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Master's Thesis in

Urban, Energy and Environmental Planning

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Cities and Sustainability

Equitable Access and Justice: The Role of Accessibility in Nature-Based Solutions for Climate Change Adaptation

Insights from Køge Bugt Strandpark

Chiara Galioto

Kristīne Eglīte

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Department of Planning
Rendsburggade, 14 9000 Aalborg
http://www.plan.aau.dk/

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Authors:
Chiara Galioto
Kristīne Eglīte

Supervisor:
Martin Lehmann

Co-supervisor:
Anna Brigitte Deeg

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Abstract:
Climate change impacts are already taking place globally, disproportionately affecting the most economically and socially marginalised urban residents. This research explores the link between accessibility and justice in Nature-based Solutions (NbS) through the case study of Køge Bugt Strandpark. The term accessibility in this context it encompasses the ability of all community members, regardless of socioeconomic status or mobility opportunities, to enjoy the benefits provided by NbS. The link between accessibility and justice serves as a reference to assess accessibility conditions of Køge Bugt Strandpark. Findings from data collection activities show unbalanced distributions of opportunities throughout the park associated with accessibility challenges for people with lower income levels. The disparities highlighted by the developed accessibility index emphasise the need for a more inclusive planning strategy. Strandparken's modernisation plans need to address accessibility to ensure equitable enjoyment to NbS benefits. This research provides a framework for understanding and addressing the equity implications of climate adaptation strategies, aiming to promote justice through accessibility.

Preface

The research is part of the master's studies in Urban, Energy and Environmental Planning at Aalborg University, specialisation in Cities and Sustainability, the fourth-semester project "Master's Thesis". This research project is a direct outcome of the participation in the "Just Adaptation" laboratory, organised by the Planning Department. This report is the result of all the theoretical and practical knowledge the authors acquired during the two years of study. Bringing together all the knowledge gained, the focus of this research is on accessibility and climate justice, using Køge Bugt Strandpark as a case study.

The focus of the research also aligns with the Unite Nations (UN) Sustainable Development (SDG) goal No.11: Sustainable cities and communities, target 11.17: By 2030 provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities (UNEP-UN Environment Programme, n.d.).

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Chiara Galioto

Kristīne Eglīte

Executive Summary

The effects of climate change, such as rising temperatures, changing rainfall and increasing extreme weather events, are evident across all regions. Urban areas, with their dense population, infrastructure and economic activity, are particularly vulnerable to climate-related hazards. Nature-based Solutions (NbS) have become effective tools for climate adaptation and mitigation. However, many adaptation responses are fragmented and unevenly distributed, raising significant justice-related concerns.

This research investigates the link between accessibility and justice in NbS projects, using Køge Bugt Strandpark as a case study. Strandparken's dual role as a recreational area and a coastal protection measure against storm surges and floods makes it an ideal case for this research. The primary objective is to understand how assessing accessibility challenges can promote justice in climate adaptation projects, with a particular focus on the distribution of accessibility between neighbourhoods and the NbS by recognising social groups of different income levels.

To address the problem, a comprehensive methodology was established using a case study approach and methodological triangulation. The research includes a conceptualisation of accessibility in the specific context of Køge Bugt Strandpark, identification of existing problems and exploration of how these problems can lead to injustices.

Key findings reveal significant disparities in accessibility among different neighbourhoods. Lower-income areas in Greve and Ishøj face greater challenges in accessing the park compared to higher-income areas in Brøndby. These differences highlight the importance of incorporating spatial and statistical analysis to accurately determine the relationship between accessibility and justice.

Assessing accessibility challenges within NbS projects for climate adaptation is critical to promoting justice across multiple spheres. By identifying and addressing accessibility challenges, it is possible to ensure that marginalised communities have equal access to the benefits of NbS, such as improved resilience and well-being. Furthermore, understanding the intersection of accessibility and justice highlights broader societal inequities, underscoring the need for an inclusive and participatory approach to climate adaptation planning.

Further research is necessary to explore these dynamics more in-depth by incorporating a wider range of demographic data to improve the developed accessibility index and ensure a comprehensive assessment of vulnerable groups in the context of climate justice.

Table of contents

List of Figures

List of Tables

List of Formulas

List of Appendices

List of Annexes

Annex_1 Accessibility_index_results

Annex_2 Strandparkens_visionsplan_2021

Annex_3 Principaftale_af_7_september_2022_om_Køge_Bugt_Strandpark

Annex_4 Modernisering_af_Strandparken_Input_til_en_anlægslov

List of Abbreviations

CO_2	Carbon dioxide
EbA	Ecosystem-based Adaptation
EC	European Commission
EbM	Ecosystem-based Mitigation
EEA	European Environmental Agency
ESS	Ecosystem Services
EU	European Union
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GI	Green Infrastructure
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NbS	Nature-based Solutions
OECD	The Organisation for Economic Co-operation and Development
OSM	Open Street Maps
RQ	Research Question
SDG	Sustainable Development Goal
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

Various Facets of Just Adaptation in NbS Projects

Climate change impacts are already taking place all over the world, with the most significant ones being rising temperatures, changes in rainfall patterns and an increasing number of extreme weather events (Kabisch et al., 2016; Pörtner & Belling, 2022). With further warming, climate change impacts will become increasingly complex and more difficult to manage, interacting with non-climatic ones, resulting in compounding and cascading risks across sectors and regions (IPCC, 2023).

Urban areas, which now house 4.2 billion people (IPCC, 2022), are increasingly vulnerable to climate-related hazards due to the concentration of population, infrastructure, and economic activities (Kabisch et al., 2016; IPCC, 2022). Multiple impacts have been recorded in cities on human health, livelihoods and key infrastructure (IPCC, 2023). According to the Intergovernmental Panel on Climate Change (IPCC) (2023), infrastructure, including transportation, water, sanitation and energy systems have been compromised by extreme events, with resulting economic losses, disruptions of services and negative impacts on well-being.

Exacerbating this vulnerable situation, climate impacts are disproportionately felt by the most economically and socially marginalised urban residents (IPCC, 2022). This disproportion leads to injustices that are notably exacerbated by the interaction between the built environment's physical characteristics and the high proportion of socially vulnerable residents (EEA, 2024), attracted by the urban economics opportunities (Kabisch et al., 2016). The interaction among these factors creates distinct experiences of vulnerability and influences the adaptive capacities of groups and individuals (EEA, 2024). These vulnerabilities are influenced by various drivers of inequality such as gender, class, race, ethnicity, age, ability, and sexuality, all within the context of cultural norms and diverse values, making it harder for them to prepare for, resist, or recover from climate impacts (IPCC, 2022; EEA, 2024).

To overcome climate impacts, adaptation has emerged as a top priority response to climate change, as mitigation efforts are not sufficiently effective in containing global warming (IPCC, 2021). Adaptation actions may vary from coastal and flood protection, agroforestry, green infrastructure, landslides protection, sea level rise barriers, habitat restoration, urban drainage systems, ventilation systems, wildfire controlling technologies, smart irrigation systems etc. (IPCC, 2022).

As climate change adaptation is generally defined as the process of alleviating or moderating its adverse impacts and to be effective in perpetuity, adaptation solutions need to be effective not only in addressing present challenges but also in responding to changing conditions and

uncertainty into the future (Turner et al., 2022). Adaptation actions must comprehensively address multiple hazards and face the unpredictability of a changing climate. With additional global warming, limits to adaptation and losses and damages, strongly concentrated among vulnerable populations, will become increasingly difficult to avoid (IPCC, 2023). In addressing serious and complex impacts, climate adaptation measures often fail to benefit all societal members equally (IPCC, 2022).

It has been documented that, most observed adaptation responses are fragmented, sector-specific and unequally distributed across regions. Despite progress, adaptation gaps exist across sectors and regions, with the largest adaptation gaps among lower-income groups (IPCC, 2023).

Marginalised communities frequently have less access to green spaces and encounter significant financial challenges in acquiring flood insurance or implementing flood-proofing strategies, highlighting the uneven distribution of adaptation benefits (EEA, 2024).

In many European countries, vulnerable communities are often found in dense urban settings, where the physical features of these areas often align with increased social vulnerability, leading to an uneven distribution of climate change impacts and risks (EEA, 2024). Additionally, these communities might have limited resources for adaptation or restricted access to crucial public services like green spaces, transportation, health, and education (Breil et al., 2018).

For the IPCC (2022), adaptation plays a key element in climate resilient development, integrating physical infrastructure approaches for its achievement and deploying Nature-based Solutions and social interventions. The concept of Nature-based Solutions (NbS) embodies new ways to approach adaptation and resilience (European Commission, Directorate-General for Research and Innovation, 2021).

NbS were first cited in 2008 in a report from the World Bank that presented a list of projects addressing the biodiversity and climate crises, with a particular focus on adaptation and vulnerable communities (Castelo et al., 2023). NbS were clearly described in the final report of the Horizon 2020 Expert Group (European Commission, Directorate-General for Research and Innovation, 2015) and since then, they have been increasingly recommended for urban adaptation and as an alternative to traditional urban infrastructure (Castelo et al., 2023). Since their first theorisation, NbS have quickly risen to the top of the sustainable urban development agenda as solutions that harness the power of nature to mitigate and adapt to climate change, while also improving livelihoods and biodiversity (Cousins, 2021; Sowińska-Świerkosz & García, 2022).

NbS stand as solutions that ensure and promote sustainable solutions to environmental challenges in the long term (EC, 2015; Castelo et al., 2023). In the urban context, NbS can be a key part of urban climate adaptation efforts (IPCC, 2022). Direct human adaptation benefits

may stem from the cooling effects of urban forests and green spaces (parks and green roofs), and perceived thermal comfort, from coastal wetlands and mangroves reducing storm surges and flooding and from sustainable drainage systems designed to reduce surface flooding as a result of extreme rainfall (IPCC, 2022; castelo et al., 2023). Moreover, the capacity of NbS to deliver a broad range of social co-benefits is widely recognised by practitioners and policymakers (Keniger et al., 2013; Munang et al., 2013; Hartig et al. 2014; Hou Jones et al., 2021; European Commission, Directorate-General for Research and Innovation, 2021; Castelo et al., 2023;). In fact, NbS can enhance microclimate regulation, increase biodiversity levels, manage stormwater runoff, and lessen the impacts of sea level rise, supporting human well-being by improving public health and delivering social advantages (Revi et al., 2014; Cohen-Shacham et al. 2016; Castelo et al., 2023). Today, NbS are a core element of the European Union (EU) Biodiversity Strategy for 2030 and of the European Climate Change Adaptation Strategy (EC, 2020; EC, 2021).

To fully grasp what NbS provide and ensure that the above-mentioned benefits are delivered, it's crucial to clearly define this concept, moving beyond vague and often misleading popular interpretations. The ambiguity surrounding the concept of NbS limits their effectiveness, making their integration into planning and development akin to providing a global solution to climate change (IPCC, 2022; Cousins, 2021). By comprehensively defining NbS, planners and policymakers can ensure that the extensive benefits—ranging from environmental improvement to enhanced well-being—are effectively realised and equitably distributed. This is particularly crucial for ensuring that even the most vulnerable populations can access and benefit from these solutions.

