The polygon layer showing the buildings was acquired through overpass-turbo.eu. By combining heat hotspots and a risk map for heavy precipitation exposed institutions are identified.

2.2.2. Utilisation of Semi-structured Interviews

Semi-structured interviews are a research method employed in this study to gain practical information and a deeper understanding of the planning processes. This method provides a level of structure to ensure that key topics are covered but it also allows for a level of flexibility. During the interviews a set of predetermined questions is used with the option for open-ended follow-up questions based on the interviewees' responses. This approach is particularly useful when researching topics that do not have clear, concise answers, and allow the exploration of paths to unexpected new insights (Steinar Kvale, 2007).

The interview partners are identified and chosen based on their connection to the research topic. The people that are contacted include the authors or respectively departments responsible for the relevant official climate adaptation documents, NGOs and other institutions working with disadvantaged vulnerable groups as well as climate activists. The contacted people and institutions are listed in Table 1 in alphabetical order.

Table 1 Overview of requested interviewees

Contacted institution	Description
Bezirksseniorenbeirat Hamburg-Mitte	Institutionalised representation of elderly in Hamburg-Mitte
Departement Hochwasserschutz (BUKEA)	Ministry's department responsible for flood protection
Departement Klimastrategie Stadt und Bezirke (BUKEA)	Ministry's department responsible for climate action strategy
Energielotsen Hamburg	Public consulting service for citizens to adapt their homes and make them more energy efficient
Fridays For Future (Hamburg)	Local activist group of global climate justice movement
Hinz&Kunzt	NGO working with and helping homeless people in Hamburg
Klimaschutzmanagement Hamburg-Mitte	responsible department in Hamburg-Mitte's district administration for climate action planning and the integrated climate protection concept (IKK)
Klimaschutzmanagement Harburg	responsible department in Hamburg-Harburg's district administration for climate action planning
MOSAIQ e.V.	NGO situated in Hamburg-Mitte, focussing on anti-muslim and anti-black racism
Provider of kindergartens in risk areas (62)	Kindergartens lying in urban heat island risk and areas at risk of flooding from precipitation
Provider of retirement homes at risk (11)	Retirement homes lying in urban heat island risk and areas at risk of flooding from precipitation
RISE – Bezirks-Gebietskoordinator/in (6)	People responsible within Hamburg-Mitte's district administration for the RISE programme areas

Stabsstelle Klimafolgenanpassung/RISA (BUKEA)	Ministry's department that coordinates climate adaptation and is responsible for adaptation to heavy rain
Zentrum für Energie, Bauen, Architektur und Umwelt (ZEBAU)	Engineering company involved in creating Hamburg-Mitte's integrated climate protection concept (IKK)
Integrationsbeirat Hamburg	Hamburg's advisory board for integration of refugees

The disadvantaged groups were identified by their vulnerability noted in literature towards a specific climate-related impact. The potential interview partners are identified by internet searches and mentioning of stakeholder groups in the documents, they are contacted via phone or e-mail. Stakeholders which expressed that they did not have the time for a semi-structured interview were asked to answer a set of questions via e-mail. Interviews were conducted in German and preferably in person. If it was not possible to meet up, they were conducted via video call or phone. The interviews are analysed focussing on their meaning.

If the interview partners prefer not to be recorded, instead notes are taken and immediately after the conversation a protocol is written to record what was said as accurately as possible. The interview protocols can be found in the annex.

2.2.3. Utilisation of Document analysis

Document analysis is a qualitative research method, usually used in combination with other research methods. It is a systematic procedure to review or evaluate different types of documents, involving skimming, reading and interpreting. Out of Bowen's (2009) five mentioned uses, this research uses the method to provide context, provide supplementary data, verify findings and facilitate further questions used for the research in general and for interview questions. The documents were searched for keywords and its table of contents and, if available, executive summary was read (Bowen, 2009).

For this research, document analysis proved to be valuable determining climate adaptation measures, assessing how climate justice is mentioned and of relevance in climate adaptation planning and how climate adaptation is relevant in planning for disadvantaged communities. The analysed documents and the analysed data are shown in Table 2.

Table 2 Analysed documents

Documents selected	Data analysed
Ergebnisbericht des Projektes RISA-RegenInfraStrukturAnpassung (Waldhoff et al., 2015)	Adaptation measures towards heavy precipitation Use of social factors and climate justice concepts
Förderrichtlinie Maßnahmen zur Anpassung an die Folgen des Klimawandels (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 2021)	Use of social factors and climate justice concepts
Fortschreibung Integriertes Entwicklungskonzept Sanierungsgebiet Gängeviertel / Valentinskamp (Bezirksamt Hamburg Mitte & Steg Hamburg, 2019)	Climate adaptation measures

Hamburgisches Klimaschutzgesetz (*Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019)	Legal requirements Climate justice considerations
Hintergrunddokument der Freien und Hansestadt Hamburg zum Hochwasserrisikomanagementplan der Flussgebietsgemeinschaft Elbe (BUKEA & LSBG, 2021)	Adaptation measures towards storm surges Use of social factors and climate justice concepts
Integriertes Entwicklungskonzept für Wilhelmsburg Ost (Korallus-und Bahnhofsviertel) (Bezirksamt Hamburg-Mitte, 2023)	Climate adaptation measures
Integriertes Entwicklungskonzept RISE-Fördergebiet Veddel (Bezirksamt Hamburg-Mitte, 2020)	Implementation of climate adaptation measures
Integriertes Klimaschutzkonzept Altona (Bezirksamt Altona, 2019)	Use of social factors and climate justice concepts
Integriertes Klimaschutzkonzept Bergedorf (Stahl et al., 2017)	Use of social factors and climate justice concepts
Integriertes Klimaschutzkonzept Eimsbüttel (Bezirksamt Eimsbüttel, 2022)	Use of social factors and climate justice concepts
Integriertes Klimaschutzkonzept für den Bezirk Hamburg-Nord Berichtsteil I: Grundlagenbericht (ENTWURF) (Schröder et al., 2023)	Use of social factors and climate justice concepts
Integriertes Klimaschutzkonzept Hamburg-Harburg (Adwiraah et al., 2021)	Use of social factors and climate justice concepts
Integriertes Klimaschutzkonzept Hamburg-Mitte (Röttgers et al., 2023)	Climate adaptation measures Use of social factors and climate justice concepts
Hamburger Klimaplan (*Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019)	Planned climate adaptation measures Use of social factors and climate justice concepts
Richtlinie zur Förderung von Klimaschutzprojekten im kommunalen Umfeld „Kommunalrichtlinie“ (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 2020)	Use of social factors and climate justice concepts
Fortschreibung des Integrierten Entwicklungskonzeptes Billstedt/Horn (Bezirksamt Hamburg-Mitte & steg Hamburg, 2021)	Climate adaptation measures

2.2.4. Literature review

First a literature review is conducted. To find relevant literature for the current state of research, the theory and methodology section, a comprehensive search was conducted using

Scopus, Primo (Aalborg University Library's search engine), Google scholar and for more specific German literature Technische Informationsbibliothek (TIB), Gemeinsamer Verbundkatalog (GVK). The search was not restricted by publication dates or geographical delimitations.

As a starting point to investigate the current state of research on just urban climate adaptation, a search of review articles was conducted using the Scopus database. A set of specific keywords was used and searched for in the TITLE-ABS-KEY format, which allowed to find relevant articles. The following search string was used to find the literature:

> (urban* OR cities OR city OR municipal) AND (climate) AND (justice OR injustice OR inequality OR power OR inequity) AND (adapt* OR solution) AND (planning OR plan) AND (vulnerab* OR marginal* OR discriminat*) AND (LANGUAGE,"English" OR LANGUAGE,"German") AND (DOCTYPE,"re")

The search showed 13 results. Out of these documents the four documents that reviewed research literature regarding climate justice in the urban context were chosen as starting points for the literature review. The literature review regarding the theoretical framework was further expanded by looking into the publications they referenced.

To find literature specific to the German context multiple databases were used, first Scopus with the following search string in the TITLE-ABS-KEY format:

> (urban OR city OR municipal) AND (climate) AND (justice OR injustice OR inequality OR power) AND (adaptation OR solution OR resilien*) AND (planning OR plan) AND vulnerable OR vulnerability OR marginal* OR discriminat*) AND (europ* OR german*)

The search gave back 11 results. One of the results fulfilled the criteria of being specific to the German context of climate justice considerations in urban planning. Another article was found useful for the general review of climate justice scholarship. The search was continued in the databases TIB and GVK to find German literature concerned with climate justice aspects in urban adaptation planning using German translations of the key words. After multiple iterations of getting no results, the literature found in TIB with the following keywords was assessed:

> (umwelt*gerecht* OR klima*gerecht*) AND (klima*anpass* OR klima*adaption* OR maßnahm* OR klima*resilien*) AND (urban* OR stadt* OR städt) AND (plan* OR Stadtplan* OR Stadtentwick*)

This resulted in 8 findings. Two of those documents reviewed urban climate adaptation planning and were used for the literature review. They also made suggestions to administrations for climate adaptation planning. In GVK, the search functions were more limited. All available sources were searched, and the following search strings were used to find literature either focussing on climate adaptation or climate justice aspects in cities:

- (Klima*anpass*) UND (*plan*) UND (Stadt*)
- (Klima*anpass*) UND (Klimagerecht* ODER *Gerecht* ODER gleich*)

The search in the GVK databases gave back 15 results for the first search string and one for the second. The results' abstracts and table of contents were screened for mentioning climate justice aspects and focussing on adaptation in urban areas. One result, a guideline for urban climate adaptation planning, fulfilled the requirements and was reviewed in more detail.

The relevant climate action plans and other official documents specific to Germany and Hamburg including the district specific *Integriertes Klimaschutzkonzept (IKK)* were found via the search engine duckduckgo and snowballing through the official websites. The documents include Hamburg's *Klimaschutzgesetz*, *Klimaplan*, the district's *Integriertes Klimaschutzkonzept, Hochwasserschutzmanagementplan* as well as the urban development programm *RISE*.

To find literature for social-ecological-technological systems the Scopus search engine was used with a set of specific keywords in the TITLE-ABS-KEY format. The following search string was used to find the literature:

> ((social AND ecological AND (technical OR technological) AND systems) AND (urban) AND (framework) AND (climate))

3. Theoretical framework and background

This chapter introduces the theories used as a basis to understand and investigate the research questions. The theoretical framework consists of Social-ecological-technological systems (SETS) as the underlying idea used in this research. Explaining that the different systems understood as social, ecological, and technological are interconnected and shape human lives fundamentally, participatory planning as the leading planning idea as well as climate justice and intersectionality. Climate justice concerns itself with the observed phenomena that marginalised communities tend to be the most heavily affected by climate changes impacts and least considered in climate action aspects while emitting the least greenhouse-gases (CorpWatch, 2001; Mikulewicz et al., 2023). Intersectionality theory is crucial in understanding more complex discrimination forms and addressing these complex issues related with climate justice in urban contexts. After the exploration of the different theories a combined analytical framework will be presented on which the climate justice analysis is based on. An overview of the current state of research in the field of justice considerations in urban climate adaptation and the specific adaptation planning in the German context are further provided.

Social-ecological-technological systems refer to a theoretical framework that recognizes the interconnections and interdependencies between society, the environment, and technology. The fairly new conception suggests the need to analyse their interactions holistically rather than in isolation. The framework builds on social-ecological systems (SES) and sociotechnical systems (STS), two established concepts that highlight and explain mutually shaping connections between humans and natural systems as well as societies and its used technologies. In recent years the two frameworks tapped into considering technology and ecology respectively (Ahlborg et al., 2019).

The basis for arguing to not separate these frameworks is because in modern industrialised and urbanised societies "every basic human need […] is now mediated through a technical system." (ibid., p. 8) and "as we learn to use these technologies, we are moving from using nature to intervening directly within nature." (ibid., p. 9) But while this is happening and humanity's impacts also on its relationship with their natural environment are recognised, SES is criticised as appearing to lose sight of technology's role in this. Similarly, it is noted

that sociotechnical dynamics play a critical role in both environmentally harmful practices and the effectiveness of environmental solutions.

SETS has been proposed to bridge this and improve "understanding of system dynamics at some of the interfaces between sociotechnical systems and social-ecological systems that have so far received very limited attention" (ibid., p. 19) It is not concepted as an always best-fitting analytical framework, but it should be used to consciously reflect on the central location of technology. Cities have been conceptualised as social-ecological-technological Systems (McPhearson et al., 2022)

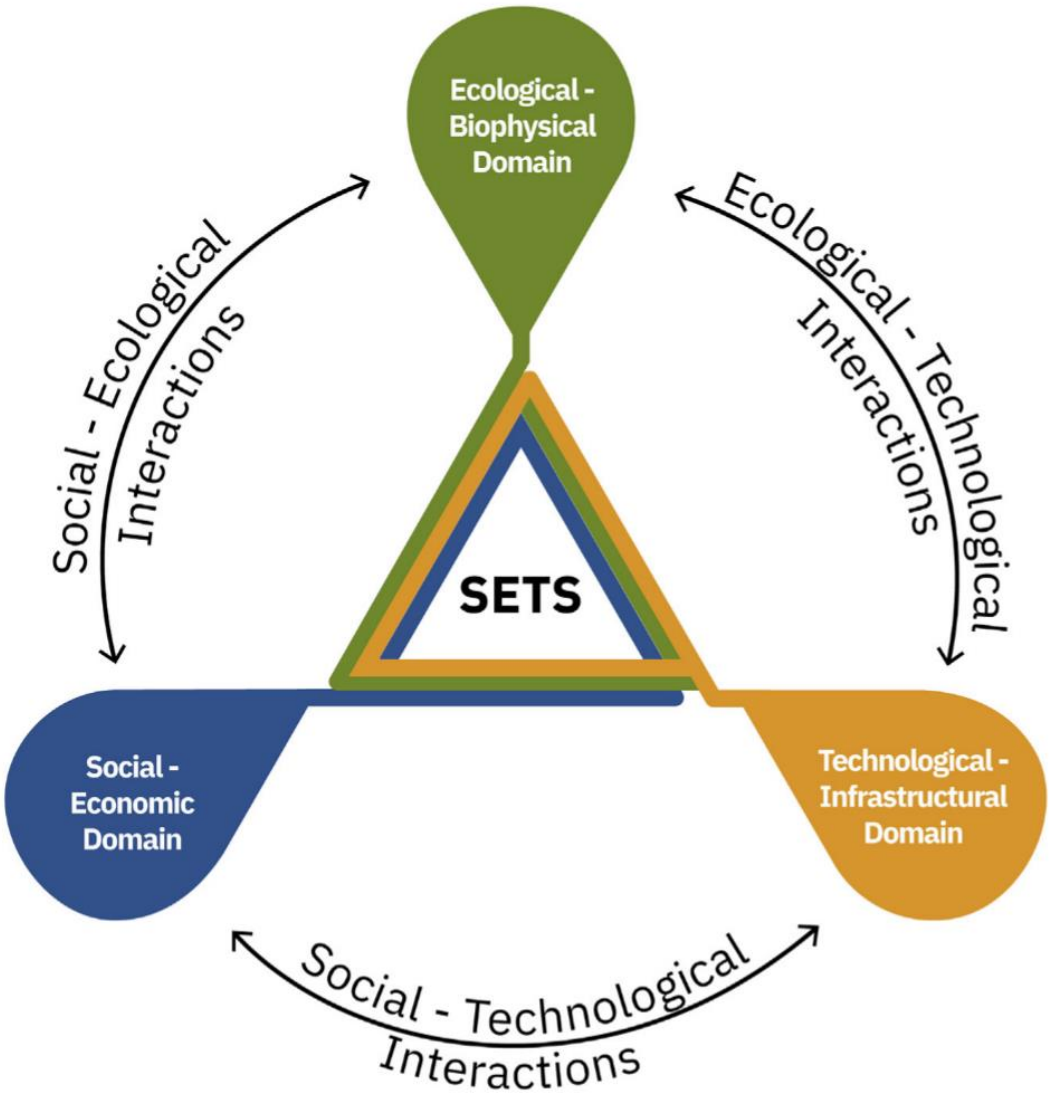

Figure 3 Social-ecological-technological systems and its domains (Ahlborg et al., 2019)

3.1. Social vulnerability in context of the climate crisis

Adaptation, resilience and vulnerability are related concepts important to understand climate crisis' impacts on different people. Resilience is defined as a "system's capacity to adapt or

transform in the face of change to support sustainability“ (Greiving & Fleischhauer, 2022, p. 114). This concept can be applied to the urban context and include the different social, ecological, and technological dimensions becoming relevant to an urban system in the light of the climate crisis. Resilience is a system-based approach that makes use of adaptation practices. Adaptation measures are intended to address perceived risks directly and effectively, thereby supporting a system's resilience. The risk of being exposed to climate hazards is the important factor for human life. Risks consist of exposure to the physical hazard itself and the capacity to deal with it, which can be referred to as the vulnerability (Adger & Kelly, 1999). There are two easy to grasp versions of how to conceptualise vulnerability: it can be described as a lack of resilience or normatively that increasing resilience reduces vulnerability (Greiving & Fleischhauer, 2022). Vulnerability is "largely determined by the socio-economic status and property relations" (Adger & Kelly, 1999, p. 256) and therefore socially constructed. Socially vulnerability is based on the extent to which people can make use of resources, their capability. It includes materials on the individual level, access on a community level and the institutional level.