Nature-based solutions, the umbrella concept

As clearly remarked by the European Commission (EC), the term NbS is an “umbrella concept” and can be explained in relation to key well-defined approaches (European Commission, Directorate-General for Research and Innovation, 2021). Overall, NbS intertwine various approaches to leverage ecosystem services for environmental and societal benefits (Cohen-Shacham et al., 2016; Pauleit et al.,2017; European Commission, Directorate-General for Research and Innovation, 2021).

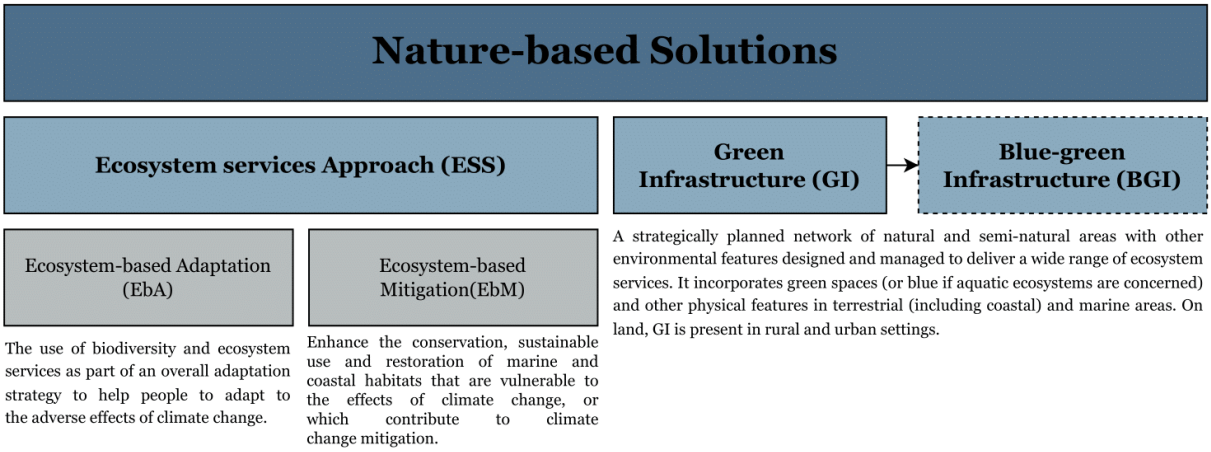


Figure 1. NbS and its relation to ESS. Created by the authors, based on definitions from the Secretariat of the Convention on Biological Diversity (2005) and EC (2013)

Pauleit et al. (2017) suggested that NbS is, specifically, an umbrella concept for EbA, GI and ESS (Figure 1). In fact, the four approaches build by and large on the same principles, such as multifunctionality and participation, but some differences can be observed in terms of breadth of concepts and their implementation in planning and practice (Pauleit et al., 2017). More specifically, EbA emphasising nature's role for climate change adaptation, and it can be considered as a subcategory of NbS. GI is a concept that emerged in planning - it helps planners and urban designer to develop strategic approaches for systematically integrating NbS and EbA into urban development at various scales, improving connectivity and green corridors (Pauleit et al., 2017). Finally, ESS, a more theorical approach, provides means for measuring and valuing nature's benefits (Pauleit et al., 2017).

The emergence and evolution of the whole field of sustainable development have solidified NbS concept in environmental sciences, nature conservation contexts and planning. International organisations, such as International Union for Conservation of Nature (IUCN), the EC, the World Bank, and the IPCC have proposed comprehensive definition of NbS as preferred method to achieve climate change adaptation and biodiversity conservation goals, moving on from simply relying on conventional engineering interventions to improving sustainable livelihoods and protecting natural ecosystems and biodiversity (Cohen-Shacham et al., 2016). The table (Table 1) below proposes the two most commonly referred ones.

Table 1. IUCN and EC NbS definitions

IUCN (Cohen-Shacham, et al., 2016) (Adopted as well by IPCC, 2022)	**EC** (European Commission, Directorate-General for Research and Innovation, 2015)
Actions to **protect, sustainably manage** and **restore** natural or modified ecosystems that address **societal challenges effectively** and **adaptively**, simultaneously providing human well-being and biodiversity benefits.	**Living solutions inspired by**, continuously supported by and **using Nature** designed to address various **societal challenges** in a **resource efficient** and **adaptable** manner and to provide simultaneously economic, social and environmental benefits.

The two definitions underscore a holistic approach to using services provided by nature (the core of the ESS approach) for delivering human and biodiversity conservation benefits in an efficient and adaptable manner. Both IUCN and EU stress the adaptative capacity of NbS, mentioning the societal challenges they aim to solve. It appears clear that NbS serve a double need: protecting and restoring the environment and providing additional benefits to people and species (Castelo et al., 2023). As mentioned, the IPCC (2022) includes NbS in the key solutions necessary to achieve climate resilient development and overcome climate challenges[1]. Defined what the NbS term encompasses, it is important to move the discussion towards which benefits NbS can deliver compared to other approaches, to ensure the correct application of the term and achieving the specific promised goals.

Nature-based Solutions benefits and possible negative outcomes

According to IPCC (2022, p.87), "Nature-based solutions cannot deliver the full range of benefits unless they are based on functioning, resilient ecosystems and developed taking account of adaptation principles".

Defining the full range of benefits NbS could deliver –also considering the side benefits- could be unnecessarily extensive. Conventional engineering approaches (the so-called "grey solutions") differ from NbS for being multifunctional, conserving and adding to the stock of natural capital, and being adaptable and contributing to the overall resilience of landscapes (Pauleit et al., 2017).

[1] The IPCC reports include NbS among the Ecosystem-based (adaptation) approaches. According to the IUCN (2016) "the Ecosystem Approach can offer a useful 'conceptual foundation' on which an operational framework for NbS can be built." An effective NbS framework enables both practitioners and policymakers to uniformly comprehend, evaluate, and enhance the effectiveness of various interventions aimed at a common goal: to empower nations and individuals in tackling significant societal challenges by sustainably harnessing crucial ecosystem services.

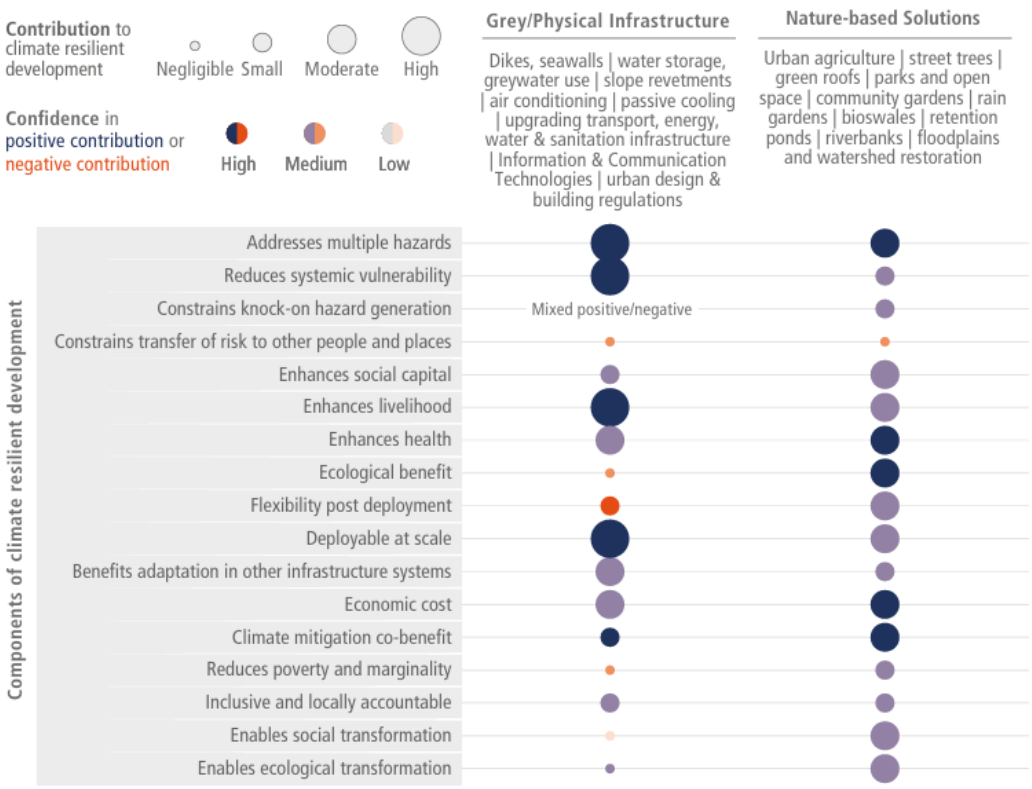


Figure 2. Contribution of urban adaptation options to climate resilient development. Source: IPCC, AR6 (2022)

From Figure 2 is possible to note the difference in contribution to resilient development of grey solutions (on the left) and NbS (on the right). Compared to the classic engineering solutions (called grey solutions), NbS can deliver a full range of benefits, recognising their role in addressing multiple hazards, improving ecological conditions, and offering flexibility after implementation together with good performance on economic costs. According to this visualisation, the main NbS benefits include - reduced overall vulnerability, improved social capital, enhanced health and livelihood, and flexibility, encompassing several mitigation co-benefits and enabling sociological and ecological transformation (IPCC, 2022). Simultaneously, there is a residual positive contribution in reducing poverty and marginality and a negative contribution in the ability to constrain the transferability of the risks to other people and places (IPCC, 2022). As highlighted by many researchers, with no reflection on the potential impacts of NbS on other areas outside the main envisioned solution, the possibility that NbS may not always be equally beneficial for all population groups is not considered (Kabisch et al. 2016). This possible negative contribution of an adaptation solution is widely referred as "maladaptation". Maladaptation describes actions that lead to increased vulnerability or major risk to climate impacts in unanticipated ways or diminished welfare or redistributed damages inequitably (IPCC, 2022; Findlater et al., 2021). A specific form of maladaptation is so-called green gentrification, which privileges wealthy urban residents in urban greening projects, offering the benefits of nature-based solutions to the few or where

NbS interventions create negative feedback mechanisms and produce indirect displacement by increasing property values (Anguelovski et al., 2019; Shokry et al., 2020; IPCC, 2023). Several studies showed how NbS can increase water demand (Nouri, Borujeni & Hoekstra, 2019) or contribute to criminal activity (Cilliers & Cilliers, 2016). For these reasons, some scholars argue that practitioners have not paid enough attention to potential maladaptation risks (Magnan et al., 2016). Barnett & O'Neill (2010) illustrated the potential negative impacts of adaptation solutions, some of which can be related to the improper use of NbS. These range from creating a disproportionate burden on vulnerable groups; incurring high opportunity costs and creating path dependence (Barnett & O'Neill, 2010). Moreover, in cities and settlements, adaptation interventions through NbS can lead to exclusionary outcomes for certain population groups (Anguelovski et al., 2016). This contributes to the well-documented disparities in how climate impacts are unevenly felt in urban settlements (IPCC, 2023). Negative equity consequences connected to NbS are designed can benefit wealthy neighbourhoods more than poor ones (Geneletti et al., 2016; Pasimeni et al., 2019; Grafakos et al., 2020).

Many cities are still in the phase of piloting or testing out appropriate adaptation actions that incorporate the analysis and mitigation of potential negative impacts, and explicitly anticipate the risks of maladaptation in decision-making (Magnan et al., 2016). Maladaptation describes actions that lead to increased vulnerability or risk to climate impacts or diminish welfare but whether an action is maladapted can depend on context (IPCC, 2023). The exclusionary outcomes of some adaptation interventions can therefore further heighten the risk to communities that are socioeconomically more vulnerable.

Nature-based Solutions as promoters of justice

Key questions about the capacity of NbS to deliver on larger societal commitments and on how to avoid maladaptation remain wide open. Sekulova et al. (2021) raise an important one: “Can NbS provide climate adaptation functions and promote equality at the same time?” It has been proved that often municipalities leverage NbS to attract new investment through green branding while leaving deeper issues untouched (Anguelovski & Corbera, 2022). Similarities can also be found in climate change adaptation literature when place change in the context of violent conflict or catastrophic disaster has been considered as a “shock” to place meanings that can be slow to evolve and potentially maladaptive (Raymond et al., 2023). As mentioned, NbS can function on two distinct levels, functional performance of ecosystems and contributions of nature to humans (Pineda-Pinto et al., 2021). Nonetheless, many scholars – supported by larger environmental organisations- have argued that NbS can lead to social segregation, displacement, and unequal distribution of benefits for marginalised and disadvantaged groups (Pineda-Pinto et al., 2021). Social, economic, and cultural structures

that marginalise people by race, class, ethnicity and gender can all contribute to climate injustices and need to be urgently addressed for adaptation options, to benefit those most vulnerable (Thomas et al., 2019; IPCC, 2023).

A perspective of NbS justice thus seeks to reduce social and ecological vulnerabilities in urban climate change adaptation in an equitable way (Wijsman & Berbés-Blázquez, 2022; IPCC, 2022). According to this view, adaptation options should equally allocate benefits among diverse groups, assuming that all individuals require an equal share of essential resources (Juhola et al., 2022). Pineda-Pinto et al. (2021) points out that in planning NbS, distribution focuses more on how the concept relates to the physical distribution of green spaces, infrastructure, or other environmental assets, rather than the distribution of environmental impacts from land use changes on nonhuman nature. The focus of the discussion revolves around human-centred issues such as the justice of socially disadvantaged groups and equity in accessing green urban spaces (Pineda-Pinto et al., 2021). Furthermore, bringing justice into the adaptation picture can help broaden participation in the design and planning processes and focus on places with low financial and institutional capacity (Cousins, 2021; Juhola et al., 2022; Wijsman & Berbés-Blázquez, 2022). Ultimately, this approach emphasises the importance of valuing individuals and distinct groups, specifically focusing on the acknowledgment of social and cultural differences and the significance attributed to these differences (Juhola et al., 2022; Wijsman & Berbés-Blázquez, 2022).

This underscores that even for NbS interventions implemented to ensure justice, it is not enough to recognise that there is inequality in how resources and opportunities are distributed; it is also necessary to recognise that different groups of society have different needs as well as opportunities (Pineda-Pinto et al., 2021).

As mentioned before, adaptation approaches could reduce human well-being and/or contribute to gentrification through increasing real-estate values and other factors that are affected by the deployment of NbS (Anguelovski & Corbera, 2022). These consequences could expose vulnerable groups to additional insecurities, potentially excluding them from the advantages that NbS can provide through climate change adaptation. Understanding who has access to what infrastructure can help to redress the drivers of social vulnerability that are central to a just adaptation (Michael, Deshpande & Ziervogel, 2018; Shi et al., 2016).

As this approach is relatively new in planning strategies for climate change, to achieve a just adaptation in projects deploying NbS, planners and researchers should focus on the drivers of justice, and which are therefore the elements that enable a more just approach in designing but also redesigning NbS.

Just Adaptation Lab

The “Just Adaptation Lab” organised at Aalborg University provides a fertile research framework for the exploration of critical factors that could promote justice in NbS projects. The “Just Adaptation Lab” organised by the Department of Planning was created to study the contribution of NbS to a just adaptation. The Lab’s team is composed of four master’s students and is led by a PhD candidate, with additional guidance provided by two associate professors and support from a student assistant. The concept of just adaptation involves the study of fair and equitable strategies to manage the impacts of climate change, ensuring that vulnerable communities receive the attention and resources necessary to adapt effectively (Juhola et al., 2022). This approach to adaptation emphasises the need for planning policies and actions that do not disproportionately benefit or burden any particular community but rather promote inclusivity and justice.

The Lab's chosen case study to explore this potential in climate change challenges is Strandparken in Køge Bay, Denmark. This site provides a real-world context for examining how NbS can be implemented to support just adaptation. Strandparken, with its coastal challenges and opportunities, serves as an ideal location for exploring how NbS approaches can be designed to benefit both the environment and the local communities.

The research group aims to assess the effectiveness of NbS in reducing climate-related risks while also promoting social equity, exploring how these solutions can be structured to ensure they are accessible and beneficial to all segments of society.

Through this case study, the Lab aims to contribute to the academic and practical understanding of how environmental planning and climate adaptation can intersect with social justice principles.

The main activities of the Lab took part under the leadership of the PhD researcher. In addition to regular group discussions that facilitate collaborative analysis and knowledge exchange, the Lab actively engages in site visits and participant observations. These field activities are integral as they provide firsthand insight into the real-world contexts of the areas under study. During the initial site visit, the group had the opportunity to acquaint themselves with the local environment, observing directly the existing the features of the area, how it used by the population and highlight the main challenges.

It was during this visit that the researchers began to identify specific aspects of the site that might benefit from deeper investigative efforts. During this visit, which focused on participant observation through the lenses of different social groups (age, gender, ethnicity), it was observed that the majority of people present in the area did not reflect the demographic composition of the nearby residential community. Although this situation is unquestionably the result of multiple processes (sociological, demographic, political-territorial, environmental etc.), observing the demographic composition of park users motivated the

question of whether accessibility was the main driver of this result. This hypothesis led to the necessity to first investigate the infrastructure that could potentially hinder or facilitate access, particularly for vulnerable populations and for a more detailed exploration to ascertain how these features align with the principles of Just Adaptation. The group noted points of interest that could serve as focal areas for subsequent visits, suggesting modifications or enhancements that could make the environment more inclusive and adaptable to the needs of all community members. The findings from Strandparken are intended to provide insights that could influence both local policy-making and broader academic discussions on resilient development and just adaptation.

Case study description

Køge Bugt Strandpark (literally "beach park" in Danish), located southwest of Copenhagen, Denmark, serves as a great example of integrated coastal management and environmental foresight. This park is located on the eastern coast of the Zealand Island, stretching over the municipalities of Greve, Ishøj, Vallensbæk, Brøndby, and Hivdovre (Figure 3). The area spans more than 7 kilometres along the coastline, offering expansive views and access to the Baltic Sea. It is characterised by its sandy beaches, dune formations, and a series of green spaces that are designed to provide recreational opportunities and to protect the urbanised areas from coastal flooding.

Figure 3. Strandparken area and its localisation. Source of base map: ESRI Satellite

The beach park was first mentioned in 1936 in the planning document "Københavnsegnens grønne områder" (*The green areas of the Copenhagen Region*) on the development of regional green spaces in Greater Copenhagen (Jørgensen et al., 2022; Lund et al., 2022), by then, the area was still mainly farmland (Jørgensen et al., 2022; Lund et al., 2022). Since its first

idealisation, the beach park should have held a double function as a recreational area as a defence for coastal flooding (Lund et al., 2022). In fact, the area became fully populated during the '60s and the '70s, when the huge urban development project of Køge Bay was built as a 22 km long linear city along the bay, planned for around 150.000 people (Jørgensen et al., 2022). In 1975, the establishment of the partnership Køge Bugt I/S (consisting of the municipalities of Hvidovre, Brøndby, Vallensbæk, Ishøj, Greve, Frederiksberg and Copenhagen and the regional governments of Copenhagen and Roskilde) managed to start the work to realise the Beach Park (Jørgensen et al., 2022; Lund et al., 2022). The plan encompasses the early vision of providing a natural buffer zone to protect against coastal erosion while offering recreational spaces for the public *(*Strandparken I/S, 2024). The construction started in 1977, in 1979, the project was finalised, and in 1980, the project was inaugurated (Jørgensen et al., 2022; Lund et al., 2022). Initially, the focus was on land acquisition and the stabilization of the coastline through the planting of marram grass to prevent dune erosion (I/S Køge Bugt Strandpark, 1986). The initial project had a limited inclusion of citizens in the planning phase, including meetings with the homeowners along the coastline (Jørgensen et al., 2022). Over the years, additional amenities, including pathways, bicycle tracks, picnic areas, swimming bridges, and observation posts, were added to enhance the visitor experience without impinging on the natural environment (Strandparken I/S, 2024).

The area faces significant challenges from coastal erosion and sea-level rise, a situation made more pressing by the effects of climate change. From Strandparken's establishment in 1980 to 2024, 19 storm surges with measured water levels of over 120 cm have been recorded in the area (Kystdirektoratet, 2018). The whole park area has been equipped with systems that are able to manage excess water coming from rainfalls and the sea, combing inner and external dikes, lake systems, locks and water pumps (Figure 4) (Strandparken I/S, 2024).

Figure 4. Coastal protection systems in Strandparken. Adapted from Strandparken I/S (2024)

When the Strandparken was established in 1980, the height of the dykes was determined on the basis of 60 years of information on water levels, wind and wave directions (Strandparken I/S, 2024). When the dikes were established, it was with the expectation that the facility capacity would be exceeded once per 1000 years (Strandparken I/S, 2024).

Nowadays, the area is intended to be modernised and to install more facilities considering the climate projections for the area (Jørgensen et al., 2022). Future impacts anticipated in the area include not only the physical changes to the coastline but also the potential for increased salinity in freshwater bodies and the loss of biodiversity in coastal marshlands (Copernicus, n.d.). These changes necessitate ongoing adaptation strategies in the park's management, focusing on both hard and soft engineering solutions to protect the coastline while maintaining the area's natural beauty and ecological function. For this reason, since 2022, the formal partnership is jointly owned by the five municipalities (Greve, Ishøj, Vallensbæk, Brøndby and Hvidore) at the coast, under the Danish Government's vision, with the goal of modernising the beach park, presenting a strong emphasis on sustainability, new connections and new activities in the landscape (Jørgensen et al., 2022; Lund et al., 2022). The partnership launched a new vision for bringing the park up to date, both in relation to coastal adaptation and recreational facilities for the residents (Jørgensen et al., 2022).