In assessing risk, vulnerability, and the responses of adaptation measures, consideration of spatial and temporal dimensions are necessary to adequately grasp the issues (Christmann et al., 2012). Some authors emphasize "the multifunctional and multidimensional character of resilience" (Greiving & Fleischhauer, 2022, p. 117) and name mapping and scenarios as the appropriate methods (ibid.). Vulnerable people and communities in this study are people who are politically marginalised and additionally, according to statistics, are more heavily impacted by the climate crisis. These include: elderly with low-income, children with a low social status, homeless and areas with a low social status in general.

3.2. Participatory planning

Participatory planning is an umbrella term for related but distinct theories and models that see inclusion of the general public or a specific community as central for decision-making processes in regional and urban planning. The different notions such as transactive, advocacy, and communicative planning originated from the criticism on previous planning ideas (Lane, 2005). Planning is embedded in bigger policies to follow one or multiple aims and it is one instrument to achieve bigger goals (Albers & Wékel, 2017). Planning has significant impacts on people's lives and society in general: "depending on how we use it, planning can result in disempowerment and marginalization or empowerment and the achievement of peace and political compromise in contested cities." (Jabareen, 2018, p. 291)

In the beginning of modern planning 'the public interest' has been the guiding criterion for planners: the state should pursue the needs and interests of all citizens for the greater good and not private or sectoral interests (Moroni, 2018). This way of 'blueprint planning' saw planners as omniscient rulers, technical experts or as doctors of sick cities, being dominant up until the 1960s (Albers & Wékel, 2017; Lane, 2005). Their plans were created in the spirit of providing societal guidance following a "rational-comprehensive approach, [that] involves: a survey of the region, an analysis of the survey, and finally the development of the plan." (Lane, 2005, p. 288)

However, this way of 'blueprint planning' was criticised for its failure to consider society's actual goals and objectives as well as missing the importance to resolve conflicts between means and ends, which are now considered central to a planner's work (Lane, 2005). An important change occurred in the 1950s and 1960s: alongside the spreading of cars, synoptic planning was introduced. This notion was made up of 4 central elements: "

1. An enhanced emphasis on the specification of goals and targets;
2. an emphasis on quantitative analysis and prediction of the environment;
3. a concern to identify and evaluate alternative policy options; and
4. the evaluation of means against ends" (Lane, 2005, p. 289)

This concept was criticised but also praised for its simplicity. Furthermore, it was still using the idea of a unitary 'public interest' that assumed in societies there are universally shared goals above sectoral interests while disregarding objections and conflicting interests. Although some changes happened in planning paradigms occurred and limited public comment was institutionalised, the rational-comprehensive continued to dominate planning in practice. The degree of participation in this is criticised as tokenism referring to Arnstein's 'Ladder of Participation' (Arnstein, 1969; Lane, 2005).

Beginning in the 1970s, this started to change, and the idea of societal transformation became more prominent, arguing "that the state and other institutions need to be transformed in order that the conditions of others can be ameliorated." (Lane, 2005, p. 287) Planning turned away from its rational-comprehensive outlook and theories turned towards more inclusive democratic processes. Planning became increasingly precepted as normative and political and embedded within broader policies. Collaboration with regular non-specialist citizens increased through demands of low-income groups (Albers & Wékel, 2017; Gunder et al., 2018b). The essential aspects of participatory planning in scholarship include:

1. Emphasis on planning's political nature as well as recognising its ideological and distributional dimensions, and therefor highlighting the importance of public involvement.
2. Assumption of political plurality and an atomistic society with individual actors that have varying, competing, and contradicting interests. The notion of one unitary public interest is rejected.
3. The function of participation in decision-making and planning as a fundamental element compared to being an adjunct (Lane, 2005).

The notion of one unitary 'public interest' has been criticised from different perspectives and while not being completely dismissed, academics recommend to critically examine and redefine the understanding of the term (Moroni, 2018). With participatory planning becoming more mainstream, it has been institutionalised in many cases. Undisputed is the positive impact of institutionalised citizen participation that "increases the information available to policy-makers by providing local knowledge" (Fainstein, 2018, p. 135).

But participatory planning has been criticized as not incorporating the voices of the marginalized groups in practice as promised and rather favouring middle-class interests (Fainstein, 2018). In more radical terms some authors have criticised it for "allowing the poor to administer their own dependency" (Jabareen, 2018, p. 290) instead of an actual change and not managing to topple this because of limited resources and hegemony of neo-liberalism (Gunder et al., 2018).

The concept of participatory planning is closely related to notions of procedural justice within climate justice theory, emphasizing the importance of inclusive decision-making processes which is outlined in 3.3.

3.3. Climate Justice in the Urban context

Climate justice refers to a fair distribution of burdens due to climate crisis' impacts and the benefits of climate action policies and measures as well as just processes while recognising previous history. This sub-chapter begins with a brief history of climate justice and its evolution over time, followed by an overview of the current state of the research. The core ideas, and different conceptions of climate justice and intersectionality are explored. Climate justice usually focuses on historically marginalized groups who are disproportionately affected by the impacts (Schlosberg & Collins, 2014).

The term climate justice and the ideas referring to it have gained prominence in discussions about the climate crisis in the last years. Some authors even state that the concept "is now omnipresent in debates about the climate emergency" (Newell, 2022, p. 1). Even though issues of climate justice have been touched upon in relevant international agreements and other documents like the UN Framework Convention on Climate Change and IPCC reports before, e.g. by mentioning the "common but differentiated responsibilities and respective capabilities" (*United Nations Framework Convention On Climate Change*, 1992, p. 4), the prominent notions of climate justice did not start from a purely academic perspective (Lee et al., 2023). Activists played a significant role, they were trying to shift the discussions and proposed solutions away from climate change being set "mostly in the technical arena" (International Climate Justice Network, 2002, p. 1) to making it a human rights issue (CorpWatch, 2001).

The origins of climate justice lie in the grassroots movements of environmental justice in the United States which criticised the unjust exposure to environmental pollution and risks of marginalised communities in the 1980s. Over the years, more and more issues were added to the original agenda including global environmental issues, like the climate crisis. The climate crisis was integrated in the environmental justice considerations in the late 1990s – 2000s when its impacts became more apparent. And subsequently the term climate justice was born (Schlosberg & Collins, 2014). The further development of climate justice followed shortly. Barnett (2006) summarised the climate justice scholarship with the following key points:

1. Responsibility for causing the climate crisis is unequally distributed, countries in the Global North and wealthy people in general being the main emitters of greenhouse gases.
2. Climate crisis' impacts will affect people differently with countries in the Global South and already disadvantaged groups being the most vulnerable to the impacts.
3. Political-economic processes shape experienced and observed inequities. The processes benefit some groups and disadvantage others.
4. Climate crisis' effects compounds inequities.
5. Climate Action policies can create unfair outcomes by ignoring, maintaining, or exacerbating inequities (Barnett, 2006).

Later framings of climate justice built on this, dove deeper using different foci while still containing the same key points. In the research field of urban climate justice and planning accordingly, it is commonly accepted that procedural, distributive, and recognition justice are the important conceptions to consider in the urban context (Amorim-Maia et al., 2022; Bulkeley et al., 2014; Shi et al., 2016). These authors are drawing from Schlosberg's (2004) work that provided a unified framing for global environmental justice as being threefold.

There are two notions that are also used and framed as forms of climate justice: rights and responsibilities, they are usually used in international contexts (Bulkeley et al., 2014).

The mentioned notions of justice are not isolated categories standing for themselves. Procedural justice and recognition justice can be considered as a component and as a prerequisite for achieving justice. They are distinct forms and experiences of injustice, but they are closely connected to distributional inequalities (Bulkeley et al., 2014). "without recognition […] true procedural justice is impossible to achieve, and distributions are likely to be affected too, whether they are distributions of rights or responsibilities." (ibid., p.39)

1. Distributive justice is concerned with producing fair outcomes. The goals is to achieve "equal and fair distribution of opportunities, resources, and environments free from climate hazards and risks regardless of individual/group identity or background." (Chu & Cannon, 2021, p. 89) It is following "Rawls (1971) classic definition of justice as the distribution of goods so that they benefit the disadvantaged the most" (Mohtat & Khirfan, 2021, p. 2). The concept has evolved to encompass various aspects such as time, space, scale and topic. In the urban context, "it refers to a fair spatial and temporal distribution of the material and social advantages and disadvantages of adaptation responses among urban communities regardless of their diverse socio-economic conditions, adaptive capacity, and political voice" (ibid.)
2. Procedural justice focuses on fair and inclusive decision-making processes. The fulfilment of this notion is evaluated based on the degree to which "procedures are transparent, accountable, and include diverse voices, values, and viewpoints"(Chu & Cannon, 2021, p. 89). To achieve procedural justice a special focus is set on including the voices of marginalized and vulnerable communities in creating the plans to ensure equal access to democratic decision-making methods including participation, deliberation, and negotiation (Bulkeley et al., 2014).
3. Recognition justice refers to acknowledging the different identities, values, and perspectives of individuals and communities, and the need to incorporate these into the decision-making process. Considering the differences thus means taking historical and systemic injustices in account and adjusting processes accordingly (Bulkeley et al., 2014; Chu & Cannon, 2021).
4. Rights refer to the entitlements of individuals and communities to emit greenhouse gasses as well as to benefits from climate action and protection from dangerous environments (Bulkeley et al., 2014).
5. Responsibility in climate justice discussions refers to the obligations of different actors, such as individuals, private sector actors, NGOs, and governments, to respond to climate change and ensure that their responses meet distributive goals (Bulkeley et al., 2014).

3.3.1. Current discourses on justice in urban climate adaptation planning

A more fundamental critique on climate injustice is found e.g. in Amorim-Maia et al. (2022) whose theoretical frameworks focusses on recognition justice and identifies the historically built and developed "racial and gendered capitalism" (ibid., p.6) as the underlying root causes of climate injustice, criticising the "colonial, scientific, technocratic, and expert-driven approaches to planning and development" (ibid., p.6) which result in "historical and structural inequalities, pre-existing risks and urban vulnerabilities" (ibid., p.6) (Amorim-Maia et al.,

2022). Therefore, the goal should be to “dismantle systems of gender and racial oppression and subordination” (Amorim-Maia et al., 2022, p. 6) and to “rethink planning from a care perspective” (ibid.)

In general previous justice conceptions are critiqued by saying that “traditional framings of justice as a matter of ensuring 'fair' distribution of resources or access to decision-making processes are captive to the contexts in which they are created, suggesting different questions need to be asked.” (Bulkeley et al., 2014, p. 33)

“We argue that, rather than confine analysis to the principles by which climate justice might operate, it is vital to examine empirically the processes which structure urban political economies, the relations of power within them, and the opportunities for contesting existing responses and developing alternatives.“ (ibid.)

Questions of (in-)justice in urban climate action planning have been discussed in the scholarship for more than 15 years. Even though conceptions of climate justice have been around for decades and urban climate justice for many years, many climate action and adaptation plans have a technocratic base or outlook (Chu & Cannon, 2021). Some authors go even further and argue that it is valuable to take the non-human world in to the consideration, which other authors working on climate justice in the urban environment usually not consider (Mohtat & Khirfan, 2021; Steele et al., 2012).

Even though some climate action plans made use of climate justice considerations, comprehensively taking in account the different dimensions of justice, is anything but the norm. (Bulkeley et al., 2014). A large systematic review of climate adaptation-related responses has shown that climate justice considerations are not the norm. Considering questions of climate justice are less frequent in cities, where in only 37% of investigated cases equity played a role in adaptation planning and 44% in implementation (Araos et al., 2021). Considerations of equity differ also significantly in regions around the globe. In European literature only 26% mention climate justice aspects. For the less common consideration of equity in European adaptation responses, a possible explanation is the more top-down planning and implementation. In comparison, in the Global South bottom-up planning is more regular. (Araos et al., 2021).

Although it is consensus in the theoretical consideration that all justice aspects should be taken into when aiming for climate just adaptation measures, they are not given the same importance. In literature and actual planning when justice was considered the focus has been on achieving distributive justice, questions of procedural and recognition justice are underrepresented (Araos et al., 2021; Swanson, 2021). Especially in the Global North, distributive justice is the dominant notion (Araos et al., 2021).

Just as important as the question of which justice conceptions are prevalent is the question of which disadvantage-mechanisms are named and considered to be important for adaptation planning. Araos et al. (2021) have shown that “overall, across regions and sectors […] adaptation practices rarely consider age, disability, or migrant status in the planning or implementation stages” (p. 1461). In the cases where a disadvantage is considered, it mainly is inequity based on low-income (ibid.).

To achieve procedural justice, vulnerable groups need to be substantially involved in the planning process. Currently, research has shown that “participatory mechanisms primarily became a vehicle for middle-class interests.” (Fainstein, 2018, p. 135) As opposed to its original purpose of empowering low-income groups (Fainstein, 2018). Indicating that even

though inequity based on low-income is the most considered injustice, it has not changed the practice of decision-making to be more procedural just.

As a reason for unjust adaptation measures a simplifying distinction between urban populations is used between the “urban elite, who have the political influence and financial stability to insulate themselves from climate change, and the urban poor, who find themselves lacking the capacity to reduce the direct and indirect impacts of climate change" (Swanson, 2021, p. 290).

This relationship between the two groups is used to explain the two ways how climate action measures can increase the vulnerability of disadvantaged groups. Through:

1. Injustice of commission, which refers to adaptation inventions during which marginalized are heavily affected or displaced. This is more common in the Global South.
2. Injustice of omission, which refers to the prioritisation of adaptation measures in wealthier communities over measures from which marginalized groups would profit more (Swanson, 2021).

Injustice of commission does not recognise previous vulnerabilities and creates new ones by actively making use of unjust processes. It creates a new adverse situation for marginalised groups against which they are not able to resist. In acts that create injustice of omission, there is an aim to have fair outcomes but it lacks just procedures thereby creating unjust results.

Several practical difficulties have been identified in implementing climate justice ideals in adaptation measures. One is to determine who is part of a vulnerable group that needs to be favourably addressed and included in the process and on who the measures should focus on. Also, the definition of who is vulnerable is more dynamic than often assumed. Some authors see in practice a "trade-off between procedural justice considerations that ensure equity and justice outcomes in the short-term, and long-term viability of adaptation agendas" (Swanson, 2021, p. 293) Additionally, researchers focussing on climate justice are concerned “whether and how adaptation may be introducing new forms of vulnerability for some people and places, and about the equity dimensions of these potential redistributive effects.” (Swanson, 2021, p. 291)

The main recommendation for implementing just climate adaptation policies is to focus on the most affected and vulnerable people and areas for the measures to have the maximum effect (Greiving & Fleischhauer, 2022). This being the basis for considering something as climate-just. "Shift is required to adequately account for both the problems of correctly attributing rights and responsibilities below the national scale and, in cities, the complex geographies of inequality which are compounded by the costs and benefits of climate change action" (Bulkeley et al., 2014, p. 39)

3.3.2. Intersectionality

Intersectionality is a theory in social sciences that explains how different forms of discrimination or oppression intersect and interact with each other. The term Intersectionality came to prominence in 1989 when Kimberlé Crenshaw criticised popular notions of feminist theory and antiracist politics and used it to describe specific forms of discrimination that

Black women faced by which neither Black[2] men nor *white* women were affected (Crenshaw, 1989; Osborne, 2015). Crenshaw (1989) argues that additional to the discrimination racialized women face, based on either their gender or their race, they also get discriminated against because they are the disadvantaged within these marginalised groups.

In arguments about discrimination the most privileged people within the observed group tend to be the reference point. In question of sexism, usually the main reference point will be *white* women. In matters of racism: Black men, masking connected and stronger forms of oppression (Crenshaw, 1989). "The intersections of race, class, and gender" (Squires, 2013, p. 795) were the first categories used for showing the theory's relevance in analyses. The categories found useful to describe intersecting power mechanisms, were further expanded to include more demographics. Collins & Chepp (2013) noted for their working definition "gender, race, class, sexuality, age, ethnicity, ability, and similar phenomena cannot be analytically understood in isolation from one another" (p. 88)

Following Collins & Chepp (2013), intersectional scholarship can be described by five core ideas:

1. The systems of power must be understood integrally and not in isolation because they coproduce one another and intersect. "Stated differently, racism, sexism, class exploitation, and similar oppressions mutually construct one another, drawing upon similar practices and forms of organization" (Collins & Chepp, 2013, p. 89).

2. Knowledge is constructed within power systems, helps to construct the intersecting power relations, and cannot be separated from them. "The distinctive social locations of individuals and groups within intersecting power relations have important epistemological implications." (ibid., p. 89) An Individual's or a group's standpoint shape their experiences, knowledge, what they can imagine. It also acknowledges that one can "simultaneously experience privilege and disadvantage" (ibid.)

3. "Systems of power are constituted and maintained through relational processes" (ibid., p. 90) The intersecting nature of our social systems and power structures is shown in the case that "various social positions […] necessarily acquire meaning and power […] in relation to other social positions. " (ibid.)

4. Multiple social locations have different perspectives, ways of knowing, and experiences. The different perspectives are shaped by the relationships and interactions between different social groups and can coexist and be valid at the same time, challenging the notion of one objective truth in this context.

5. Awareness of boundaries is important for understanding complex social issues. It is necessary because a too simple or "one-dimensional understanding of identity politics fails to account for social locations on the margins and borders of identity categories." (ibid., p. 91)

3.3.3. Intersectional climate justice for urban adaptation planning

In studies concerned with climate justice, questions and topics not unfamiliar to intersectionality arise. Links between intersectional theory and climate justice scholarship has been identified e.g. by Amorim-Maia et al. (2022) and Mikulewicz et al. (2023) Their work

[2] The capitalization of "Black", and the cursive spelling of "*white*" denote the colonial construction of race.

highlights the common roots of the theories and promote the focus on the foundations of observed inequities as well as their use of similar methods. A combination of factors by which people are discriminated against increase their vulnerability considerably.