The four[2] municipalities surrounding the park have a varied demographic composition. Ishøj is known for its high percentage of immigrants and descendants from non-Western countries, resulting in a diverse population that includes a significant number of residents with immigrant backgrounds, 26% of the resident population was born outside Denmark and within this, 16% was born in Asia (Denmark Statistik, 2022). This has enriched the local culture but also presented challenges in terms of integration and social services. Ishøj typically has younger demographics compared to national averages (Denmark Statistik, 2022). In Greve the population is more homogeneous, predominantly of Danish origin, 81% of the population was born in Denmark (Denmark Statistik, 2022). It is characterised by middle to upper-middle-class families, with a high rate of homeownership and a significant proportion of residents employed in the private sector (Denmark Statistik, 2022). Brøndby is known for its sports facilities, including the famous Brondby Stadium. This area has a mixed demographic with a substantial number of middle-class families and a growing number of immigrants (Denmark Statistik, 2022). Vallensbaek is the smallest among the four municipalities and features mainly residential areas. Vallensbaek's demographics include a higher proportion of elderly residents (Denmark Statistik, 2022).

Connecting justice, accessibility and NbS for coastal protection

The case of Køge Bugt Strandpark stands out as a robust example for researching accessibility within NbS, particularly in the context of climate adaptation. Originally developed with the primary aim of green infrastructure for coastal defence, the park has gradually evolved to serve multiple functional roles. Its current use incorporates an EbA, which not only mitigates the impacts of climate change by bolstering coastal defences but also enriches biodiversity and enhances the area with extensive leisure and recreational facilities, classifying itself as a great example of NbS. This multifunctionality showcases the seamless integration of natural systems into urban environments, reinforcing climate resilience while promoting urban liveability. Køge Bugt Strandpark's transition from a coastal defence recreational space to a comprehensive climate adaptation measure reflects a broader shift towards holistic environmental planning. The park's strategic location and its role serve the diverse communities of four surrounding municipalities, each with unique demographic characteristics. This diversity, its size and multiple access points make Køge Bugt Strandpark an ideal setting for examining how NbS can be structured to ensure inclusive access and distribute benefits equitably among different social groups, in different areas of the park. As

[2] In the context of this research, Hvidore is not considered because its residential area is not directly connected to Strandparken.

environmental strategies increasingly prioritise justice and equity, the concept of accessibility within NbS like Strandparken becomes critical.

The term 'accessibility' in this context extends beyond physical reach; it encompasses the ability of all community members, regardless of socioeconomic status or mobility, to enjoy the benefits provided by such green spaces. This includes easy physical access for people with disabilities, affordable transportation options for lower-income residents, and appropriate amenities that cater to the diverse local population.

These elements, together with the first observed concerns regarding who was actually accessing the park, underline the potential for research focused on exploring various dimensions of accessibility.

Considering the objective of the Just Adaptation lab, this research could assess the physical layout and connectivity of the park to various transport systems, investigate barriers that might prevent certain community members from using the park, and evaluate the social inclusiveness of the space. Such a study would provide valuable insights into how well NbS are performing in terms of providing equitable access and whether these solutions are meeting the broader goals of social justice within climate adaptation strategies.

This makes Strandparken not just a case study of ecological and climate resilience, but a focal point for exploring the critical intersections of justice, urban planning, and community accessibility. The findings could significantly influence future NbS projects, ensuring that they are designed and implemented with a strong emphasis on accessibility and equity, ultimately leading to more sustainable and just climate resilient development.

Problem formulation

According to the European environmental Agency (EEA), urban public green spaces that prioritise easy access for walking, cycling, leisure, and other outdoor activities can enhance mobility and access to vital services, especially for women, older adults, children, and low-income groups (EEA, n.d.). Several studies connect the co-benefits of urban green spaces like NbS to climate change mitigation, adaptation, and human health (Kingsley & Ontario, 2019; Pineda-Pinto et al., 2021). These studies investigate how physical access contributes to social interaction and cohesion and ensures the fruition of those NbS co-benefits (improved air quality, shade creation, enhanced biodiversity and wildlife, reduction of outdoor air temperatures, and decrease the likelihood of flooding, etc.). Kingsley & Ontario (2019) focus on the concepts of “availability and accessibility” as enablers of these co-benefits. Furthermore, they considered urban mobility as a critical aspect when planning just NbS, emphasising the fact that ensuring accessibility would allow people to reconnect with nature (Kingsley & Ontario, 2019; Pineda-Pinto et al., 2021). This includes access to resources and opportunities for interaction and essential services like safe drinking water, clean water and infrastructure

for hazard protection and risk management (Cousins, 2021). Additionally, they refer to the ease with which any land-use activity can be reached from a location using a particular transport system (Geurs & Van Wee, 2004). Physical accessibility ensures that the health, recreational, and psychological benefits of nature are available to all, contributing to broader community resilience against climate impacts (IPCC, 2023).

Considering these elements could provide insights on who and how is able to access a green area and address potential disparities among population groups. From this, it is obvious to state that if NbS are accessible only to certain segments of the population they can inadvertently exacerbate existing inequalities and lead to injustices. This includes adequate infrastructure that enables people with disabilities, elderly populations, and others with mobility challenges to benefit from green spaces and other NbS installations. Empirical evidence from diverse geographical locations where NbS have been implemented can provide practical insights into how accessibility influences the success and justice of these projects.

It is therefore central to investigate to which extent and how to consider accessibility in climate adaptation projects that utilise NbS as a solution that aims to provide several co-benefits. The following research question has been developed to support the research process in investigating how accessibility can serve as a provider of justice:

How can assessing the challenges related to accessibility contribute to promoting justice in Nature-based Solutions projects for climate adaptation?

This question guides the research in examining the multifaceted role of accessibility, ensuring that NbS are not only effective in climate adaptation but also equitable and just in their implementation and benefits distribution.

This question is supported by the three sub-research questions, that will assist in answering the main question:

SUBRQ n.1: How can the link between accessibility and justice be measured?

The first sub-research question will focus on developing a robust conceptual link between the ideas of justice and accessibility to explore how this relationship can be practically applied in analysing land use and services that benefit citizens.

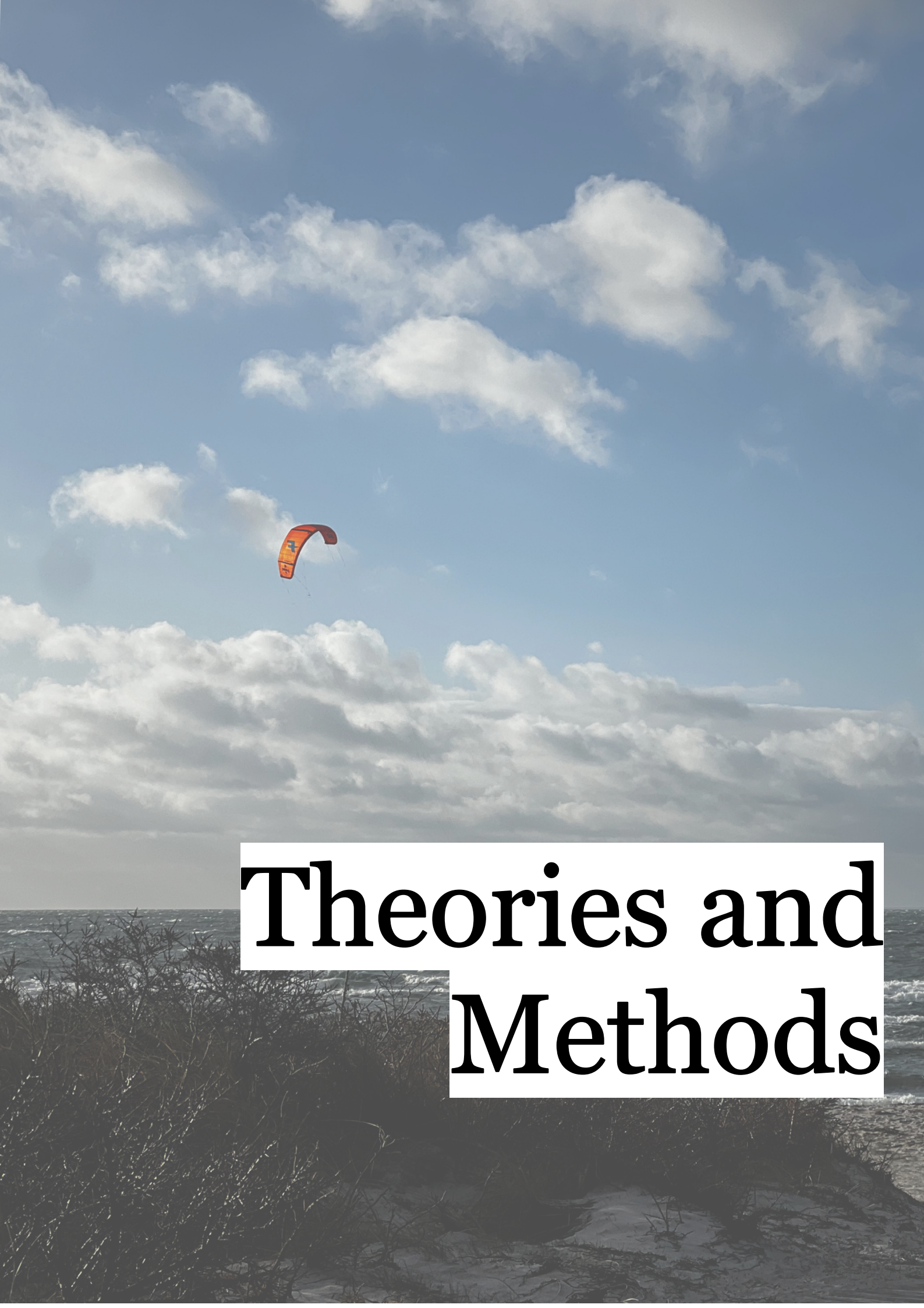
The output from sub-research question one will directly be applied to the case study chosen in this research, answering the following sub-research question.

SUBRQ n.2: What are the existing accessibility challenges that Køge Bugt Strandpark faces?

The second sub-research question will include a series of observations and analysis of the park area with the goal of assessing the accessibility conditions of Køge Bugt Strandpark, allowing highlighting potential challenges and inequalities related to justice.

SUBRQ n.3: How do the identified accessibility challenges in Køge Bugt Strandpark promote injustice?

The third sub-research question aims at calculating an accessibility index for the area considering the findings from sub-research question 2. The results from this index and the analysis of the modernisation plan will provide a solid understanding of which are the potential injustices related to accessibility in Køge Bugt Strandpark.



Theories and Methods

Research Design

The following section of the report illustrate the research design that has been established to support the report development and to answer the main research question.

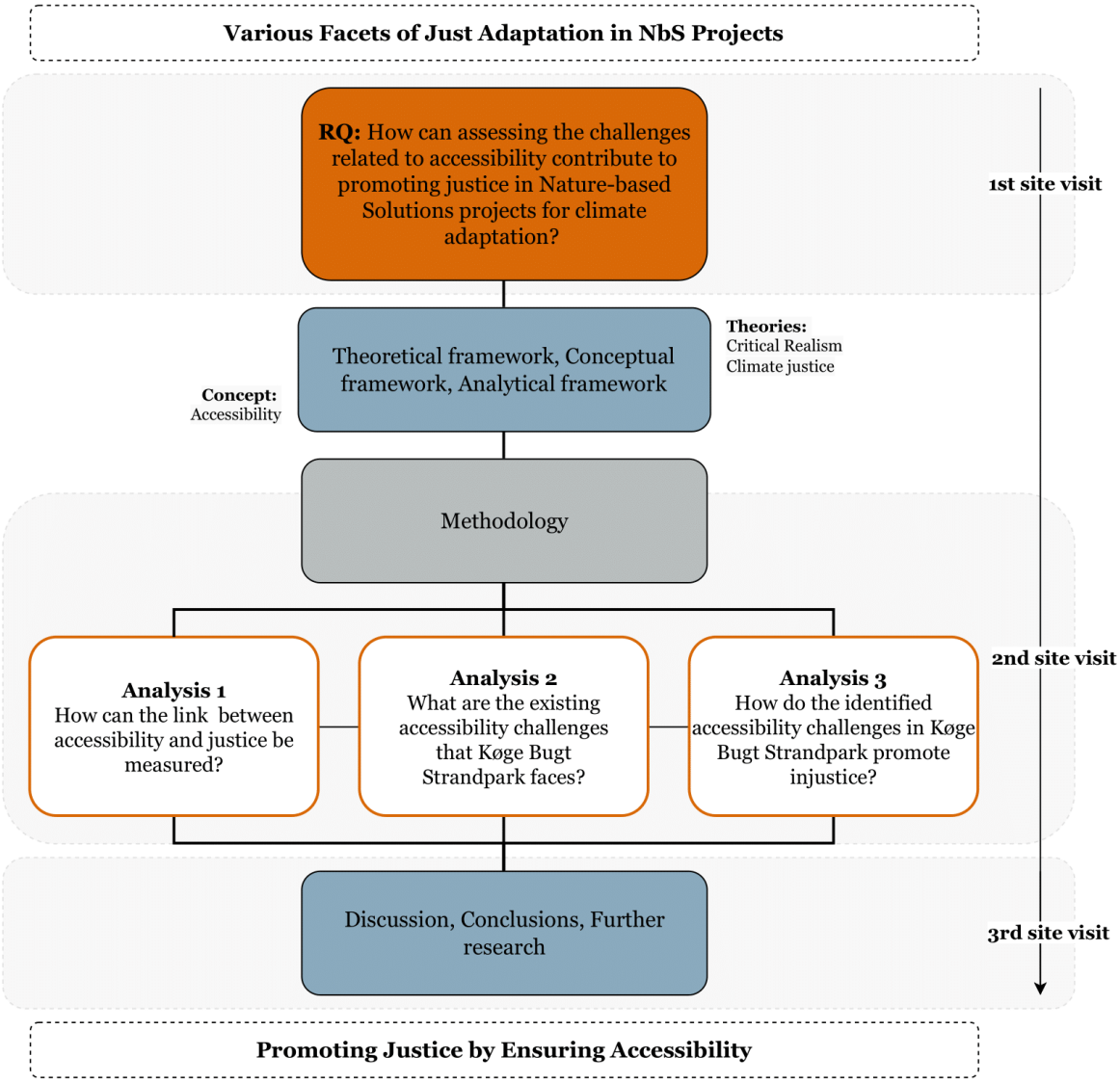


Figure 5. Research design schematic representation

The schematic representation of the research design (Figure 5) serves as a visual roadmap, outlining the overall structure and flow of the research. This representation provides a clear overview of the research process, illustrating the connections between key components and stages and how each part contributes to the research's objectives and outcomes.

Theoretical Framework

Building a theoretical framework provides a shared worldview that supports one's approach to problem-solving and data analysis (Grant & Osanloo, 2014). In addition, it offers a rationale for the chosen topic and establishes connections between research questions, problem analysis, design, and other research components. As emerged from problem analysis, NbS - and its application- carry a distinctive level of complexity when analysing the associated benefits and adaptation opportunities. It became necessary that understanding these multifaceted issues requires robust theoretical frameworks. Critical realism serves as one such framework, providing a holistic approach necessary for examining the deep societal impacts wrought by climate change, emphasising the importance of understanding the underlying structures and mechanisms that shape social and environmental reality. This perspective underscores the necessity of analysing specific structures to fully comprehend the dynamics of change, as exemplified by the employment of a case study in this research. Simultaneously, the focus on justice within the Just Adaptation Lab highlights the need to define the concept of Climate justice. This delves into the ethical and moral dimensions of climate change, prioritising the rights and interests of marginalized communities and future generations. Integrating the two theories promotes a more holistic understanding and interdisciplinary thinking, allowing engagement with a wider range of literature and research methodologies.

Critical Realism

In the context of climate change, critical realism can provide a framework for understanding the environmental crisis without falling into erroneous nomothetic interpretations (Banai, 1995). According to Buch-Hansen & Nielsen (2023) critical realist approach presents a lens to understanding and addressing the climate crisis, emphasising the contribution of a changing and evolving society. Critical realism's strength lies in its adaptability, rigorous grounding in certain non-negotiable principles, and its applicability to understanding and addressing complex issues like the climate crisis through a multidisciplinary approach (Buch-Hansen & Nielsen, 2023). For Buch-Hansen & Nielsen (2023), critical realism is portrayed as an evolving philosophy that is open to incorporating new concepts, ideas, and syntheses with other philosophical strands. This openness, however, is not limitless; critical realism maintains certain foundational principles that cannot be compromised. The following sections will delve into the definition of critical realism in contraposition with other philosophical approaches, its clear connection and relevance to climate change studies and how critical realism provides a strong framework in ensuring a just adaptation. By addressing critical realism theory and its application, this chapter aims to clarify the role of this theory in this research and provide a

deeper understanding of the complexities and layers of reality embedded in addressing climate change.

What is critical realism

"Reality has an objective existence but that our knowledge of it is conceptually mediated: facts are theory-dependent but they are not theory-determined. This in turn means that all knowledge in fact is fallible and open to adjustment. But not all knowledge by far is equally fallible" (Danermark et al., 2001, p.15).

Realism posits that there exists an objective reality independent of human thought and beliefs, this reality can be discovered and understood through scientific methods. Realism is often split into two main types: direct realism, which suggests we can perceive the world as it is, and critical realism, which acknowledges that while a real world exists independently of human perception, our understanding of it is inevitably filtered through social, cultural, and individual lenses (Bryman, 2016). Critical realism attempts to uncover the structures and mechanisms that produce observable phenomena in the world. Emerging as a response to the limitations of positivism and rationalism, critical realism posits that reality consists of multiple layers, including observable events and the unseen mechanisms driving them (Banai, 1995). According to Bhaskar, the first to have theorised about critical realism, this philosophy stands on three core principles:

- Ontological realism: being is real and the world exists and acts independently of our knowledge of it (Bhaskar, 1975).
- Epistemological relativism: knowledge is socially produced under specific social and linguistic conditions and is therefore changeable and fallible (Bhaskar, 1975).
- Judgemental rationality: it is possible to arrive at decisions between relative and competing beliefs or theories because not all interpretations are epistemically or morally equal (Khazem, 2018).

Critical realism recognises that reality exists independently of our perceptions and that our understanding of it is fallible but not entirely relative. It asserts that while facts are influenced by theories, they are not wholly determined by them (Danermark et al., 2001).

Critical realism posits a layered conception of reality that acknowledges both observable events and the underlying, often invisible mechanisms that produce them. This approach maintains that while our understanding of these mechanisms and their manifestations in observable events is mediated by our socially constructed frameworks, it is still possible to gain insights into the real structures and processes that constitute the world. Thus, critical realism offers a robust philosophical foundation for social science methodology, emphasising the critical exploration of the relationship between science and reality (Danermark et al.,

2001). Overall, critical realism advocates for a research approach that seeks deeper explanations beyond observable events, focusing on the underlying mechanisms and structures that produce them. This perspective aims to provide a more comprehensive understanding of reality, considering not just what happens, but why it happens (Easton, 2010). According to the critical realist view of the world, we must admit the existence of real entities, events, agents, and structures that interact in complex ways (Banai, 1995; Easton, 2010). For Banai (1995), this is the "integration of social and spatial system". Understanding how this integration requires delving into the critical realist ontology, which emphasises the complexity and layered nature of reality.

Structures in critical realism refer to the enduring systems, institutions, norms, and relationships that constitute the social and natural world. These are not directly observable but are real in their effects and influence on agents and events. Structures are seen as the rules and resources organised as properties of social systems. They pre-exist individual agents and condition their actions, yet they are also continually reproduced and potentially transformed by these actions (Danermark et al., 2001; Banai, 1995). Agents are individuals or collective entities capable of action, decision-making, and contributing to the reproduction or transformation of structures (Banai, 1995). Agents operate within the constraints and enablement provided by structures but also possess agency, which allows them to interpret, negotiate, and sometimes change those structures. Agency is not merely about making choices within a given set of options but also involves the capacity to imagine and enact change (Danermark et al., 2001). Finally, events are the outcomes or occurrences that happen when agents interact with structures and each other. They are observable manifestations of the underlying causal powers of structures and the agency of actors. Events can be regular and predictable, or they can be unique and transformative, depending on the interplay of structures and agency at any given time (Easton, 2010). Considering this, critical realism provides a particularly powerful means by which to make sense of the claims about structural causation without eliminating the freedom of agents (Cloutier, 2019). Critical realism asserts that while our understanding of the world is inevitably partial and mediated, humans are capable of reflexivity and agency.

Consider this, properties of social structures as defined by Bhaskar (1978, p.14):

1. "Social structures, unlike natural structures, do not exist independently of the activities they govern";
2. "Social structures, unlike natural structures, do not exist independently of the agents' conceptions of what they are doing in their activity";
3. "Social structures, unlike natural structures, may be only relatively enduring (so that the tendencies they ground may not be universal in the sense of space-time invariant)".

Connecting these insights to climate change highlights the critical role of human society in both contributing to and addressing this crisis. It underscores the need for a comprehensive approach that goes beyond technological fixes to include social, economic, and cultural transformation. By recognising the malleable nature of social structures and the power of collective human agency, we can better navigate the complexities of climate change mitigation and adaptation, steering towards a more sustainable and equitable future.