Following Bulkeley et al. (2014) recognition justice in this framework is seen as the foundation for all other conceptions of justice. Only taking historical and structural injustices into consideration a truly procedurally just process can be implemented.

The following table drawing mainly from Amorim-Maia et al. (2022),Chu & Cannon (2021) and Collins & Chepp (2013) lays out the key points of the analytical framework:

Table 3 Components and indicators of the analytical framework

Component	Indicators
Distributive Intersectional Justice	Degree to which measures are adequate to reduce climate hazards and risks Degree to which different groups profit from measures considering their current vulnerability to the hazards and risks in all known dimensions. Awareness of boundaries in measures and affected groups
Procedural Intersectional Justice	Degree to which decision-making processes and procedures are transparent, accountable, and open to include diverse voices, values, and viewpoints. Degree to which dissenting views from marginalised groups are included
Recognition Intersectional Justice	Degree to which varying power structures in different societal spaces are recognised. Degree to which structural barriers that prevent marginalised groups from participating in decision-making processes are removed Degree to which different views are included in setting up the decision-making process

Where injustices are revealed, they are further categorised in injustice of omission and injustice of commission.

3.4. German urban adaptation planning

One of the main goals for planners, in Germany, is to pursue and ensure equal living standards for everyone which is also mentioned in the German constitution (Albers & Wékel, 2017; *Grundgesetz Für Die Bundesrepublik Deutschland*, 2022). The reality of the climate crisis adds to the existing challenges and makes just adaptation planning a relevant topic. In Germany, climate adaptation planning has been introduced in 2008 by launching the programme "Deutsche Anpassungsstrategie an den Klimawandel" and subsequently introducing funding programmes for municipalities to create adaptation concepts and implement appropriate adaptation measures (Bundesministerium für Umwelt Naturschutz

und nukleare Sicherheit, 2021; Greiving & Fleischhauer, 2022; Simon, 2022). So, the first cities started creating urban adaptation concepts more than a decade ago. The municipalities' task by implementing this programme, is to consider ecological, economic as well as social consequences of the climate crisis in their municipal territories (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 2021).

German key documents used the terms "climate resilience" and "climate-change adaptation" interchangeably or without elaborating on the specific nature of climate resilience in relation to climate-change adaptation (Greiving & Fleischhauer, 2022). Adaptation is generally "understood as an actor-centric concept" (Greiving & Fleischhauer, 2022, p. 115) while "resilience is a more systems-based approach" (ibid.)

Considering this, climate-resilient urban development was predominantly conceived "to be achieved by providing green and blue infrastructure, improving the city climates, and planning for reducing the potential impacts of river floods and flash floods" (Greiving & Fleischhauer, 2022, p. 116). Contemporary events like floodings or heat events were also the focus points for German-speaking research on resilience or vulnerability, while research questions "focused on the implementation and provision of policy advice for politicians and planners." (Greiving & Fleischhauer, 2022, p. 116). Public recommendations for climate action or climate adaptation measures for municipalities focus on inner-governmental organisational improvements (Lünenbürger et al., n.d.).

Cities encounter multiple challenges and are responsible for managing all of them simultaneously. In the context of climate action three tasks are identified, municipalities should increase the use of renewable energies, reduce land use and adapt to the expected climate impacts. Climate adaptation has been the last of these three to enter mainstream planning in the cities (Simon, 2022). With reference to the uncertainties of how much the climate is changing, it is suggested to the cities administrations to plan and take "no regret"-measures that without many extra-costs reduce negative climate impacts. Methodological groundwork and preparations are started in larger and already affected municipalities. However, their implementation often fails due to lack of personnel and resources (Simon, 2022).

Because climate crisis is affecting many areas of human life in the city, adaptation measures should also be implemented across different sectors. Sometimes, climate adaptation and climate action measures are partially not declared as such, in order to avoid conflict and resistance to the measures by the public and rather some taken measures are explained with local necessities. Adapting to and prevention of flooding is usually institutionalised in water departments and water law (Simon, 2022).

In German climate action documents, the adjective "*klimagerecht*" (climate-just) is frequently used (Ahlhelm et al., 2020; Röttgers et al., 2023; Simon, 2022). Although, it seems similar *"klimagerecht"* does not directly refer to the justice aspects which are meant when the German translation of climate justice, *"Klimagerechtigkeit",* is used (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, 2023). It rather refers to measures and plans taking the physical aspects of the changing climate into account analogous to *"umweltgerecht"* (Böhme & Köckler, 2018).

The reviewed guidelines for urban climate adaptation do not mention climate justice, environmental justice or their key concepts and frameworks (Ahlhelm et al., 2020; Simon, 2022). Social aspects are only mentioned as a concern when it comes to possible unwanted consequences of climate action that increase housing costs (Simon, 2022). Greiving &

Fleischhauer (2022) confirmed that this is also true for the actual plans and concepts in practice: "A look at urban adaptation concepts and analysis in Germany shows that only a small proportion of these concepts take into account socio-economic information and their impact on the design and selection of adaptation measures." (Greiving & Fleischhauer, 2022, p. 118). German cases investigating differences in exposure to climate risks and how marginalized groups are involved in creating and improving the plans are rare.

DAS recognises the vulnerability of certain groups, mentioning elderly and children and argues to specifically reach out to the vulnerable groups and focus information campaigns on them (Die Bundesregierung, 2008). The related programme, which regulates the financial support of climate adaptation concepts, *Förderrichtlinie Maßnahmen zur Anpassung an die Folgen des Klimawandels,* names three key indicators for assessing the effectiveness of the concepts:

1. The number of people reached and benefitting from adaptation policies and measures or their share in the general population.
2. The share of resilient public infrastructures, buildings or areas measured in km or m² or the number in relation to the respective total in the supported municipality.
3. The number of new or improved institutionalised structures or processes for addressing climate change and established informational and methodological tools for resilience enhancement (and in relation to the people or infrastructures, buildings, areas reached or benefited thereby) (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 2021).

For receiving the funding, the concepts do not need to incorporate any social factors or that there is a focus on certain socio-economic or other vulnerable groups (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 2021). However, in an additional document which is referenced in the programme funding document, *Merkblatt nachhaltiges Anpassungsmanagement*, suggestions are made to improve the adaptation planning and measures in practice. In the document, climate adaptation is described as a cross-cutting task that affects many different areas of governmental and private actions. It should be integrated in every municipal department and aspect of planning. Therefore, the development and coordination of an adaptation strategy or concept is a municipal task that spans across all fields of action. Although not required, including all relevant stakeholders as much as possible is suggested with a particular focus on vulnerable sectors and groups of people (ZUG, 2021).

A sustainable adaptation management as lined out in the document, consist of 6 steps :

1. Pre-planning: The municipality starts the process by exploring and assessing its capacity, defining responsibilities as well as identifying resource needs, and gathering necessary expertise and data. It sets the foundation for effective implementation of subsequent adaptation strategies and a comprehensive response to climate challenges.
2. Assessing the impacts and risks of climate change and municipal adaptive capacity: It is required to include:
    a. a range of potential futures with at least two climate projections
    b. their adaptive capacity in terms of financial, human, technical and organizational resources, as well as other parameters.

    c. Uncertainties and chances that can be identified

3. Creating an adaptation plan: to reduce the sensitivity of natural and human systems to climate impacts. It should be in collaboration with relevant stakeholders to align the planning with other relevant policies, strategies, and plans, and to reduce potential conflicts between the adaptation measures and other policies and programmes. The adaptation plan needs to:

    a. Relate to the overarching context on the federal and state level

    b. Develop municipal goals while incorporating existing strategic objectives and sector-specific plans

    c. Identify adaptation measures suitable for recognised vulnerabilities and risks, including nature-based, soft, and grey infrastructure options

    d. Evaluate adaptation responses based on local needs and capacities, involving decision-making processes and participation of key stakeholders

    e. Have a decision-making process that involves the management level of the relevant municipal departments, and should include previously participating experts, other important stakeholders such as private and municipal companies, NGOs and local representative bodies. Demographic, socio-economic, and environmental conditions, should also be adequately considered.

    f. Prepare the adaptation plan document with the selected measures, including timelines, responsibilities, and budgets, and ensuring monitoring, evaluation, and continuous improvement

4. Implementation of measures: by translating the identified measures into concrete activities, establishing clear responsibilities, and ensuring cross-departmental coordination for effective execution.

5. Monitoring and evaluation: are essential for assessing, documenting, and reviewing a municipal adaptation plan to confirm progress and identify early indications of inadequate adaptation, allowing for adjustments to the plan and measures.

6. Communication: Inform about the adopted measures internally and collaborate with third parties in the implementation process.

This described management contains elements of procedural justice but is lacking recognition justice considerations. Climate justice issues have been touched upon in different academic articles, that investigated how health in cities can be improved, without using the term (Baumgart et al., 2018). The term “justice” is used only in the context of environmental justice (Böhme & Köckler, 2018). As laid out in Fehler! Textmarke nicht definiert.Fehler! Verweisquelle konnte nicht gefunden werden. environmental and climate justice have strong connections but are not identical.

The exposure of certain vulnerable groups to climate impacts is highlighted and the mechanism explained (Rüdiger, 2018). Even though these considerations have been discussed in German scholarship they are rarely implemented in planning and planning guidelines (Baumgart et al., 2018; Greiving & Fleischhauer, 2022).

The different climate impacts on urban areas and its relations with the demographic change and impacts on social groups are displayed in Table 4.

Table 4 Impacts of climate crisis and their demographic and socio-demographic relevance (Baumgart et al., 2018, p. 341)

Climate impacts	Demographic relevance	Impact on social groups
Increasing risk for human health due to extreme events	Amplifying effect, as in particular an increased proportion of persons in need of assistance risk significantly increased and the Adaptability reduced	Socially disadvantaged groups often live in densely built up quarters (e.g. prone to heat waves)
Increasing energy demand for cooling and decreasing thermal comfort	Ambivalent effect, since a shrinking population has lower overall needs but especially the elderly are vulnerable	Socially disadvantaged groups often live in densely built up quarters (danger energy-induced gentrification)
Changing demands of water and energy supply as well as water disposal	Ambivalent effect, since a shrinking population has lower needs overall, but the shrinking population of neighbour-hoods increases the costs of the technical infrastructure. In addition, the sewer networks must be designed for more intensive and frequent heavy rainfall events	Rising ancillary costs place a considerable burden on the socially disadvantaged
Need for adaptation in construction in risk areas of extreme events	Dismantling could take place as a priority in endangered areas	Technical property protection measures are in some cases very costly
In urban centres, the supply of fresh air should be ensured via unobstructed fresh air corridors.	Targeted dismantling can restore fresh air corridors in shrinkage rooms and create open spaces	Socially disadvantaged, elderly and migrants primarily live in poorly ventilated inner-city areas
Behavioural and personal precaution of the population by providing information and awareness-raising	Especially the elderly are physically barely able to take precautions	In particular socially disadvantaged people and migrants are often difficult to reach by regular information campaigns

4. Analysis

This chapter presents the results of the analysis. Starting with the climate crisis' impacts on Hamburg (4.1), it is further explored how Hamburg, which areas in the city and who is affected by the identified climate impacts focussing on one district (4.2). Adding to it Hamburg's climate adaptation plans and measures are assessed (4.3). Using the previous analysis Hamburg's climate adaptation plans are analysed through the lens of intersectional climate justice framework (4.4).

4.1. Climate impacts on Hamburg

Using Hamburg's *Klimaplan* to identify the major climate impacts on the city, three climate-related hazards are further investigated in this section. The projected impacts on Hamburg are further explored in the three sections: 4.1.1 Extreme Heat in Hamburg, 4.1.2 Sea level rise and Storm surges in Hamburg and 4.1.3 Heavy precipitation in Hamburg.

Hamburg is situated in Northern Germany with a humid temperate climate. The river Elbe is flowing through the city and connects it to the North Sea to which the distance is less than 100 km. Therefor the tide is affecting the water level of the river (BUKEA & LSBG, 2021). The anthropogenically changed climate has various impacts on Hamburg, these include: an increase in average temperature and extreme heat events, less frost days, an increase in heavy rain days and sea-level rise with danger of higher water levels during storm surges. Storm event projections are inconclusive according to the latest reports and no significant change has been observed yet (Borsche et al., 2021; BUKEA & LSBG, 2021; Kahlenborn et al., 2021; *Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019).

4.1.1. Extreme Heat in Hamburg

The average temperature in Hamburg has already risen by 1,7°C since weather records began. According to the projections, it is expected that the average temperature further rise, ranging between 0,7°C and 2,1°C at the mid of the century. The projected temperature increase at the end of the century is depending stronger on the emission-scenario: in RCP 2.6 the median temperature rise is 1,1°C, in RCP 8.5 3,6°C (Borsche et al., 2021).

Higher average temperatures are not the main concern regarding human health, it is the extreme events which are happening more frequently and more intense in the last years, setting new records (Imbery et al., 2023). E.g., 2022, saw the first day on which a temperature above 40°C was officially measured in Hamburg or anywhere in Central Europe above the 53° latitude. Adding to this it is projected that peak temperatures will continue to rise, the average number of days with temperatures above 30°C as well as tropical nights, meaning temperatures are not falling below 20°C, will increase (Pressestelle der Behörde für Umwelt und Energie, 2018). High temperatures during the day and lack of cooling at night prevents humans from recovering and increases heat stress which has negative impacts on health even leading to death. (Borsche et al., 2021; Claußen et al., 2018). In 2020, 200 deaths have been attributed to heat waves in Hamburg. Even in a coastal city in Northern Europe the heat can be deadly (Robert Koch-Institut, 2022). Elderly, young children, people with cardio-vascular- and respiratory diseases as well as mental illnesses are pointed out as being particularly vulnerable in the context of extreme heat (Claußen et al., 2018).

Urban heat island effect in Hamburg

In Hamburg, as in other densely built-up areas, the urban heat island effect is a relevant factor leading to increased heat stress and negative consequences for people's health. The effect describes the changed micro-climate in dense urban areas, particularly higher temperatures in comparison to more rural areas and especially lack of cooling during the night. Figure 4 Temperature profile over a week in CologneFigure 4 shows the temperature differences that occur between more central urban and rural areas over a week. In the shown case the measured temperature difference is up to 10°C.

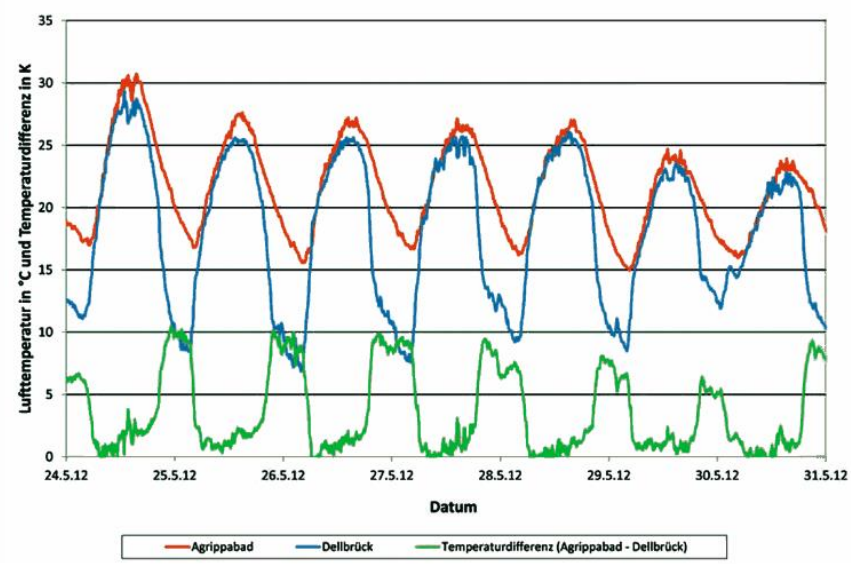

Figure 4 Temperature profile over a week in Cologne for locations in the city (red), outskirts (blue) and the temperature difference (green) (Ahlhelm et al., 2020)

The effect is caused by a several factors that are characteristic for modern cities: reduced ventilation and air exchange with the surrounding area, increased radiation absorbing surface due to the geometry of urban structures, increased heat capacity and thermal conductivity, reduced evaporation due to the direct discharge of precipitation water into the sewerage system, changed radiation balance due to the increased emission of gases and increased anthropogenic heat production (GEO-NET Umweltconsulting & Gross, 2018).

Figure 5 illustrates the urban heat island effect in Hamburg spatially by showing the temperatures across the city during a summer weather condition with a low air exchange rate at 2 m above ground at 14:00. The visualisation is based on a simulation conducted by GEO-NET Umweltconsulting & Gross (2018).

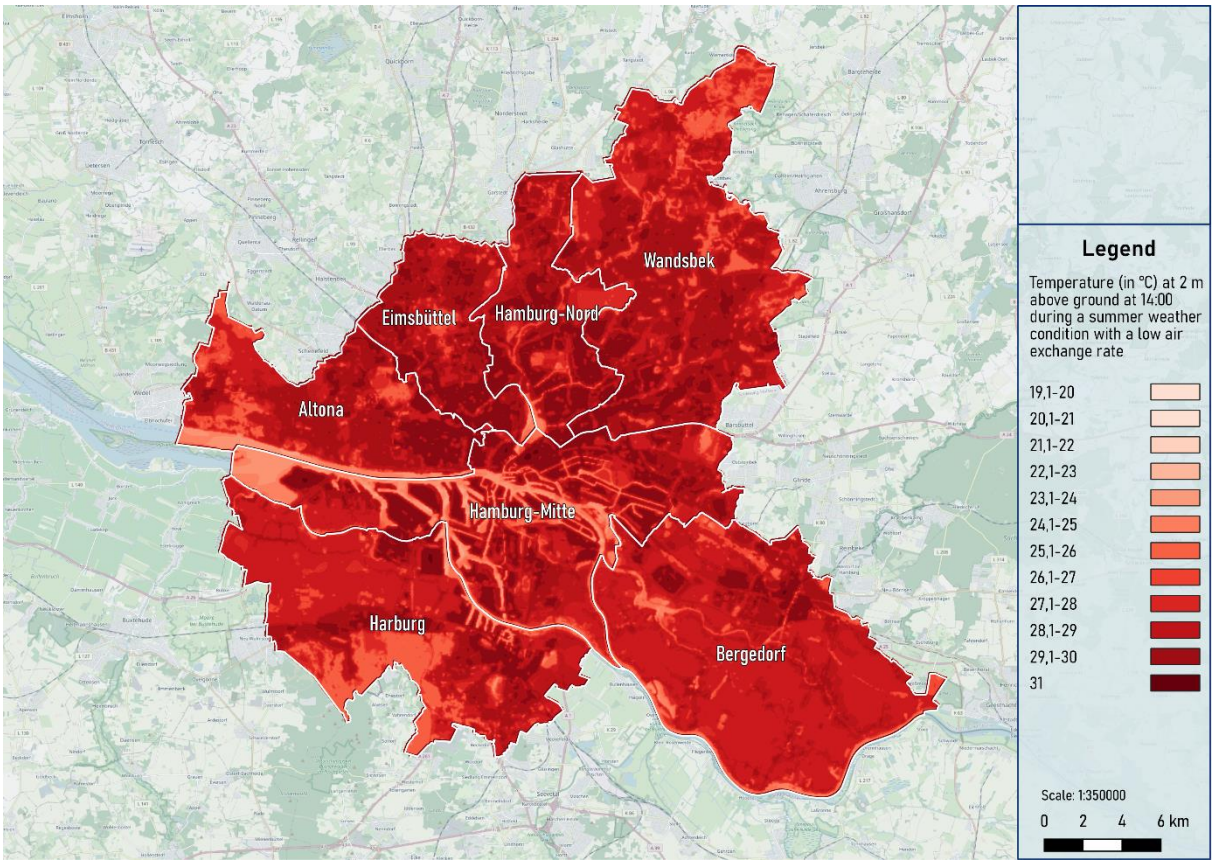

Figure 5 Urban heat island effect in Hamburg (data: GEO-NET Umweltconsulting & Gross (2018))

The urban heat island effect is not evenly distributed across Hamburg. Most districts are affected by the UHI effect but to varying degrees. In every district there are areas which are strongly influenced by the trapped heat and areas which are less to not at all affected. Generally, it is strongest in the centre of the city including many of the central quarters in the districts of Altona, Eimsbüttel, Nord, Wandsbek and Mitte, and the centres of formerly independent cities like Bergedorf and Harburg. People in these areas mainly live in appartement buildings. Temperature in these strongly affected areas lie about 4°C above the city's average temperature at night. In contrast to ca. 4°C below average in more green areas with less soil sealing which are predominantly located at the city fringe where the residential areas mainly consist of detached houses (GEO-NET Umweltconsulting & Gross, 2018).

4.1.2. Sea level rise and Storm surges in Hamburg

Hamburg is affected by the sea-level rise and tides in general via the river Elbe. Regional studies regarding the water-level rise in Hamburg are not available but the sea-level rise in the North Sea is considered to be very close to the average global sea-level rise (BUKEA & LSBG, 2021). Therefor the accelerating global sea-level rise is used for projecting the impacts on Hamburg. In relation to the period from 1986-2005, the most optimistic greenhouse-gas reduction scenario (RCP 2.6) is expecting a sea-level rise of 17-32 cm mid of the 21st century and 29-59 cm towards the end of the century. In comparison the business-as-usual scenario (RCP 8.5) is projecting a sea level rise of 23-40 cm short term and longer term of 61-110 cm (Borsche et al., 2021).

The concrete local water levels in Hamburg are affected by a series of factors including remote waves influenced by the weather on the Atlantic, constellation of sun and moon,

human interventions as well as winds. Storm surges create particularly high water-levels when a high tide coincides with a storm event pushing water from the North-West against the coasts and via the rivers into the mainland. Storm surges have been recognised as a serious threat for long times and dykes have been built to protect the low-lying areas (BUKEA & LSBG, 2021; hamburg.de, n.d.-e). Storm surges will also become more severe with a generally rising sea-level if no counteracting measures are taken (Borsche et al., 2021). The storm surge water-levels in Hamburg will rise at the same rate as the global sea-level (BUKEA & LSBG, 2021).

Past storm surge events after the severe flooding in 1962 have not had extensive serious impacts in Hamburg, even though water-levels have been higher than during Hamburg's most deadly storm surge of the 20th century. Some property damage has been observed but no fatalities (hamburg.de, n.d.-e).

Following European legislation, the potential risk areas within Hamburg have been assessed and a report has been issued (BUKEA & LSBG, 2021). More on the report and adaptation can be found in Fehler! Verweisquelle konnte nicht gefunden werden.. The areas at risk during a coastal flooding event are shown in Figure 6. The most endangered districts are Harburg, Bergedorf and Hamurg-Mitte. Some low-lying areas in the city e.g. Fischmarkt are regularly flooded, other areas are also at risk of being flooded mainly in Hamburg-Mitte. This includes the harbour areas that lie in front of the dyke-protection line.

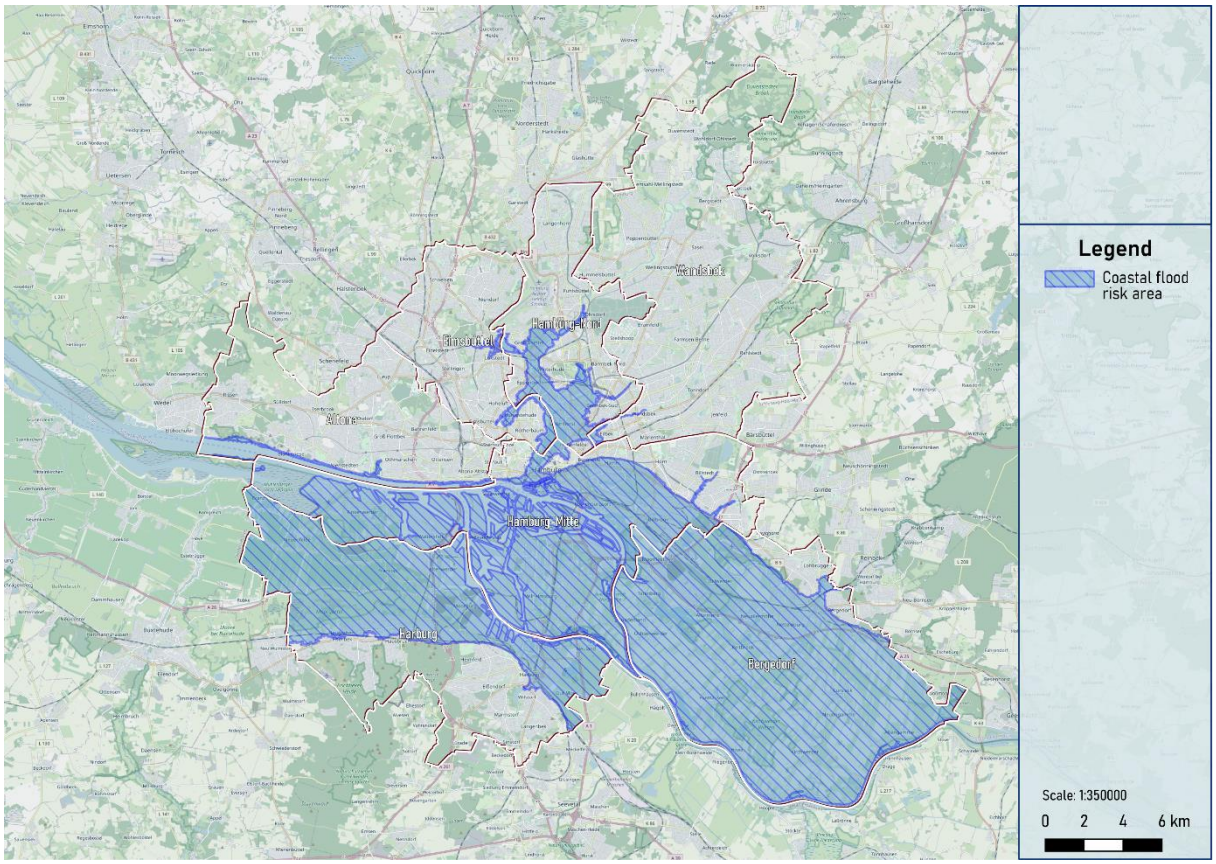

Figure 6 Coastal flood risk area in Hamburg (Landesbetrieb Geoinformation und Vermessung, n.d.)

4.1.3. Heavy precipitation in Hamburg

Another important climate impact is the changing frequency and intensity of precipitation in Hamburg. Overall precipitation has increased since the start of weather records during every season. The highest observed increase is in winter, followed by autumn, spring, and summer. In short term projections a small increase in total precipitation (3%) is expected. Long term projections in an optimistic scenario expect a small decrease (-1%) or an increase (8%) in the business-as-usual scenario. In general, an increase of total precipitation in winter and a decrease in summer is expected as well as an increase of days with heavy precipitation (BUKEA & LSBG, 2021).

Heavy rainfalls are mentioned in Hamburg's *Klimaplan* as relevant because of their high damage potential (*Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019). Projections show that particularly high precipitation events increases more strongly than lower precipitation events increase (BUKEA & LSBG, 2021). Bigger amounts of water in shorter time periods will happen more often and increase the potential damage (Claußen et al., 2018)

Heavy rainfall in the last years has been responsible for substantial amounts of property damage. Between 2002 – 2017, 31 extreme events caused a damage worth 40 million Euro in Hamburg (GDV & DWD, 2019). Additional to property damage people can be affected by various mental and physical health conditions (Zhong et al., 2018). Hamburg's central office for climate adaptation has issued a map based on an elevation profile showing the risk areas during heavy rainfall on a small scale.

4.2. Intersections of vulnerable groups and most affected areas

Vulnerable people and communities in this study are people who are politically marginalised and additionally, according to statistics, are more heavily impacted by the climate crisis. These include: elderly with low-income, children with a low social status, homeless and areas with a low social status in general. People with low-income, low formal education, and migrants have been found to be less active in political processes in Germany (De Vries & Sobis, 2022).

4.2.1.Hamburg's most vulnerable district: Hamburg-Mitte

Hamburg is a single municipality, distributed in seven districts. Figure 7 displays how Hamburg is geographically structured in seven districts and 104 quarters.

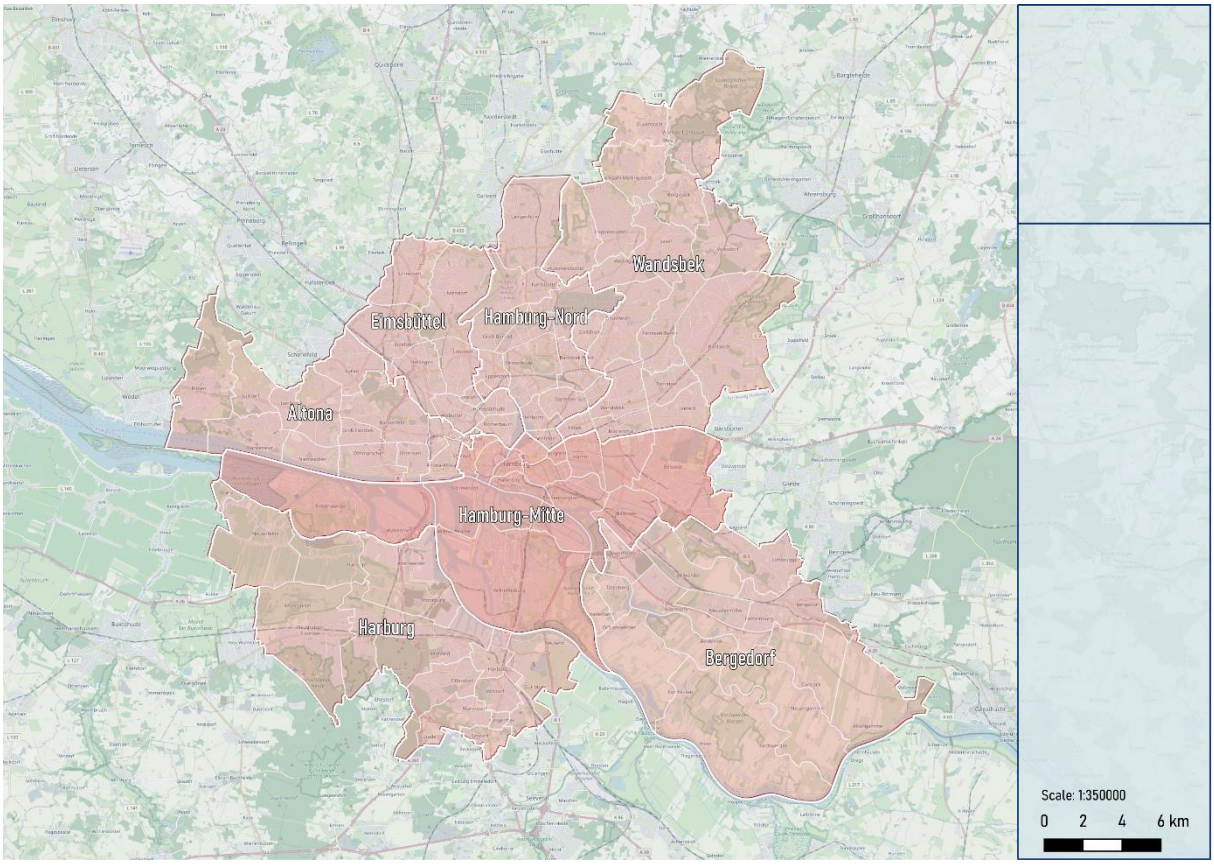

Figure 7 Hamburg's districts and quarters

In the district Mitte, almost every quarter is considered to be a risk area for storm surges. It also is the district that has the most areas affected by a strong urban heat island effect and many areas are marked as potential risk areas during heavy rain (Landesbetrieb Geoinformation und Vermessung, n.d.).

In Hamburg there are geographic clusters of neighbourhoods with a high or a low socio-economic status, but their distribution is more complex than describing simple demarcation lines. People of all classes live in all seven districts but to varying degrees. Distinct areas can be identified for the different social classes in every district (Maaß et al., 2022). Figure 8 shows the spatial distribution in a high resolution of social status in different neighbourhoods.

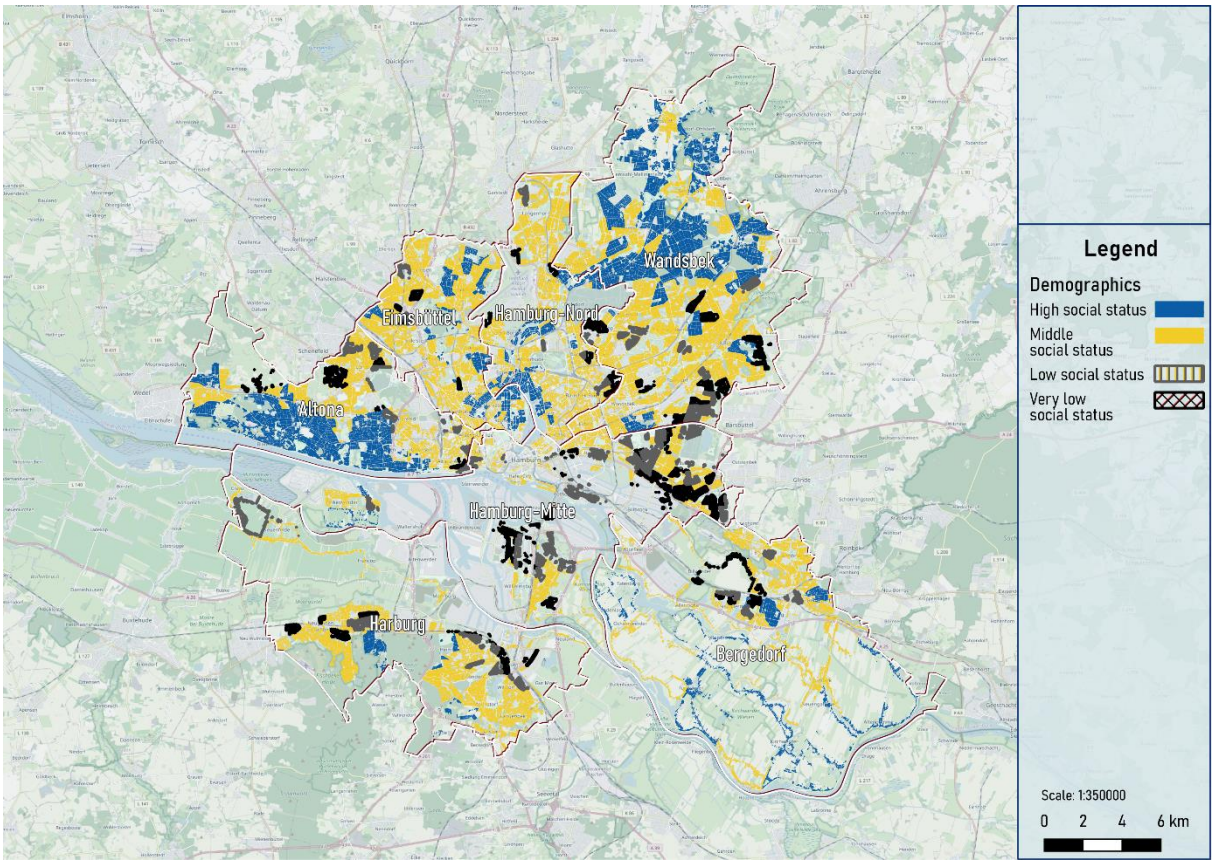

Figure 8 Social status in Hamburg (Landesbetrieb Geoinformation und Vermessung, n.d.)