By applying critical realism to climate change, one can acknowledge the physical transformations happening in ecosystems, weather patterns, and biodiversity due to human activities like greenhouse gas emissions (GHG). The connection between climate change and critical realism underscores the importance of recognising the objective reality of environmental degradation and the need for systemic changes, comprehensive and equal adaptation options to address this global challenge. This perspective can help shift the discourse on climate change from mere speculation to concrete action based on scientific evidence and an understanding of the real-world implications of environmental disruptions. By integrating critical realism into discussions about climate change, individuals and policymakers can adopt a more grounded approach to addressing this pressing issue, emphasising the need for transformative actions that are rooted in an objective understanding of the complex environmental changes.

Acknowledging complex causality

Critical realism proposes that the world is real, structured, and complex and it accepts the idea of a complex causality between different structures and open systems, unlike empiricism (Bhaskar, 1975; Khazem, 2018). The notion that causes and effects are generated concurrently through social interactions negates the existence of a closed system. In such a system, causes would need to be distinct and manipulable individually, and remain separate from their effects — this is why they are termed independent variables in empirical studies (Khazem, 2018). The nature of social reality, where closed systems are unattainable, precludes the feasibility of conducting experiments in social sciences (Rutten, 2019). This necessitates an alternative research methodology in social sciences, marking a significant divergence from empiricism (Rutten, 2019). “Critical realism, with its emphasis on interdisciplinarity, helps us deal with the interconnectedness and complexity of the world we live in” (Khazem, 2018, p.129). Critical realism can therefore present the best lenses to analyse and comprehend the relations of causality in such complex open systems that involve different structures and different agents like the context of studies related to climate change. Thanks to the multidisciplinary approach offered and encouraged by critical realism, researchers studying climate change and its implications on society can adopt a critical method that enables them to understand the “multiplicity of causal structures, mechanisms, processes or fields” (Bhaskar et al., 2010). As

a result, critical realism helps us to consider the different and interconnected spheres of activity that can contribute to sustainability, including those that contribute to, or engender, mitigation and adaptation of climate change (Khazem, 2018). This understanding can lead to more effective strategies that address root causes rather than just symptoms. Grasping the cultural and ethical dimensions of environmental issues demands a multiple perspective view that recognises how various societal constructs and phenomena—such as consumer behaviour, population growth, and urban development—interact with and influence natural systems, especially in light of the now-recognised significance of human activity on the rate and scale of climate change. Acknowledging so means accepting the need for profound transformations of our society structures. These transformations are a complex process that entails changes at the personal, cultural, organisational, institutional and systems levels. It is not always clear what exactly needs to be transformed and why, how, in whose interest, and what the consequences will be (O´Brien & Sygna, 2013).

The potential for societal transformation

Humans have been transforming the Earth for millennia, but the scope and scale of human impact have escalated dramatically over recent centuries, significantly altering the planet's climate system (O´Brien & Sygna, 2013). The scientific community agrees that human-driven environmental shifts are fundamentally transforming Earth's ice cover, sea levels, ecosystems, species distributions, and modifying extreme weather events patterns (IPCC, 2018).

Studying and addressing the influence of modern social structures, such as capitalism and consumerism, on climate change -as a natural system- requires acknowledging the mentioned complex causality among the different events and agents. According to Bhaskar (2013), thoroughly analysing and explaining how these structures contribute to climate change is difficult because addressing the issues they pose necessitates understanding how substantial changes in individual behaviours work. Capitalism and consumerism, as pervasive social structures, have been identified as significant drivers of environmental degradation and climate change due to their emphasis on continuous economic growth, high consumption rates, and the exploitation of natural resources (Meyer, 1995). These systems are deeply ingrained in societal norms and practices (structures), shaping how individuals (agents) and societies operate and make choices (events).

Bhaskar's (2013) critical realism framework emphasises the importance of understanding the underlying mechanisms and power dynamics that sustain these structures. It suggests that meaningful change towards sustainability involves both structural changes at the societal level and significant behavioural changes at the individual level (Bhaskar, 2013). These behavioural changes, in turn, often depend on other structural changes, creating a cycle that's hard to break. This dual focus acknowledges that while individuals are shaped by the broader social and

economic systems in which they live, they also possess agency that can be harnessed to transform these systems in response to the climate crisis (Bhaskar, 2013). Therefore, addressing the climate crisis, according to the framework given by critical realism, necessitates not only innovative research and awareness-raising but also collective action aimed at structural transformation (Buch-Hansen & Nielsen, 2023). Critical realism stands as a valuable framework for generating knowledge and practical alternatives to combat climate breakdown, supporting diverse standpoints and practices beyond its core principles and can underpin scientific research (Buch-Hansen & Nielsen, 2023). It is seen as an essential, though not singular, entry point for developing understanding how actions to significantly reduce Carbon dioxide (CO_2) emissions and ease the catastrophic impacts of climate change work and which effects they have on populations.

This approach recognises that climate change mitigation and/or adaptation strategies may vary significantly across different geographical and socio-economic contexts, necessitating tailored approaches rather than one-size-fits-all solutions. This means recognising the potential for societal transformation through conscious action and policy interventions that address both environmental and social justice issues.

Critical realism is intricately connected to justice through its framework that emphasises understanding the relationships between environmental factors, vulnerabilities, and adaptive capacities concerning climate change. Scholars have developed critical realist models of climate justice to address the disproportionate impacts of climate change on various communities, including those with disabilities (King & Gregg, 2021). These models highlight the importance of recognising vulnerabilities, power structures, and resource distribution for and mitigating and adapting to the effects of climate change. By employing a critical realist lens, it is possible to identify how environmental features can disable or disadvantage certain populations, such as minorities or people with disabilities, in the face of climate change challenges. Through critical realism, scholars and policymakers can work towards changing and transforming structures without imposing undue burdens on vulnerable population. In essence, critical realism provides a valuable perspective for examining climate justice by shedding light on how social and political institutions, along with environmental factors, interact to create vulnerabilities and impact different communities disproportionately in the face of climate change.

Climate Justice

Identifying and addressing the needs of vulnerable populations has become a central issue in global climate change discourse, as highlighted by reports from the IPCC and the United Nations Framework Convention on Climate Change (UNFCCC). Additionally, the power dynamics among different stakeholders in planning and decision-making processes have long been discussed in planning theories (Porter et al., 2020). Porter (2020) emphasises that the core issue is not just discovering the "right" answer through historical analysis or future predictions, but also understanding the dynamics of participation and influence of the involved stakeholders throughout the various stages of decision-making processes.

Although there have been successful climate change mitigation and adaptation actions in various cities and regions (Juhola et al., 2022), the latest IPCC report highlights that further delays in reducing emissions will have negative impacts not only on climate but also on equity (Porter et al., 2020). Theories of climate justice are based on a broader understanding of justice as the equitable distribution of social and material benefits across temporal and spatial scales (Shi et al., 2016). This includes not only the equitable distribution of resources but also the recognition of cultural diversity and the meaningful participation of marginalised groups in decision-making processes (Shi et al., 2016).

To provide a comprehensive overview, this chapter will begin by highlighting the commonalities and differences between theories of global, environmental, and climate justice. Exploring these intersecting systems will lead to a better understanding of the unique challenges and opportunities presented by climate change and the pursuit of justice. The discussion will then narrow its focus to define climate justice and explore its four dimensions: recognitional, distributive, procedural and restorative justice. By addressing variations of climate justice theories and their application, this chapter aims to foster a deeper understanding of the complexities inherent in addressing climate change while respecting the principles of equity and justice.

Defining climate justice

Discourse on justice in the context of climate change is undeniably complex, raising questions about different practices and ways of thinking that distinguish it from long-established theories of global and environmental justice (Baxi, 2016). Baxi (2016) identifies the following three forms of justice as separate but, interrelated with their principles and goals: global, environmental and climate. Global justice, as outlined by Baxi (2016), includes the recognition of basic human rights and the equitable distribution of responsibility for environmental protection on a global scale. While it addresses inequalities of resources, wealth, and opportunity, both locally and globally, it also embraces the notion of transboundary justice,

recognising the interconnectedness of global challenges. On the other hand, environmental justice focuses on both local and international dimensions, advocating for the right of all individuals to live in a clean, healthy, and safe environment (Baxi, 2016). This includes addressing fundamental issues such as pollution, biodiversity loss and ecological disasters, with a particular focus on ensuring equity and justice in diverse communities. Finally, in climate justice the concept of intergenerational justice holds one of the central stages, emphasising the long-term impact of anthropogenic emissions on generations (Baxi, 2016). Unlike global justice, which has only recently begun to consider historical injustices, climate justice stresses the urgent need to address past, present, and future wrongs related to GHG emissions (Baxi, 2016).

Over the past decade, planning theory has focused considerably on understanding the justice implications of climate change (Fünfgeld & Schmid, 2020). At the same time, interest in how climate change impacts society has also increased in public debates and movements. One of the key issues in the context of climate justice is that the negative effects of climate change are felt most directly and severely by countries that have contributed relatively little to the increase in emissions, highlighting the need for justice and equity (UNDP, n.d.). Juhola et al. (2022) defines just climate adaptation as process which: 1) recognises past and current disadvantages in society, 2) identifies the potential unequal way in which climate impacts and costs and benefits of adaptation measures are distributed, 3) is based on inclusive processes throughout planning, implementation, monitoring, and evaluation, and 4) restores past inequalities through adaptation (Juhola et al., 2022, p.609).

This definition of climate justice draws on different theories and frameworks to address the complexities of climate change impacts on society. Although the theory traces its origins to Rawls' conception of justice from 1971, it has evolved to adapt to contemporary challenges and incorporate new insights (Baxi, 2016). This development reflects a growing awareness of the need for a just and inclusive response to climate change. Therefore, it is important to address each of the dimensions as they work together to ensure that climate action is not only effective in solving environmental problems, but also ethical, inclusive, and socially transformative.

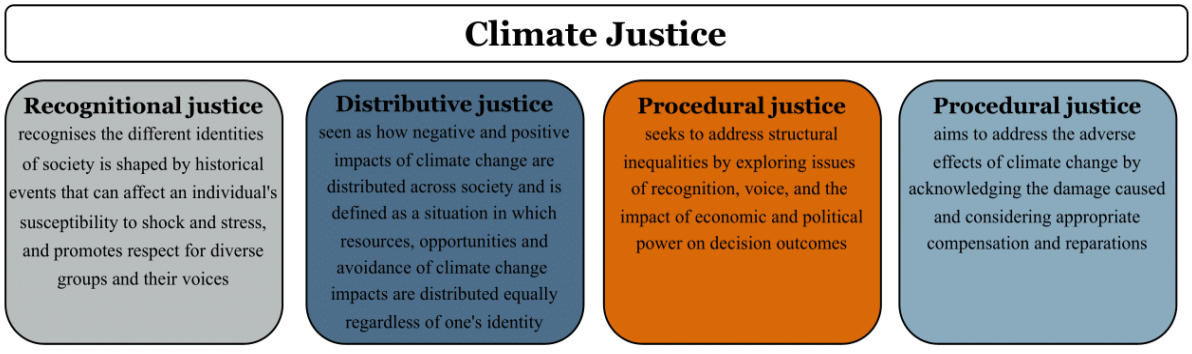


Figure 6. Four dimensions of climate justice and their core principles. Created by authors, based on Juhola et al., 2022; Holland, 2017

Further, an in-depth explanation of each dimension of climate justice is presented (see Figure 6 for a summary).