Hamburg-Mitte is the district with the highest amount of people with a low or a very low socio-economic status absolutely and as a percentage. About 144.000 people or 49,4 % of Mitte's population fall into this category. The district comes first in this category by a wide margin, compared to the next district, exceeding more than 20 percentage points. Adding to the picture, it is also the district with the lowest amount of people with a high social status, just below 1 % or 2487 citizens (Maaß et al., 2022). Applying the aforementioned criteria, Mitte is the most vulnerable district. The social status combines statistics of children with migrant background, children with a single parent, people in general receiving social benefits, asylum seekers receiving the lower asylum seekers benefits, unemployed people, children receiving benefits, elderly receiving benefits and people's level of education (Pohlan et al., 2010).

The district Hamburg-Mitte is Hamburg's central district, encompassing central parts of the old city close to the Alster, the central train station, the harbour, continues to the east including Billstedt, the new HafenCity quarter as well as the quarters Wilhelmsburg and Veddel islands in the river Elbe and traditionally working class neighbourhoods (Nommensen, 2019).

The vulnerable, intersectionally disadvantaged groups considered in the following are:

- Children with a low social status: susceptible to environmental hazards and subject to classism and potentially racism
- Elderly receiving social benefits: susceptible to environmental hazards because of their age and subject to classism and potentially racism
- Homeless people: susceptible to environmental hazards and subject to classism

- Very low and low social status according to Hamburg's "Sozialmonitor"

The social status combines statistics of children with migrant background, children with a single parent, people in general receiving social benefits, asylum seekers receiving the lower asylum seekers benefits, unemployed people, children receiving benefits, elderly receiving benefits and people's level of education (Pohlan et al., 2010).

4.2.2. Vulnerable groups exposure to extreme heat

Heat-related health impacts are not simply correlated with peak temperatures. The timing, duration of a specific temperature level and people's personal physical condition are also relevant parameters which influence how a person is affected by a heat event (Claußen et al., 2018). Humans can adapt to different environmental conditions. The process of physiological adaptation to a new temperature level is called acclimatisation, it can be divided into short-term and long-term acclimatisation. Depending on the individual, the short-term physiological change to cope with the increased temperatures takes place within about 14 days, the changes include an adaptation of the circulatory system, and an increase in sweating. (Claußen et al., 2018).

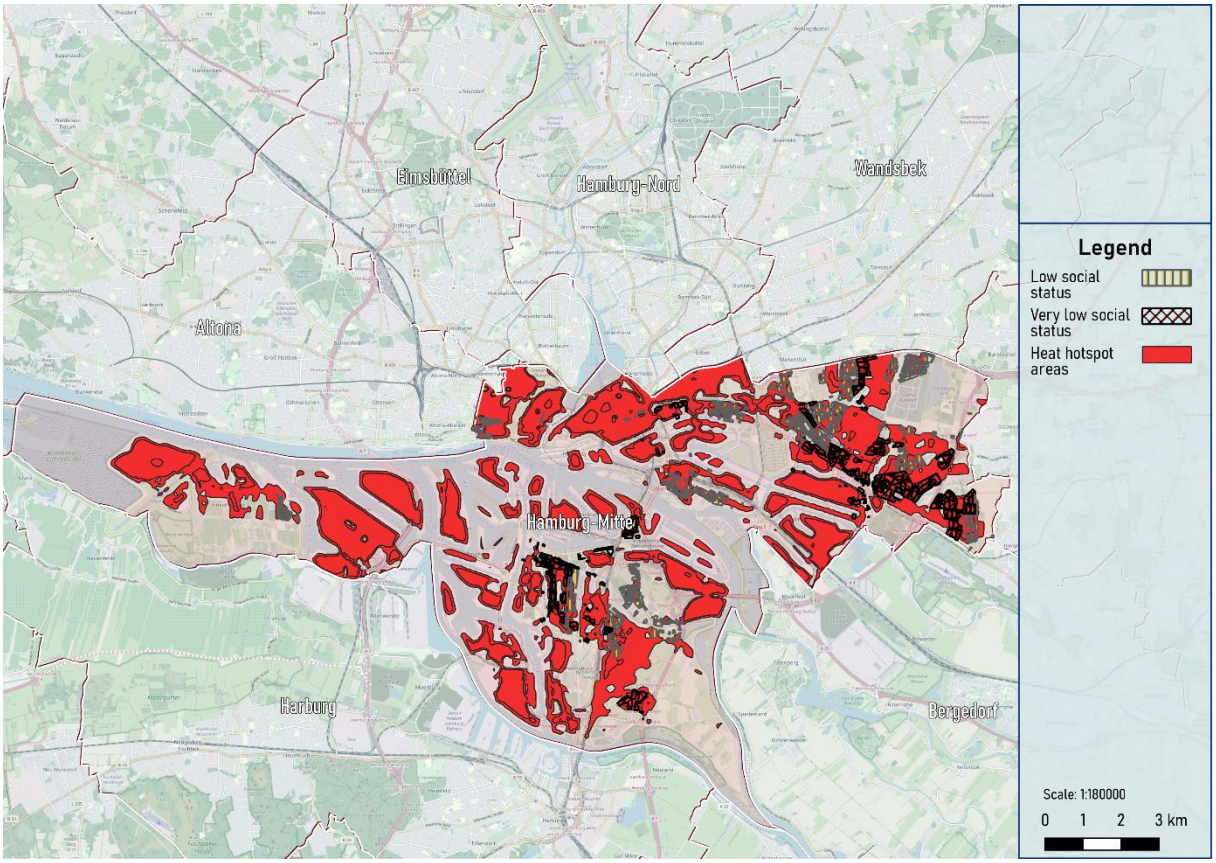

Figure 9 Urban heat island hotspots and social status (GEO-NET Umweltconsulting & Gross, 2018; Landesbetrieb Geoinformation und Vermessung, n.d.)

The projections indicate were heat hotspots areas are in the district. Figure 9 shows the areas where the urban heat island effect is strongest in Hamburg-Mitte and neighbourhoods which are categorised as low and very low social status. It shows that all areas with a low or very

low-social status in Hamburg-Mitte lie in an urban heat island hotspot. People with a lower social status are more likely to suffer from extreme heat in their homes.

Young children are particularly sensitive towards heat e.g. because cannot as easily adapt (KLUG – Deutsche Allianz Klimawandel und Gesundheit e.V., 2023). Many children spend their daytime in kindergartens close to their homes, so these are important institutions to consider in adaptation planning. There are 148 kindergartens in the district spaced out across the whole district accommodating thousands of children. 116 of these kindergarten buildings lie in the identified heat hotspot areas ("Kita Einrichtungen Hamburg," 2023). A conducted questionnaire to assess the actual impact on the institutions showed that some of the institutions suffer from increasing heat but it did not yield enough viable answers to allow generalising statements.

Elderly people are also endangered due to high temperatures because of their reduced adaptive capacity. When they have a lower income, they become especially vulnerable. People living in retirement homes are in the district with the lowest social status therefore people in these institutions could be subject to classism and in parts to racism additionally to their susceptibility. Via Hamburg's Branchenbuch 20 retirement homes across Hamburg-Mitte were identified of which 11 are in areas that experience extremer heat due to the urban heat island effect (hamburg.de, n.d.-d, n.d.-a, n.d.-c). The questionnaire conducted to evaluate the impact on the institutions revealed that some of them are affected by increasing heat. However, due to limited viable answers, it is difficult to make general statements. However, people within these institutions profit from the provided care which makes them less vulnerable. Elderly who are living on their own without home care are especially vulnerable to heat (KLUG – Deutsche Allianz Klimawandel und Gesundheit e.V., 2023).

Many homeless people live in the city centre including Hamburg-Mitte which is shown by the fact that nine homeless shelters are situated in Hamburg-Mitte (Landesbetrieb Geoinformation und Vermessung, n.d.). Homeless people are marginalised through many ways and are vulnerable to the heat because they lack access to sheltered cool areas and refreshment facilities. Adding to it social isolation and health conditions especially addiction disorder worsen their situation and makes them particularly vulnerable (KLUG – Deutsche Allianz Klimawandel und Gesundheit e.V., 2023). The locations of the homeless shelters are shown in Figure 10.

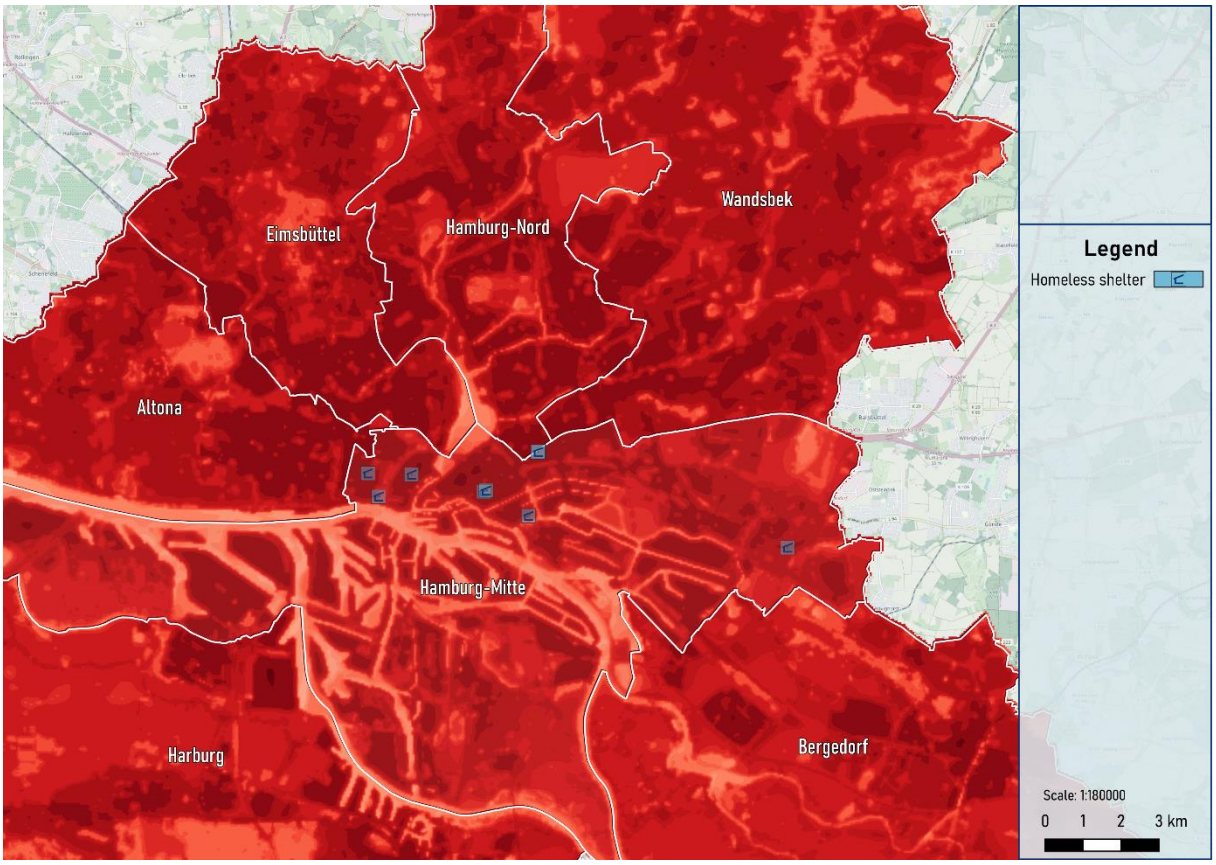

Figure 10 Homeless shelter in Hamburg-Mitte

Many people in Hamburg-Mitte especially in Wilhelmsburg and Veddel consider themselves as traditional working class (Bozukluhan, 2023). Workers who have to do heavy physical work especially outside are also stronger affected by the heat than other employees (KLUG – Deutsche Allianz Klimawandel und Gesundheit e.V., 2023).

4.2.3. Vulnerable groups Sea level rise and storm surge impact

Risk areas due to storm surges are the river islands which are all part of Hamburg-Mitte. In the identified coastal flood risk area everyone would be affected when the protection measures fail. Especially people living in the lower stories or houses lying lower than 7,5 m. People with reduced mobility are more endangered because for them it is harder to escape to more safer places. These are typically elderly and people with disabilities. A low social status coincides with reduced access to cars which can make it especially hard for elderly receiving social benefits to escape if needed (Canzler, 2021). Figure 11 shows the coastal flood

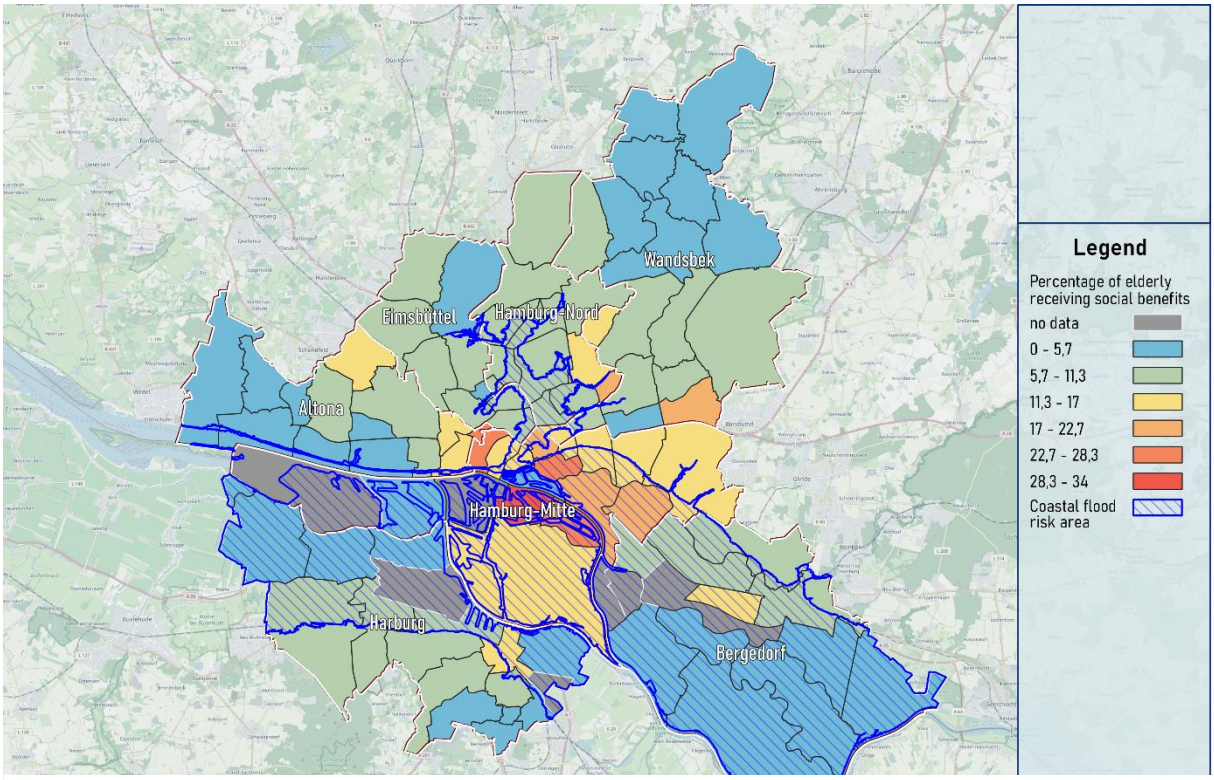

Figure 11 Coastal flood risk area and Percentage of elderly receiving social benefits in Hamburg's quarters (Landesbetrieb Geoinformation und Vermessung, n.d.; Statistikamt Nord, 2022)

risk area together with the percentage of elderly receiving social benefits in Hamburg's quarters. Veddel is the district with the highest percentage of seniors receiving social benefits and would be strongly affected by a storm surge.

Figure 12 shows the coastal flood risk area and neighbourhoods with low and very low social Status in Hamburg-Mitte. Many of these areas potentially at risk but many areas in the North-East in the quarter Billstedt are considered to be safe from flooding.

In the case of flooding, potential direct health consequences due to storm surges are physical injuries like fractures or sprains or even death by drowning. Other direct adverse health consequences may be skin/eye diseases and mental disorders such as depression and post-traumatic stress disorders (Zhong et al., 2018). The "likelihood of infectious disease outbreaks following flooding […] are low" (Hajat et al., 2005, p. 192) because Hamburg is in a temperate industrialised country. Indirect health consequences of such extreme events are impairments of the infrastructure of health care, water treatment and drinking water supply, crop failure and shortages of food, loss of dwelling, destruction of livelihoods, loss of income and relocation of the population (Claußen et al., 2018).

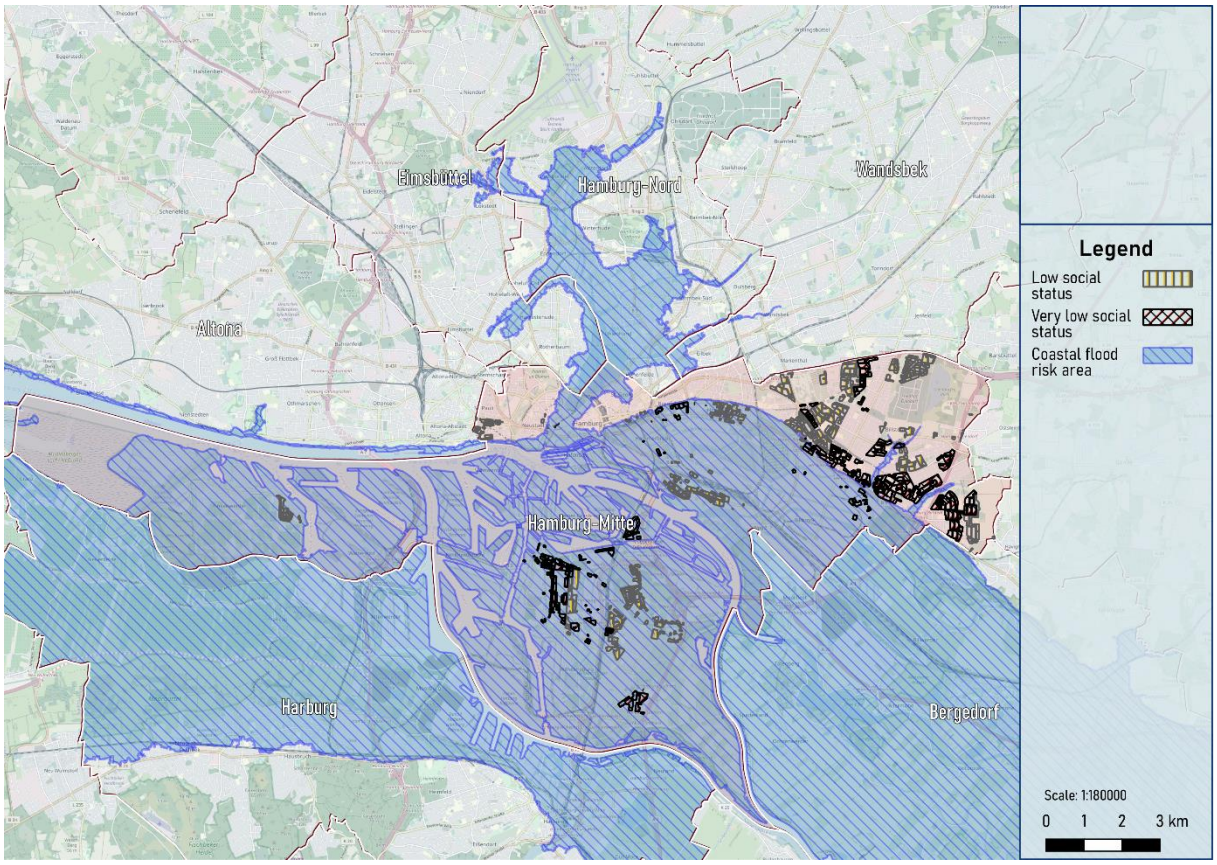

Figure 12 Coastal flood risk area and neighbourhoods with low social Status in Hamburg-Mitte (Landesbetrieb Geoinformation und Vermessung, n.d.; Maaß et al., 2022)

4.2.4. Vulnerable groups exposure to heavy precipitation

Heavy precipitation can occur in every part of the city and it is hard to predict where exactly rain will fall. The risk map shows that across the city many areas can potentially be affected in heavy precipitation events but for a qualified statement the exposure to heavy precipitation must be observed on a smaller scale (Waldhoff et al., 2015). How people's buildings and property are affected depends on their specific housing situation. People living in rental buildings have to rely on their landlord and cannot do any major changes to the building themselves (Döring et al., 2020). Low-income households are more likely to rent instead of owning their own homes and therefor have to depend on their landlords for adaptation measures (Statista, 2023). Different residents in the district have expressed their sense and negative experiences with increasing heavy rain. Including a kindergarten in Wilhelmsburg that struggled with flooding itself and their landlord to take adaptation measures. (Dahlgaard et al., 2023; Hipperling, 2023).

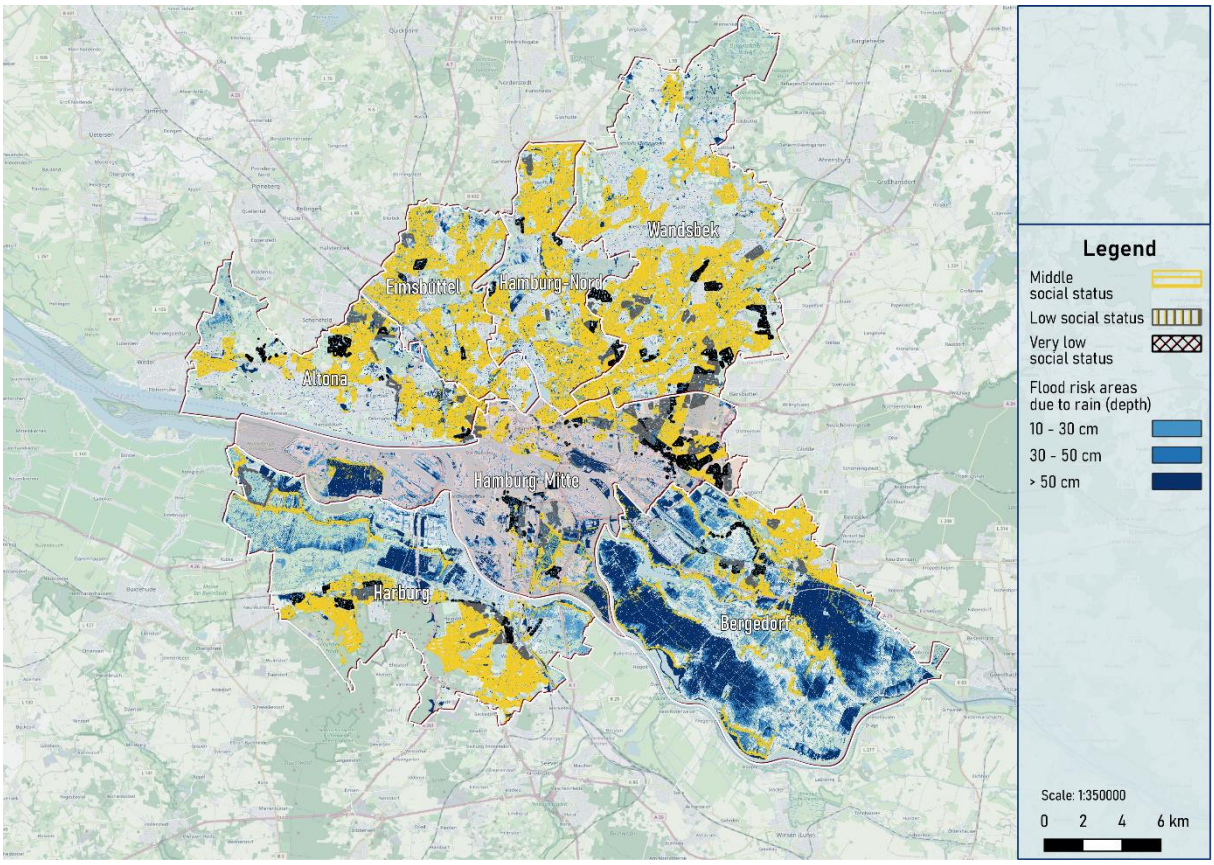

Figure 13 Flood risk areas due to rain and social status (Maaß et al., 2022)

4.3. Hamburg's climate adaptation planning

This section describes Hamburg's efforts to adapt to climate hazards through different programmes and institutions. It starts with a description of the relevant documents and institutions and is then followed by sub-section outlining the adaptation plans and measures for each climate-related hazard.

4.3.1. Hamburg's institutionalised adaptation plans and programmes

Hamburg's climate adaptation planning is influenced by European regulation, federal German climate action policies and urban development funding programmes. Hamburg-Mitte's planning therefor relates to Hamburg's overall policies and federal programmes and regulations. In Germany, institutionalised climate adaptation planning has been introduced in 2008 by launching the German Adaptation Strategy and subsequently introducing funding programmes for municipalities to create adaptation concepts and implement other climate action measures (Greiving & Fleischhauer, 2022).

The Senate of Hamburg (short the Senate) is the executive branch of Hamburg's government which governs the whole city. The Senate is composed of 11 ministries (hamburg.de, n.d.-b). BUKEA (Behörde für Umwelt, Klima, Energie und Agrarwirtschaft) is the ministry responsible for climate protection and consolidates and coordinates climate action within Hamburg (BUKEA, 2023). Hamburg's administrative body is additionally geographically separated in seven districts and respective *Bezirksämter,* local administrations . The city government, transfers rights and responsibilities to the districts. The district administrations, *Bezirksamt*, then execute the tasks partially on their own and partially working together with other authorities (Landeszentrale für politische Bildung Hamburg, 2023). Their duties include inter alia a form of local governance as well as local planning tasks (Oelrichs et al., 2019). One of

the districts' responsibilities is to create detailed local climate action plans called *Integriertes Klimaschutzkonzept* (IKK) (Bezirksversammlung Hamburg-Mitte, 2021; Röttgers et al., 2023).

Climate adaptation planning in Hamburg is considerd a common task distributed over multiple ministries, departments and district authorities. The *Stabsstelle Klimafolgenanpassung* is coordinating climate adaptation within Hamburg's administration and it is situated in BUKEA, the ministry responsible for climate action. It is the same entity as the office concerned with managing heavy rainfall: RISA. The office is coordinating the efforts between different actors to adopt the city and prepare the citizens. These include the different departments in ministries on a city-wide scale and on the district level executing adaptation efforts. This includes e.g. the department for disaster protection situated within the ministry of the interior (Behörde für Inneres und Sport, n.d.; BUKEA, 2023; Röttgers et al., 2023).

Up until 2023, no climate adaptation plan has been released investigating the issues comprehensively and in-depth for Hamburg. No comprehensive climate adaptation concepts following the federal funding programme have been issued by 2023 (BUKEA, n.d.-b). But one district, Altona, started working on it in February 2023 and intends to finish by 2025 (Bezirksamt Altona, 2023). The relevant documents and programmes necessary for describing Hamburg-Mitte's approach and efforts for climate adaptation are:

- *Hamburgisches Klimaschutzgesetz*, setting the legal basis for Climate Action in Hamburg
- Hamburg's *Klimaplan*, a document outlining the Senate's targets and measures to achieve climate goals (*Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019).
- *Integriertes Klimaschutzkonzept* (IKK) for each district that investigates and plans measures in more detail for their territory (Adwiraah et al., 2021; Bezirksamt Altona, 2019; Bezirksamt Eimsbüttel, 2022; Röttgers et al., 2023; *Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019; Stahl et al., 2017)
- *Hochwasserrisikomanagementplan*, is the plan according to EU regulations and created by BUKEA working together with other stakeholders outlining the adaptation response to coastal flooding (BUKEA & LSBG, 2021). Its contents are explained in more detail in 4.3.3Fehler! Verweisquelle konnte nicht gefunden werden..
- RegenInfraStrukturAnpassung (RISA) is a research project that aims to improve Hamburg's adaptation to heavy precipitation (Waldhoff et al., 2015). Its measures are further explained in 4.3.4.
- *Rahmenprogramm Integrierte Stadtentwicklung (RISE)* is the city's urban development programme that supports areas with 'special development needs' (Behörde für Stadtentwicklung und Wohnen, 2022b)

Figure 14 displays the different institutions, plans and programmes relevant for urban adaptation planning in Hamburg-Mitte and their connections.

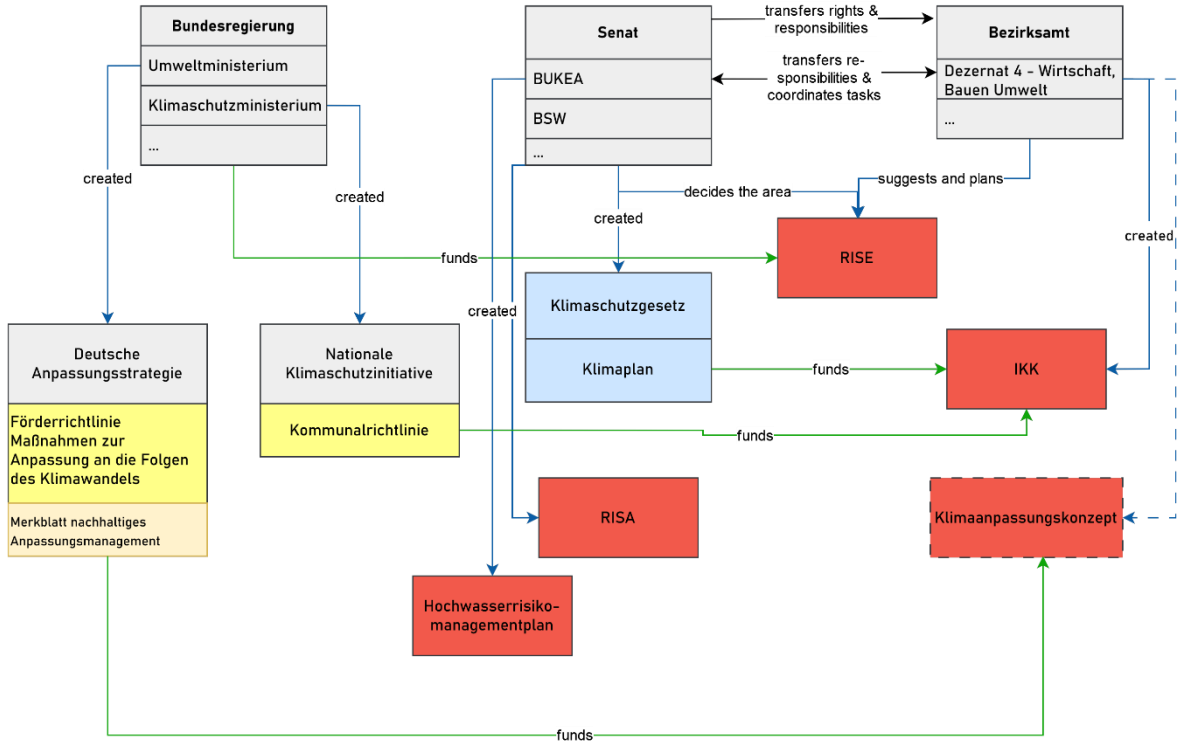

Figure 14 Government institutions and programmes relevant for climate adaptation planning in Hamburg

Upon consultation with the affected departments, it is a political decision made within the districts to create an IKK or adaptation concept (Röttgers & Pleuser, 2023). The IKK for each district assess the status quo and presents measures to tackle the climate crisis and deal with its impacts. The *Kommunalrichtlinie* sets the conditions an IKK needs to fulfil to get federal funding (Bundesministerium für Wirtschaft und Klimaschutz, 2023b): it must identify short-, medium- and long-term goals and measures to reduce greenhouse gas emissions and thus contribute to achieving the national climate protection goals at the local level. The process must involve all relevant actors and contain the following points: an energy and greenhouse gas balance, potential analysis, reduction goals, a catalogue of measures, a recommendation for a suitable controlling- and management instrument, as well as a communication strategy (Bundesministerium für Wirtschaft und Klimaschutz, 2023a). The document lists in detail the measures that are eligible to funding (Bundesministerium für Wirtschaft und Klimaschutz, 2023b).