Recognitional justice

Climate change threatens several basic human needs and rights, yet there is a lack of further research into recognising the damage experienced by vulnerable communities its implications (Brincat, 2015). Recognitional justice is characterised as the acknowledgement of the plurality of societal actors, and their differing needs, desires, and abilities for adaptation (Juhola et al., 2022). Furthermore, this dimension of climate justice recognises the diverse identities of members of society, such as race, gender, age, etc.; and that these identities are shaped by historical events that may influence an individual's susceptibility to shock and stress; and that it should promote respect for diverse groups and their voices (Juhola et al., 2022).

As vulnerability to climate change varies by geographical and societal context, it is critical to identify the adaptation requirements of different societal groups. Expert assessment, according to Juhola et al. (2022), can be used to identify different needs of social groups. However, recognising their ability to make their demands for climate adaptation is critical to empowering marginalised populations. This requires a change in strategy from a top-down to a bottom-up approach, helping to identify power differentials between stakeholders (Juhola et al., 2022). Furthermore, recognising the underlying social structures can lead to the identification of the drivers that contribute to social injustice (Juhola et al., 2022). This means recognising that structural factors influence how different people can access resources and information about climate adaptation (Juhola et al., 2022).

Distributive justice

Distributive justice considers both negative and positive climate change and climate adaptation effects and how they are distributed within society (Juhola et al., 2022). A just situation, under the lenses of distributive justice, is defined as a situation in which resources, opportunities and avoidance of climate hazards are equally and fairly distributed, regardless of a person's identity (Juhola et al., 2022).

Given their similarities, there is a fine line between confusing the terms distribution and social justice. The scope of social justice is much broader than issues related to the distribution of goods and opportunities. Saying this, it is possible to argue that distributive justice has characteristics that apply to only a part of the more general normative theory of institutions, not itself (Maroni, 2019).

How adaptation measures are implemented plays a major role in shaping the distribution of climate change impacts. As mentioned, adaptation has the potential to create both new opportunities and injustices, changing socio-spatial dynamics and reinforcing pre-existing differences (Fünfgeld & Schmid, 2020). As an example, choices that prioritise the

development of coastal infrastructure to safeguard valuable properties along the coast could lead to increased benefits for wealthy residents, reducing the vulnerability of certain groups while imposing economic burdens and injustice on others (Fünfgeld & Schmid, 2020). In addition, these decisions may also affect cultural aspects of climate change, such as a sense of place attachment and identity. Therefore, it is safe to say that urban planners and decision-makers play a crucial role in ensuring distributive justice. Local governments have great autonomy and influence on guaranteeing opportunities and well-being of their residents. For example, they can help improving infrastructure and green area access, availability of services, etc., through increasing the accessibility of different modes of transport (Maroni, 2019).

Several approaches have been proposed to address the unequal distribution of negative and positive impacts of climate change. Risk and vulnerability assessments have become routine at national, regional, and local scales (Juhola et al., 2022). Risk assessment typically consists of climate change-related hazards with a clear methodology and analysis of exposure and vulnerability (Juhola et al., 2022). In addition, vulnerability is widely discussed as a complex phenomenon that describes multiple social conditions and processes that affect the extent to which different members or groups of society are affected by climate change hazards. Both general and hazard-specific vulnerability characteristics and attributes have been identified in the literature and their inclusion in risk and vulnerability assessments has become routine (Juhola et al., 2022).

Procedural justice

Another important dimension closely related to both recognition and distributive justice, but distinct in its own right, is procedural justice. Procedural justice is related to the fairness and transparency of decision-making processes in institutions (Holland, 2017). It seeks to address structural inequalities by exploring issues of recognition, voice, and the impact of economic and political power on decision outcomes (Holland, 2017). In climate change, procedural justice refers to justice in the climate adaptation process. This means acknowledging who may be the decision maker or participant in the planning process, how decisions are made and who provides information or ideas (Juhola et al., 2022).

In many cases, vulnerable populations are not heard during the adaptation strategy definition phase and these groups are unlikely to influence the procedures and guidelines on how and when adaptation decisions are made (Holland, 2017). Thus, to ensure procedural justice in adaptation planning, it is important to ensure that those who are and will be affected by climate change have real opportunities and access to the necessary skills to participate in the adaptation process (Fünfgeld & Schmid, 2020). This requires an open and transparent dialogue between all parties, especially those most affected. Participation can happen during the preparation of the strategy, as part of the process itself or afterwards, when evaluating the results (Juhola et al., 2022).

Procedural justice recognises vulnerability to climate hazards as a dynamic phenomenon (temporal scale) identifying vulnerable groups (spatial scale). This means that vulnerability should be periodically reassessed, which should result in updating adaptation measures (Juhola et al., 2022). Holland (2017) suggests that procedural justice actions within the adaptation are understood as an ongoing process of transformation, where vulnerable populations should have the opportunity to express their voice and power in the struggle between competing interests. Existing empirical literature on climate change adaptation suggests that in many if not all, adaptation efforts, vulnerable citizens lack the political capacity to make adaptation decisions in ways that transform the underlying or systemic causes of vulnerability to climate change (Holland, 2017).

Restorative justice

In recent years, the concept of restorative justice has emerged as a fourth dimension in the discussions around climate justice. This approach aims to address the adverse impacts of climate change by recognising the harm caused, identifying both trespassers and victims and considering appropriate compensation and reparations (Juhola et al., 2022). Within the framework of restorative justice, the concept of maladaptation assumes significance, as it often stems from existing societal inequalities, as it can exacerbate existing disparities and increase vulnerability. However, there is potential to develop adaptation strategies that address these issues in a restorative manner (Juhola et al., 2022). Despite its importance, restorative justice in the context of climate justice remains relatively underdeveloped in both theoretical discourse and practical implementation. If current approaches to viewing and implementing adaptation measures remain unchanged, restorative justice can be expected to play a greater role in addressing climate-related injustices.

Equity in climate justice

As perspectives in justice require addressing an equitable access to resources, equity and its role in this context requires further exploration. According to United Nations Development Programme (UNDP) (n.d.) *climate justice means putting equity and human rights at the core of decision-making and action on climate change*. Tahmasbi et al. (2019) point out that there are several variations and interpretations in the definitions of equity. However, there is one common feature among them all: to achieve equity, resources, amenities, services, etc., should be compared to a group of people or groups of people, and the goal of justice is to ensure equal distribution of resources, services, and benefits among individuals in society, striving to improve the distribution of benefits to reduce inequality (Tahmasbi et al., 2019, p.2). This ties directly into the principles revealed by the four dimensions of climate justice discussed earlier in this chapter.

Equity in climate justice can be considered from many facets, few of them, recognised by UNDP (n.d.), are presented below:

- *Structural inequalities:* even within the borders of the same country, the impact of climate change can be felt differently by different groups of society, depending on their ethnicity, gender, or socioeconomic class. For example, women, who have fewer resources available to respond effectively to change; people with disabilities are exposed to higher risks, such as threats to health, access to food, water, energy and sanitation.
- *Socioeconomic inequalities:* the resources needed to reduce the negative effects of climate change are distributed unequally globally, where developing countries are at higher risk.
- *Intergenerational inequalities:* younger generations, who have had minimal or no contribution to the emissions exacerbating the climate crisis yet will feel the effects most directly in the future. Their fundamental human rights are threatened by the decisions of previous generations and must be the central point of all climate-related decision-making and actions.

As adaptation to climate change is at the top of the agenda across countries and cities worldwide, their interventions should contribute to reduce the vulnerability of disadvantaged groups. The concept of equity as part of climate justice is essential in achieving adequate, fair and sustainable climate action. Vulnerability, as one of the variables in equity, has both a social dimension - characterised by susceptibility based on social, economic, and political factors, and a physical dimension - which refers to the exposure of people and places to climatic conditions (Swanson, 2021). This means that climate change adaptation planning must first and foremost consider the link between climate change and equity, particularly how individuals and communities are differentially exposed to the impacts of climate change based on factors such as income, education levels, race, gender, age, and disability (Swanson, 2021). Swanson (2021) continues by underlying how multiple scholars have argued in their studies that disadvantaged groups facing initial injustices are disproportionately affected by climate change, resulting in increased inequality. Moreover, to be effective and socially acceptable, adaptation efforts must seek to promote the goals of distributive, procedural, and recognition justice (Swanson, 2021).

A comprehensive approach is essential to ensure equity in addressing adaptation to climate change. Climate justice requires expertise in diverse fields such as politics, law, urban studies, climate, social and environmental science. In addition, effective engagement with citizens, especially those most vulnerable to risks, is crucial. From a critical realist perspective, it is acknowledged that climate justice is not a one-size-fits-all concept but rather varies based on context, recognising the existence of multiple truths. Viewing climate justice through the lens

of critical realism helps uncover the root causes of injustice and inequality by going beyond surface-level observations to understand power dynamics and economic structures. This highlights the importance of historical and socio-economic factors in shaping current disparities. Additionally, critical realism emphasises the ability of individuals and communities to challenge existing systems and support transformative change despite existing power imbalances and structural constraints.

Conceptual Framework

The possibilities of understanding and interpretation of the concept related to accessibility and access are various. It depends on what is the main focus, from what scientific perspective the problem is considered, etc. To explore the rationale for the decisions made on how to define accessibility in this research and grasp the results obtained, a conceptual framework is constructed. According to Tamane (2016), the conceptual framework is the backbone of research, offering a structured system of concepts, beliefs, and theories that guide the investigation. It defines the scope of the study, creates a working platform on which to interpret and analyse data, and creates a theoretical basis for understanding the phenomena studied and informing the selection of research questions and methods. Ultimately, the conceptual framework serves as a justification for the topic's and methods' suitability, and the study's importance, acting as a roadmap for empirical inquiry (Tamene, 2016). The main objective of providing the conceptual framework within the scope of this study is to develop a comprehensive understanding of the significance of accessibility, not only as a measure in transportation service or in design principles, but also by providing a climate justice value to the term. This is crucially important especially when using NbS as a type of adaptation option, aiming for equity in opportunities regardless of what social group one belongs to.

This chapter starts by linking several definitions of accessibility to its components as an indicator of justice. It further moves on to a detailed description of how to directly measure the link between accessibility and justice. The chapter ends with the conceptualisation of accessibility within the context of this research, capitalising on the findings of what was presented in the Introduction, Theoretical Framework and in this chapter.