The *RISE* programme combines multiple urban development programmes funded by the federal government and aiming to upgrade areas with "special development needs" (Behörde für Stadtentwicklung und Wohnen, 2022c). Which areas are included in and benefit from the programme is decided by the Senate in cooperation with the districts. Since 2020, *RISE* requires the plans to contain measures in the field of climate protection/ climate adaptation/ green infrastructure that are implemented in programme areas (Behörde für Stadtentwicklung und Wohnen, 2022a). As of 2022, there were 27 RISE areas in Hamburg which profit from different, sometimes several, urban development schemes. There are a total of six RISE development areas in Hamburg-Mitte: Gängeviertel/Valentinskamp, Veddel, Wilhelmsburg-Ost and the Billstedt/Horn development area with three local focus areas Haferblöcken, Mümmelmannsberg, and Billstedt-Zentrum, highlighted in

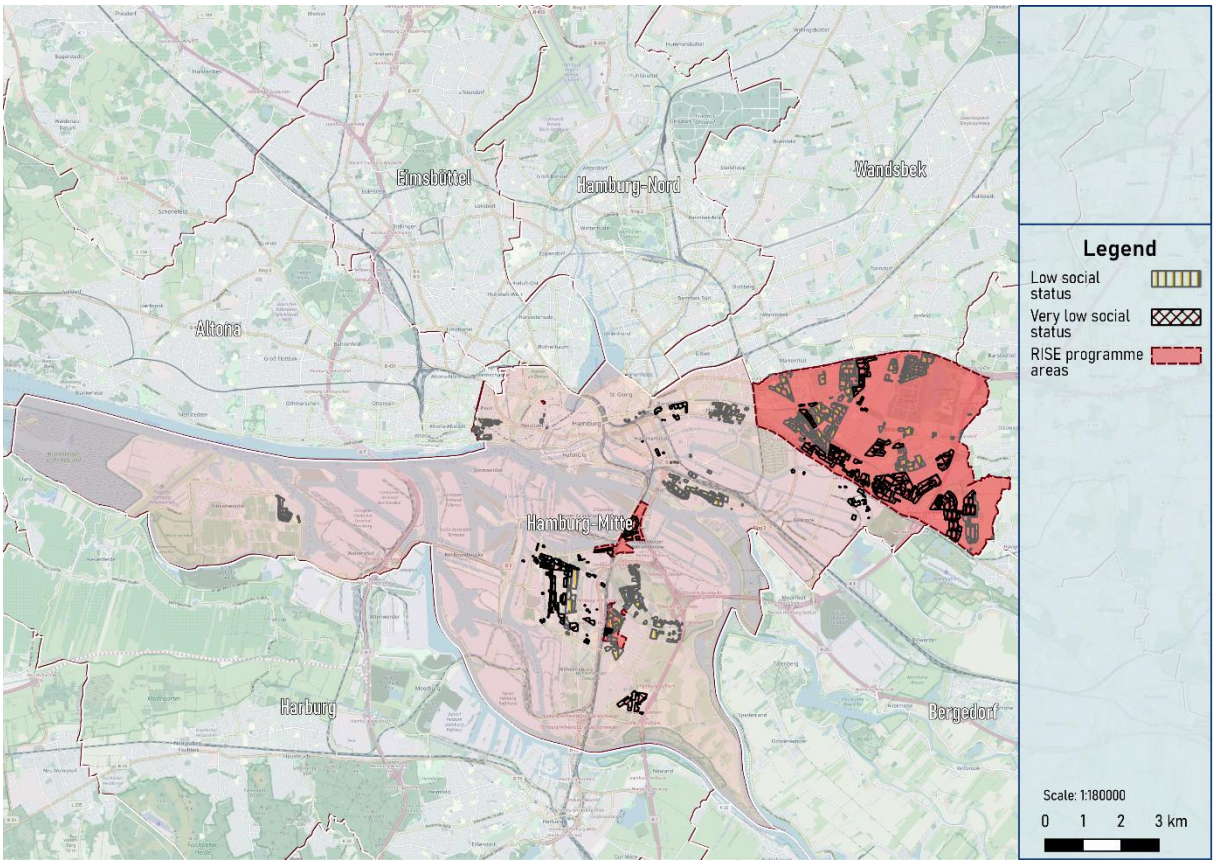

Figure 15 (Röttgers et al., 2023). Not all areas with a lower social status profit from RISE. There is no standardised regulation for the composition of the different participation bodies within the RISE programme. There are however some similarities between the bodies. They are all institutionalised and the districts parliament, *Bezirksversammlung Hamburg-Mitte.* It appoints the different participation bodies. People, NGOs and companies from the areas can apply to be appointed to the board (Bezirksversammlung Hamburg-Mitte, 2022; Sanierungsbeirat Billstedt-Zentrum, 2020; Stadtplanungsauschuss, 2021a, 2021b; Stadtteilrat Rothenburgsort, 2015).

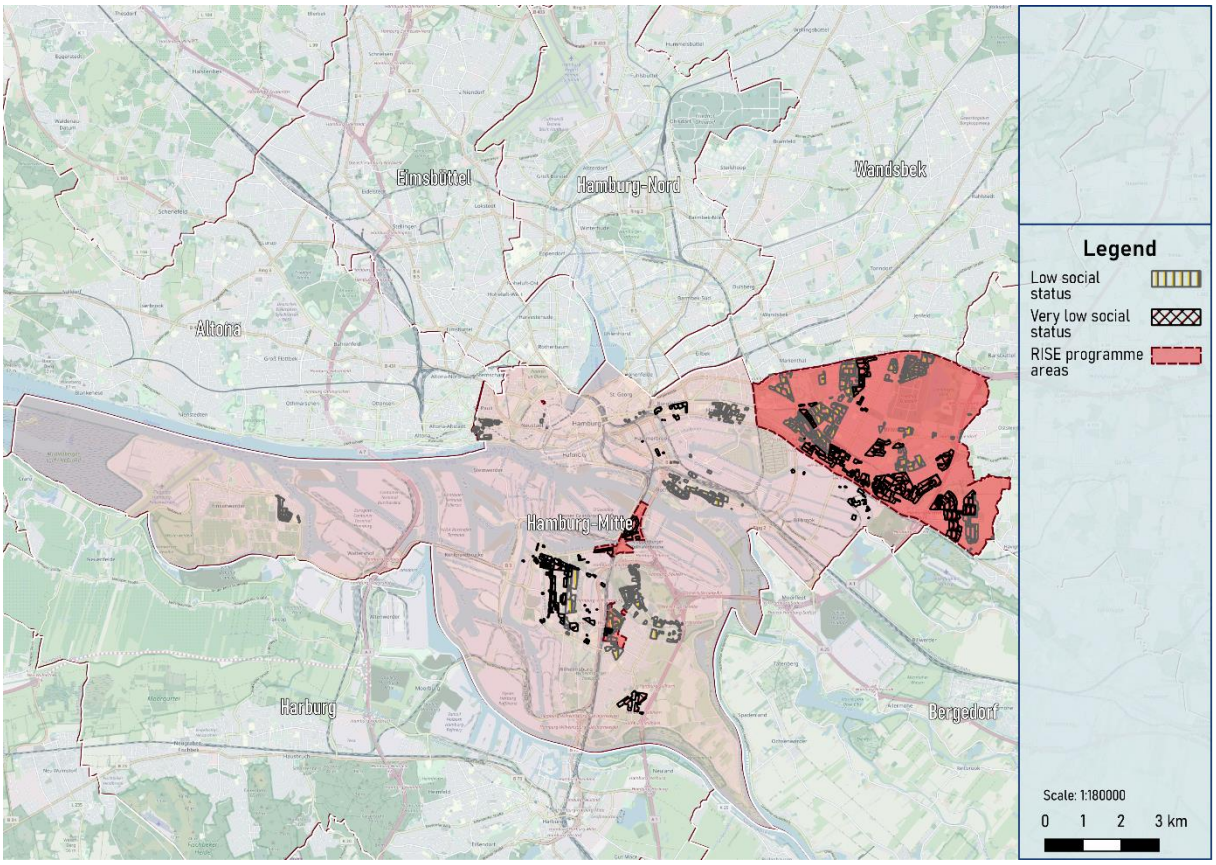

Figure 15 RISE areas in Hamburg-Mitte

In the following current adaptation measures to the hazards will be explained. In general , they can be divided into short-term and long-term measures (Claußen et al., 2018).

4.3.2. Adaptation to heat extremes

In adapting to the increasing heat, Hamburg is implementing measures on a city-wide scale but some actions are also taken by the district authorities. The measures include the green roof initiative and the campaign "Mein Baum – Meine Stadt" translating to "my tree – my city". It aims to increase the trees around the city and thereby improving the local urban climate and providing shade. The campaign enables people to choose a planned tree on a city map and donate money so that the tree can be planted with additional public funding (Röttgers et al., 2023). This measure calls for private people to donate money and choose the location. Other substantial measures to adapt to heat are not mentioned in the analysed documents (Bezirksamt Hamburg Mitte & Steg Hamburg, 2019; Bezirksamt Hamburg-Mitte, 2020, 2023; Bezirksamt Hamburg-Mitte & steg Hamburg, 2021; Röttgers et al., 2023).

Adaptation measures that change a building and its connected property lie solely in the responsibility of the building's owner. It is only restricted by the law setting certain minimum standards (Verbraucherzentrale Bundesverband, 2023; Verbraucherzentrale Hamburg, 2023). So, the decision to insulate a house to reduce incoming heat is up to the house owners. Generally, it is only allowed to install air condition when other measures can not sufficiently improve the climate within a building (*Erste Fortschreibung Des Hamburger Klimaplans Und Gesetz Zur Änderung Der Verfassung, Zum Neuerlass Des Hamburgischen Klimaschutzgesetzes Sowie Zur Anpassung Weiterer Vorschriften*, 2019, p. 111) In practice, people install air conditions when they want to and have the possibility to (Verbraucherzentrale Hamburg, 2023).

The vast majority, almost 80%, of people in Hamburg live in rental appartements and therefor have no agency over adapting their homes (Statistisches Bundesamt, 2023). The rental quote in this context gains a social-justice dimension because it is correlated with income. Overall in Germany, 28 % of the people with a monthly income of less than 2000 € own real estate and 60 % of people earning more than 4000 € (Statista, 2023). Encouragement to adapt your own real estate comes to nothing, when the most disadvantaged have the least agency over adapting their homes.

Some care institutions like kindergartens and retirement homes have started implementing measures on their own where they have the agency to do so. However, there is no specific public funding for private institutions to take climate adaptation measures (Hipperling, 2023).

4.3.3. Adaptation to storm surges

The adaptation to storm surges is a common task of different authorities within Hamburg and also includes authorities on the federal level in its actions (BUKEA, n.d.-a). The relevant actors within Hamburg are: "BUKEA, Bezirksämter, LSBG, HPA, HafenCity GmbH, Hamburg Wasser" (BUKEA & LSBG, 2021, p. 37). Many dykes have been built around the city to protect the people and property from the tides and storm surges. Managing the river Elbe including protection from storm surges is part of a coordinated effort between different authorities in Germany and with neighbouring countries. In Hamburg, the responsibilities for planning and implementing measures within the flood risk management framework depend on the water body. Usually, the responsibility lies with the water management departments in the districts. There are regular meetings between the districts' Bezirksämter and the BUKEA to coordinate their actions (BUKEA & LSBG, 2021).

For the federal waterways (Elbe) and the waters in the area of the Port of Hamburg, responsibility lies with the Hamburg Port Authority (HPA). In addition, responsibility for all measures in the field of civil protection lies with the Behörde für Inneres und Sport. The technical flood protection also protects Hamburg from river floods which are not considered a challenge for the main dyke line because they produce less waves and therefor can handle higher water-levels (BUKEA & LSBG, 2021).

An assessment of Norddeutsches Klimabüro & Meinke (2009) projects that the current levels of protection against storm surges in Hamburg will be sufficient until 2030. In 2012, the Senate decided to increase the current protection level of the dykes finishing in 2050. The new design water-level of the dykes is based on a report re-assessing the expected storm surges events while considering the climate-related sea-level rise. In the document the different factors which influence the water level during a storm surge are described and the calculation method is explained in detail. The projections (see 4.1.2) mentioned earlier estimate a changed climate that could lead to storm surges that are 30 cm – 110 cm higher at the end of the century (LSBG, 2012; Norddeutsches Klimabüro & Meinke, 2009).

Using this report the city government decided to increase the new design water-level by 80 cm. By adjusting to this new level, they claim that the new protection level is "oriented towards the future and includes possible effects of climate change in this century" (Behörde für Inneres und Sport, 2022). However, this new design water-level contains a climate safety factor of +20 cm, expecting a sea-level rise of 50 cm at the end of the 21st century, noting that Hamburg's neighbours are assuming the same sea-level rise (LSBG, 2012). Comparing it to later projections (see 4.1.2), the new protection level is 3 cm above the lower expected value in the best-case scenario for the mid of the century. However, the globally implemented

mitigation policies are not sufficient for the best-case scenario to be a likely and reasonably expected future. Currently the greenhouse-gas emissions keep rising, making the more severe business-as-usual more likely (Skea et al., 2022). This means that the lower value of the expected range will now lie 3 cm above the design water-level and 20 cm above the upper value mid of the century. To keep the intended protection level the protection level needs to be increased.

For the risk areas, plans are published with guidelines lining out how to act in case of storm surges. They are available online in standard German, simpler German and in other languages namely Turkish, Russian, English, Polish, and Arabic (Behörde für Inneres und Sport & BUKEA, 2021). In case of a storm surge water level of above 7,3 m, people in areas at risk are urged to leave either on their own or with public evacuation busses (Behörde für Inneres und Sport & BUKEA, 2021).

4.3.4. Adaptation to heavy precipitation

In Hamburg adaptation to heavy precipitation is dealt with in different departments in the ministry as well as in the districts. Main research and pilot measures were conducted within the research project RISA which now coordinates climate adaptation measures in Hamburg as *Stabsstelle für Klimafolgenanpassung/RISA* (BUKEA, n.d.-c). The project was launched in 2009 to respond to the increasing trade-offs between further sealing tendencies, potential climate crisis impacts, demands on quality of life and infrastructural requirements. Among the goals of natural water management and enhanced water protection, protection from floods caused by heavy precipitation is one of the main issues dealt with in this project. RISA issued a variety of reports and other documents that make their work accessible to the public. Within the RISA project, pilot projects at 20 locations were realised across the city. At six of the locations measures to reduce flooding from heavy precipitation implemented. Two of the pilot projects in Hamburg-Mitte aimed to tackle flooding, *"Schleemer Bach"* and "*Möllner Landstraße",* coincide with neighbourhoods that predominantly have a low or very low social status (Waldhoff et al., 2015). Figure 16 shows the two RISA pilot projects dealing with heavy rain flood protection in located in Hamburg-Mitte's North-East.

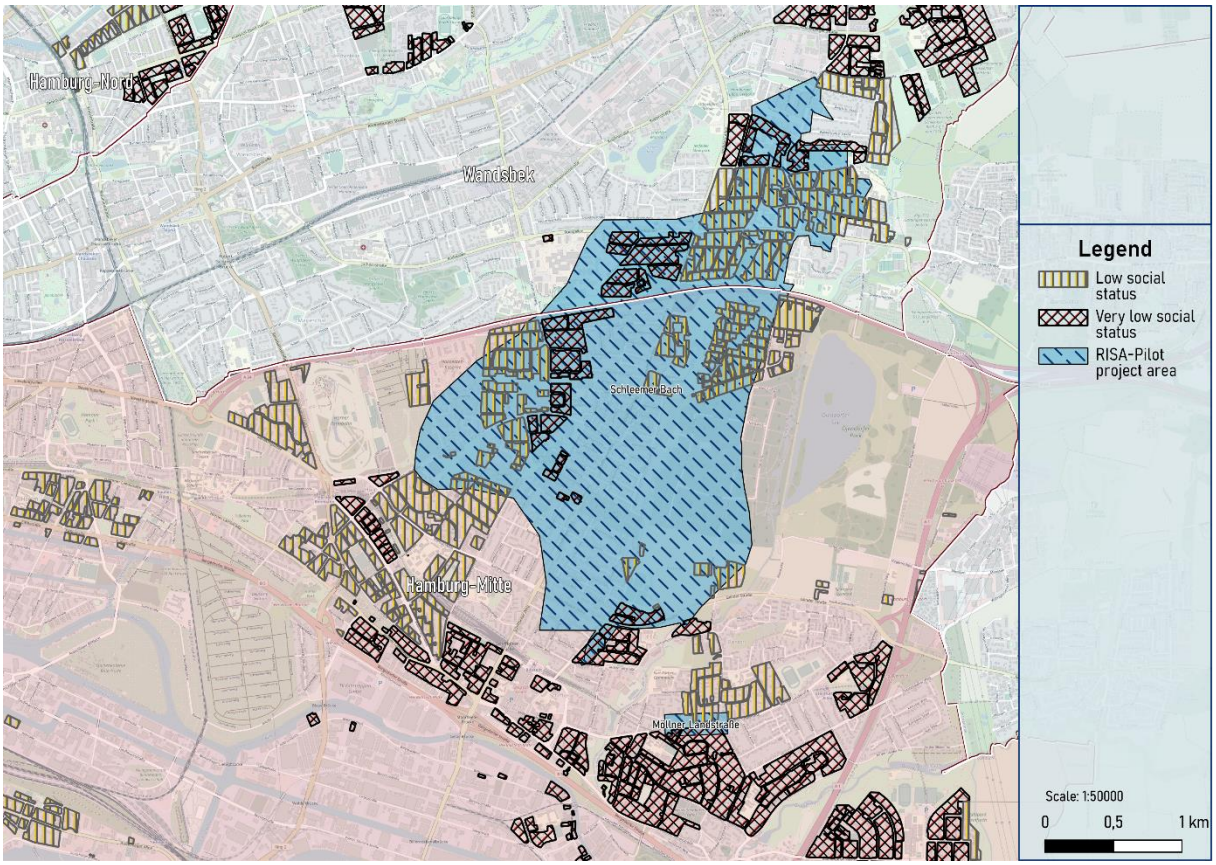

Figure 16 RISA pilot project areas in Hamburg-Mitte

In the IKK, one sight has been identified that should be unsealed, in the 'Osterbrook'. The area lies in a neighbourhood that has a middle social status and according to the flood risk assessment, the area where precipitation can accumulate is fairly small compared to other areas nearby and the depth is between 10-30 cm. The area is illustrated in Figure 17. Another goal is to increase blue-green infrastructure measures, but no specific sight has been identified yet and implementation has not started yet (Röttgers et al., 2023; Röttgers & Pleuser, 2023).

Additionally, every house owner in the city is individually responsible for protecting or not protecting their property against possible incoming heavy rain. A regular storm and tempest insurance is not covering damage from heavy rainfall, for additional protection an extra insurance against natural hazards is necessary (Döring et al., 2020).

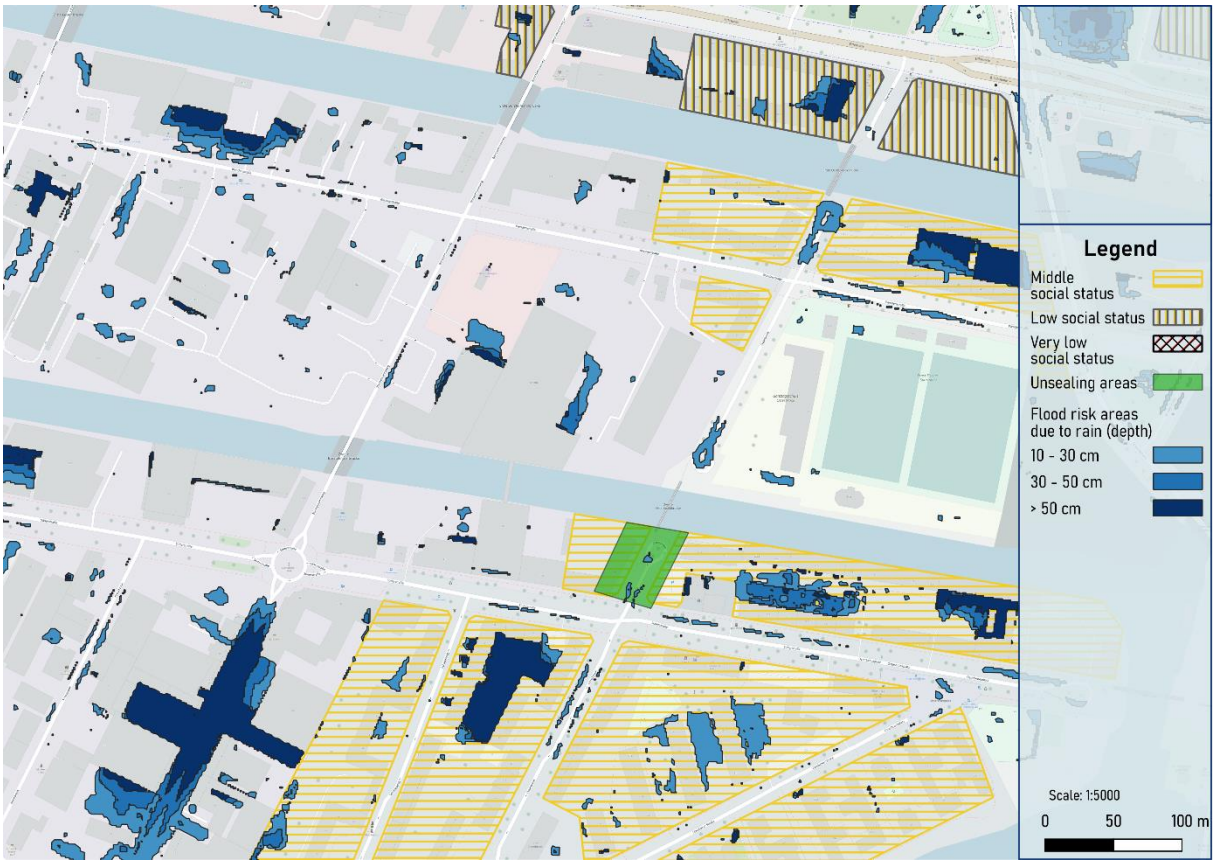

Figure 17 Osterbrook unsealing area

4.4. Climate justice and Intersectionality in Hamburg-Mitte's adaptation planning

In this chapter, the relevant plans for climate adaptation measures in Hamburg-Mitte are assessed with the framework laid out in 3.3.3

4.4.1. Analysing Hamburg-Mitte's Integriertes Klimaschutzkonzept through an intersectional climate justice perspective

Hamburg-Mitte's Integriertes Klimaschutzkonzept outlines Hamburg-Mitte's climate action efforts. Specific planned measures are few and measures in the concept stage, set to evaluate are not sufficient to say that measures are adequately reducing climate hazards and risks (Röttgers et al., 2023). Social-demographic factors are not a factor in Mitte's climate planning (Röttgers & Pleuser, 2023). The document also does not mention any of the observed marginalized or vulnerable groups and does not specify any measures direct towards their vulnerabilities (Röttgers et al., 2023). In this case where measures fail to be directed towards vulnerable groups, they are an injustice of omission.

The IKK contains a whole chapter about the communication concept and participation method. Recognising the importance of including various stakeholders into the process. In the IKK a variety of stakeholder groups is stated that were contacted to be included into the participatory processes. The stakeholder groups are divided into 6 sections: urban development, housing industry, energy, mobility, economy, culture- and civil society. The authors state in the last section representatives of vulnerable groups (Röttgers et al., 2023).

The interviews revealed that the open participation formats aimed to include regular citizens from all walks of life but primarily attract only certain demographic groups. Notably, children and younger people as well as people with a visible migrant background were underrepresented (Röttgers & Pleuser, 2023). This hints at a lack of recognising the different power structures. Barriers to participation, especially for people experiencing racism could not be successfully removed.

4.4.2. Analysing RISE through an intersectional climate justice perspective

Tackling social issues is a task of the city government and one of the tools to tackle inequity in Hamburg is the RISE programme. But not all areas with a low or very low profit from this programme. The RISE plans in Hamburg-Mitte do not focus on climate adaptation and only marginally mention own specific measures. While mentioned energy-saving measures can be considered as climate adaptation in specific cases, e.g., when they increase insulation, they are not explicitly addressed as such. Key terms related to climate adaptation, such as "heat," "rain," or "flooding," are not mentioned in the investigated plans. When measures are mentioned in the climate adaptation section, it is to provide pleasant green spaces. (Bezirksamt Hamburg-Mitte, 2020, 2023; Bezirksamt Hamburg-Mitte & steg Hamburg, 2021). However, punctual measures that increase the adaptative capacity in other building projects are supported by the Veddel RISE development project (de Temple, 2023). The residents of the low status areas profit from the measures but the degree to which risk is actually reduced is hard to determine with these marginal measures.

In terms of decision-making processes, the institutionalised participation board is one out of many actors and can only recommend and suggest, but cannot make any decisions. Decisions are made in the planning department and districts parliament. The deciding institutions are reported to be receptive of the advisory board's inputs (de Temple, 2023). A sound statement about dissenting views from marginalised groups cannot be made. In calling for participating in the advisory board in Veddel, a variety of measures are taken to lower barriers for marginalised groups: publications in multiple languages and on many platforms. The constitution of the board is decided by the district's parliament in cooperation with the responsible urban development department. There is no published and fixed set of criteria, making the process less transparent. The department's aim however is to include as many applying citizens as possible using these vague rules to increase varying views in the board. The rules of inclusion continue to be made by the district's parliament and administration and the participation boards draw up their own rules of procedure (Bezirksamt Hamburg-Mitte, 2020; de Temple, 2023; *Geschäftsordnung Für Den Sanierungsbeirat Billstedt-Zentrum*, n.d.; Sanierungsbeirat Billstedt-Zentrum, 2020; Stadtteilrat Rothenburgsort, 2015).

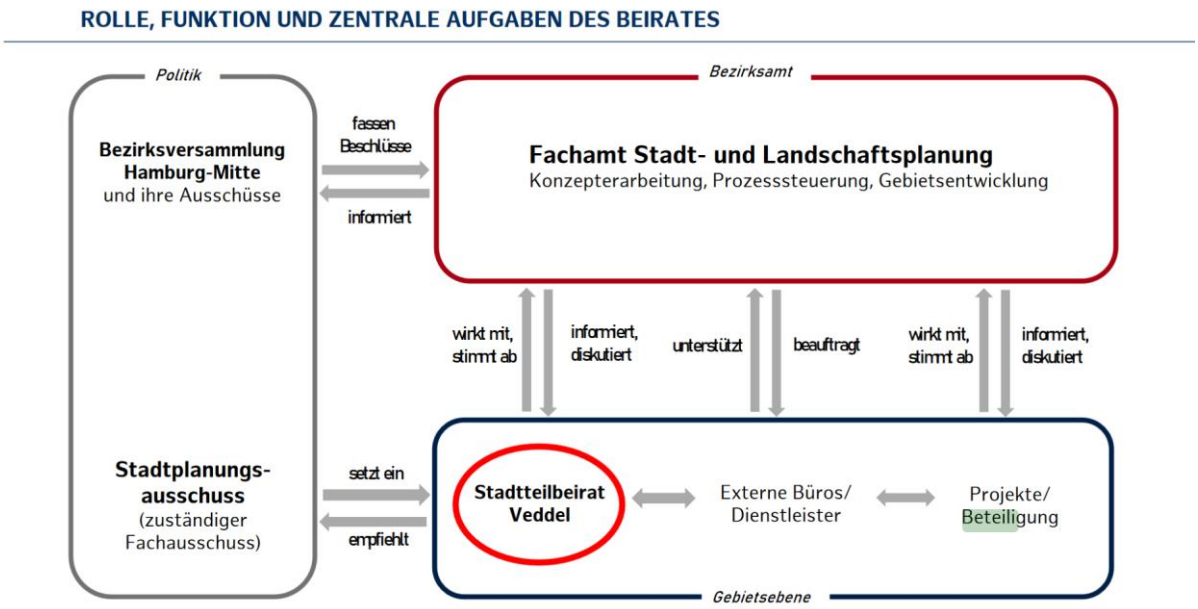

Figure 18 RISE-advisory board's role in the system (Bezirksamt Hamburg-Mitte, 2020)

In the RISE programme currently, it is required to do some measures in the combined field of climate protection, climate adaptation and green infrastructure. Making the aspect of climate adaptation mandatory could be a good first step to improve climate adaptation in areas with a low social status, shifting the focus and add to the pleasant green spaces adaptation measures. Thereby making it mandatory to implement some degree of climate adaptation in disadvantaged areas. The participation board is focused on responding to contemporary problems. For climate adaptation it could be beneficial to work with scenarios to assess how the neighbourhoods will be affected in the future and adapt proactively.

4.4.3. Analysing RISA through an intersectional climate justice perspective

RISA is the city's heavy precipitation adaptation concept designed as a top-down project arguing that the general public is hard to reach because the projects in its early stages seem to be less tangible (Waldhoff et al., 2015). Following the analytical framework of intersectional climate justice, RISA was not aiming for procedural justice and is not recognising different views or barriers to participation because a broad integration of citizens is not seen as valuable (Waldhoff et al., 2015).

Two pilot projects of RISA are situated in an area where many people with a low social status live, reducing the exposure to heavy precipitation for this group of already disadvantaged people. An important component of distributive justice is fulfilled for this measure. However, there is no consistent policy to focus on vulnerable people. This hints at a lack of recognising differential capabilities. RISA is not considering distributive, procedural or recognition intersectional justice aspects. Not considering disadvantaged areas and vulnerable groups and planning measures without them is an act of omission (Waldhoff et al., 2015).

4.4.4. Analysing Hochwasserrisikomanagementplan through an intersectional climate justice perspective

The Hochwasserrisikomanagementplan and its related measures are managing the coastal flood protection. The protection level against storm surges is increased but the increase does not take the most likely scenarios in account. The new protection level is not adequately reducing the risk. Regarding distributive justice, the citizens are not protected well enough against this climate hazard if the plans are executed like they are planned now. After the latest calculations, and taking the sea-level rise in account the protection level will not increase. It is an act of omission to not increase the dykes according to the projections (BUKEA & LSBG, 2021; LSBG, 2012). Analysing it according to the framework of intersectional climate justice, the involved authors did not aim for procedural intersectional justice or recognition intersectional justice aspects. The focus was to inform the already interested public, reduction of barriers to participation e.g., was not considered (BUKEA & LSBG, 2021).

Including the affected and vulnerable groups of the public, making the considerations transparent and explaining it to them would decrease the barriers and could improve their agency and distributive intersectional justice aspects.

5. Discussion

Document analysis and interviews allowed for a good understanding of the topic and the planners'.work and the standpoints of other actors. The use of GIS helped visualise and identify potential risk areas and vulnerable groups. Relying on existing public data allowed for displaying a wide variety of spatial information but restricted to displaying it in the categories it was made available.

Using participatory planning as a theory, did not ask the question whether in some cases a more top-down approach could be beneficial but it provided a good addition to the concept of procedural justice. The low amount of participant from marginalised groups is an issue that has been recognised in planning but planners struggle with it.

The NGOs explained there are many reasons why marginalised groups participate less. The criticism towards the current participatory planning is manyfold: People without German citizenship have less rights to participate in political processes, they cannot vote or be elected, exceptions are only made for EU-citizens for local council elections (Bundesministerium des Innern und für Heimat, 2023). By excluding people with other citizenships from central parts of democratic processes like elections, makes other political processes less appealing or makes these people feel not welcome in these panels (Bozukluhan, 2023). Also, growing up with the experience that in public settings one's voice does not count adds to this feeling (Lebrija Castillo, 2023).

Another factor is that different circumstances of life are often not recognised. When people affected by intersectional discrimination, e.g. racism and classism are included as experts to share their experiences they often do not receive proper compensation and are expected to it for free (Bozukluhan, 2023). For groups with a low social status, problems other than climate-related impacts can be more pressing, like getting enough money for rent and food (Bozukluhan, 2023). When these social issues are the main concerns, and climate impacts in Hamburg are noticeable but have not been experienced to be life or existence-threatening, they can be perceived as unpleasant but manageable. With this assessment climate adaptation measures are often not a priority in disadvantaged groups (Bozukluhan, 2023; Lebrija Castillo, 2023). Recognising these issues helps but does not necessarily solve the

issue when planning is not the right discipline for these problems, but the solution falls into the realm of social policies. The lack of resources in some groups is also an issue for planners that try to their job as good as possible .

Limitations

It is important to note that several limitations may influence the validity and reliability of research findings. It is relevant to discuss methodologic limitations.

The information gathered through interviews were relevant for the results. Although knowledge generated through the interviews was confirmed with other sources, it is possible that aspects have not been included. Different planning officials from BUKEA, RISA and the coastal flood protection and representatives from affected groups did not respond or did not have the capacity for interviews, which may have impacted the comprehensiveness of the findings.

Geospatial data was obtained from public sources and limited to its resolution and availability. The assessment of climate-related hazards relied on simulations and projections. The analysis of the urban heat island effect used data from a simulation from 2017, it was used as a good estimate without on-the-ground verification of the urban heat island effect in the specific areas studied.

The results regarding the intersections of vulnerable groups and climate hazards should be used as illustrations, strong hints for systemic issues and indicators of the phenomenon, but the used methods used do not allow for a direct attribution to specific vulnerable people.

6. Conclusion

Hamburg is already experiencing climate-related hazards: temperatures above 40°C which have never been measured before, people dying because of heat, increasing heavy precipitation events that flood streets and houses. The rising sea level, in the assessable time frame towards 2100, is an issue because it makes storm surges more dangerous and more likely to reach the design-water level. The city is acknowledging that all the identified climate-related hazards are tasks that need to be addressed by urban planning measures. Plans are created and some measures taken to adapt to the changing circumstances, but concrete effective measures are scarce. One of them, increasing the dyke's design-water level is planned in a way that the intended protection level is only reached in the most optimistic scenario. Low social status neighbourhoods are more heavily affected by the heat but no comprehensive effective measures are implemented to improve the climate. There is also no comprehensive strategy or document focussing on climate adaptation neither for Hamburg-Mitte nor for the whole city.

Some responses to the climate crises are considered to mainly be the personal responsibility of the affected people like protection one's property from flooding through heavy precipitation and adaptation to heat. Appealing only to personal responsibility neglects the different capacity to adapt.

For marginalised other than climate-related impacts can be more pressing, like getting enough money for rent and food (Bozukluhan, 2023). When these social issues are the main concerns, and climate impacts in Hamburg are noticeable but have not been experienced to be life or existence-threatening, they can be perceived as unpleasant but manageable. With this assessment climate adaptation measures are often not a priority in disadvantaged groups (Bozukluhan, 2023; Lebrija Castillo, 2023).

In the investigated institutions and programmes relevant for Hamburg-Mitte that focus on planning and implementing climate adaptation measures, social factors are not considered in identifying sites for interventions and choosing measures, when vulnerable groups profit it is by chance not by design. Intersectional climate justice aspects are not considered. Adding to the body of evidence that recognition justice is necessary for just processes and procedural justice is necessary for fair outcomes. Otherwise acts of omission occur.

On the other side of planning, Hamburg's urban development programme, RISE, that is intended to improve the lives of the most disadvantaged and should include climate adaptation lacks substantial measures. In practice some measures that can be considered as adaptation measures are taken. Partially, it is lacking procedural intersectional justice because of restricted rights and possibilities but it is also the place where the differential capabilities are best recognised and addressed in participation processes. Notable efforts to recognise differential capabilities and reduce barriers could only be observed in the RISE programme. Although participating in the institutionalised board can still be a luxury for certain marginalised people's living circumstances that is hard for planners to accommodate for with their possibilities. An improved cooperation between RISE and other institutions would benefit the ideal of intersectional climate just adaptation measures.

6.1. Future Research

This research is an initial exploration of climate justice aspects in Hamburg's adaptation planning towards climate-related hazards and ways to improve it. Further research will be necessary to improve the understanding of the challenges and adequate processes and adaptation measures. It would be valuable to conduct a more detailed investigation into the experiences of being exposed to heat or flooding and explore the relationship between the measured physical impacts, personal experiences, and the threshold at which individuals' express concerns. This research would shed light on the subjective perception and degree of inconvenience that leads to action by different people.

Additionally, it would be important to assess the extent to which the hazards investigated in this study are perceived as being linked to the climate crisis. Different people's perception of the connection between these hazards and climate change would improve understanding of climate awareness in the general public and would allow together with an improved understanding of perceived inconvenience for better adaptation planning.

By addressing these research gaps, our understanding of the complexities surrounding adaptation planning with different groups including marginalised and vulnerable people would increase.

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