Defining Accessibility

Measures aimed at increasing accessibility levels have been implemented across diverse settings and scales, encompassing various aspects such as job opportunities at local and regional levels, as well as the availability of social services, including parks, among others. To connect accessibility to the context of justice, several studies aim to investigate whether access is socially equitable or discriminatory, identifying areas of service deprivation that need special attention (Kwan et al., 2003). These investigations explore the interplay between the spatial distribution of access and specific population subgroups (e.g., ethnic minorities) (Kwan et al., 2003).

In 2021, the EC released the handbook “Evaluating the Impact of Nature-based Solutions” to present methods that can support the assessment of diverse types of NbS performance and impact (European Commission, Directorate-General for Research and Innovation, 2021).

Among many other indicators, accessibility has been identified as one of the approaches that can help evaluate NbS performance in delivering its co-benefits.

Accessibility has been defined by several scholars and organisations, as an enabler element to guarantee access to a service. In the context of this research, the "service" is the NbS, as a functional green area with several recreational purposes, access to physical and mental health benefits, increased biodiversity and connection with flora and fauna. The table below (Table 2) proposes a systematic review of several definitions that contribute to outlining the components of accessibility in light of a justice-centred perspective.

Table 2. Summary of the main definitions of Accessibility and its structural components

Author	Definition	Structural component
Geurs & Van Wee, 2004	The ease with which any land-use activity can be reached from a location using a particular transport system.	Different mobility opportunities within the transportation network
Páez et al., 2012	Accessibility as the potential for reaching spatially distributed opportunities, and it can be considered one of the main outputs of spatial development, the joint result of a transportation network and the geographical distribution of activities	
Cousins, 2021	Access to resources and opportunities to interaction and essential services like safe drinking water, clean water and infrastructure for hazard protection and risk management	Access to essential services
Wang et al., 2021	People's demands not only depend on the distance but also on where entrance location points are located.	
Kingsley & Ontario, 2019	Physical access contributes to only social interaction and cohesion, but also ensure fruition of those NbS co-benefits.	Access to resources and opportunities to interaction for everyone
Pineda-Pinto et al., 2021	Accessibility to information, participation in decision-making processes, and transportation modes that accommodate diverse societal needs, including those with disabilities or limited mobility.	
IPCC, 2023	Physical accessibility ensures that the health, recreational, and psychological benefits of nature are available to all, contributing to broader community resilience against climate impacts	
Pereira & Herszenhut, 2023	Conditions are influenced by the spatial participation of citizens, economic activities and public services, as well as the configuration and performance of the transport network.	

In the realm of this research, this set of definitions provided the main concepts to be connected to what was outlined in the problem analysis and in the Theoretical Framework to define and clarify the components of accessibility that will be considered to conduct the research. To better understand the key elements of these definitions, the following outlines the context of each research.

Well-known transport planners such as Geurs, van Wee and Neutens define accessibility as the ease with which people can reach places and opportunities, or, on the contrary, the property of places and opportunities in terms of how easily they can be reached by residents (Geurs & Van Wee, 2004; Neutens et al., 2010). Pereira & Herszenhut (2023) expand the

already established definition, adding that conditions are influenced by the spatial participation of citizens, economic activities, and public services, as well as the configuration and performance of the transport network. This makes it possible to argue that accessibility plays a major role in a person's ability to access, for example, work, schools, places of recreation, etc.

Another important clarification needed here is the difference between accessibility and mobility. Pereira & Herszenhut (2023) stress that the distinction between these concepts is often ignored even among researchers and planners who deal with these topics daily. In urban and transport planning literature, the concept of mobility refers to people's daily travel habits, such as the number, average time and distance of trips and modal split (Pereira & Herszenhut, 2023).

Measuring Accessibility

After defining accessibility and identifying its structural components, it is essential to establish codified approaches to measure accessibility effectively. This involves selecting methods that can clearly illustrate the connection between accessibility and justice. By doing so, it can be ensured that the assessments of accessibility are not only comprehensive but also aligned with the principles of justice, facilitating a deeper understanding of how these concepts interact within the framework of NbS.

In general, there are four approaches for measuring accessibility – infrastructure, land, people and utility-based measurements (Geurs & Van Wee, 2004; Pereira & Herszenhut, 2023):

- Infrastructure-based: this approach defines the ease with which opportunities can be accessed depending on the availability of existing infrastructure and transport services. This includes aspects such as the extent and connectivity of public transport and street networks, as well as the presence of transit options such as trains (Geurs & Van Wee, 2004; Pereira & Herszenhut, 2023). This type of measurement is important for transportation planning, however, from a climate justice perspective, it does not include a land use component, which is a huge disadvantage for many population groups (Geurs & Van Wee, 2004). This respectively affects the objectivity of the obtained results, in terms of the principles of equality.
- Location-based: this approach considers **geographic proximity as a key factor** in how easy it is to access resources and opportunities; the further away a place is, the harder it is to access. Estimating the level of accessibility of geographically distributed activities, such as the number of parks available within a 30-minute walk from places of origin, is part of cross-site **accessibility studies** (Geurs & Van Wee, 2004; Pereira & Herszenhut, 2023). Scholarly works have used various place-specific indicators, such as distance to the nearest point of service, number of services in a certain

geographical area or within a certain radius (Neutens et al., 2010). There are two ways on how to assess accessibility by incorporating location-based measures. The simplest one is distance, also called “connectivity measure”. The easiest way to measure this is to draw a straight line between points A and B and then calculate the average travel time and speed (Geurs & Van Wee, 2004). The second one is potential, also called “gravity-based” measures and used in approaches founded on the gravity-model theories. The potential accessibility measure evaluates the level of access to opportunities in the zone “i” relative to all other zones "j(n)", considering that the influence of smaller or more distant opportunities diminishes (Geurs & Van Wee, 2004). **This measure serves as a social indicator for assessing access services among different socio-economic groups.** It offers practical benefits as location-based measures can be easily calculated using existing land-use and transport data. However, this method can present challenges, for example, it does not consider temporal constraints, posing theoretical limitations (Geurs & Van Wee, 2004).

- People-based: this approach looks at personal characteristics, physical and psychological abilities, age, gender, race and income and how they can significantly influence individuals' access to opportunities and mobility within an area (Geurs & Van Wee, 2004; Pereira & Herszenhut, 2023). Neuten et al. (2010) further explore the benefits of technological development and how it has improved the calculation and availability of individual-level activity and travel data, particularly considering behaviour and the spatial-temporal environment. The main advantage and at the same time disadvantage of this measure is the need for detail data on an individual’s mobility habits. In case this kind of data is available, the results would show very precise levels of accessibility. But in most of the cases, detailed individual activity, such as travel data, time budget etc., is not available (Geurs & Van Wee, 2004).
- Utility-based: this perspective derives from economic research, assessing how the accessibility of various services and opportunities can contribute to economic benefits (Geurs & Van Wee, 2004). An important advantage of utility-based accessibility measures is their usability in economic evaluation, as from a theoretical aspect it encompasses all the components mentioned above (Geurs & Van Wee, 2004). However, the biggest challenge is the complexity of results interpretation and presentation, since most of the time planners and decision-makers do not have enough knowledge (Geurs & Van Wee, 2004). There is another aspect to mention, the same as with the previous type of measure, this assessment asks for relatively detailed data at the individual level.

The location-based approach stands out in connecting accessibility measurements to the concept of justice due to its emphasis on geographic proximity as a crucial determinant in accessibility. By prioritising how physical distance impacts the ability to reach necessary

resources and opportunities, this approach aligns closely with the goals of ensuring equitable access across different socio-economic groups. Moreover, unlike approaches that might focus narrowly on infrastructure or individual utility, the location-based method offers a comprehensive measure of accessibility. It incorporates the physical layout of areas and the distribution of services, supporting a holistic assessment of how different parts of a city cater to the needs of all its residents. Furthermore, location-based measures can integrate social indicators into their assessments, such as the density of services or the number of amenities within a walkable or drivable distance. This integration allows for an enhanced understanding of how physical accessibility intersects with social equity, particularly highlighting areas where improvements are essential to support disadvantaged groups. Additionally, the adaptability of the location-based approach allows for its application across various settings and scales, from small neighbourhoods to entire regions. This flexibility makes it particularly valuable for assessing accessibility in diverse geographical contexts, essential for tailoring solutions that address local needs and disparities effectively.

In practice, each of the above perspectives can be further evaluated based on different components. According to the literature, four main ones are distinguished: transport, land-use, temporal and individual (Geurs & Van Wee, 2004). Under the location-based approach, the components and their interactions are considered as follows (Geurs & Van Wee, 2004):

1. Transport: This component emphasises travel time and costs associated with reaching various destinations. This measure reflects the ease or difficulty of accessing necessary services and opportunities, which directly impacts an individual's ability to participate fully in societal activities. The focus on travel time and costs helps identify transportation barriers that could hinder access to critical services, particularly for lower-income groups or those living in less connected areas.
2. Land-use: This component focuses on the amount and spatial distribution of the demand and/or supply of opportunities. It examines how resources such as parks, schools, healthcare facilities, and employment centres are distributed geographically. The equitable distribution of these resources is crucial for ensuring that all community members, regardless of their socio-economic status, have equal access to necessary services. This ties directly into the concept of distributive justice, which seeks to ensure fair access to resources and opportunities.
3. Temporal Component: Understanding the variations in accessibility at different times—such as during peak hours or various days of the week. This aspect can influence the practicality and fairness of access, as availability can vary significantly, affecting people's ability to utilise services when needed.
4. Individual Component: The location-based approach does not directly address individual characteristics in this table; however, the integration of social group

classifications based on income level or age could enhance its utility in assessing justice. By incorporating demographic data, planners can better understand and address the specific needs and barriers faced by different groups within the community.

In summary, the location-based approach's focus on the geographical aspects of accessibility, such as travel time and the spatial distribution of opportunities, aligns closely with justice concerns. It ensures that assessments of accessibility consider the physical and economic realities of different community segments, enabling urban planning efforts to be more inclusive and equitable. This approach supports the broader goal of climate justice by ensuring that environmental benefits and burdens are distributed in a manner that does not disproportionately disadvantage any particular group.

Linking Accessibility to Justice

Páez et al. (2012), recommended by the European Commission, Directorate-General for Research and Innovation (2021), use the city of Montreal, Canada, as a case study to highlight the differences in the measured levels of accessibility depending on the locations of multiple day-care centres, presenting -among others- the gravity model as an approach to measure accessibility (Páez et al., 2012). Gravity-model is described as an approach that allows generalisations and includes the estimation of spatial interaction (Páez et al., 2012). Furthermore, Wang et al. (2021), in their study of comparing spatial accessibility measures of the urban park, **propose a new approach, that shows that people's demands not only depend on the distance but also on where entrance location points are.** In their paper, Wang et al. (2021) argue that urban planners and policymakers need to ensure adequate access to urban parks for improvements in guaranteeing environmental and social justice and positive public health intervention. For the calculations, the principles of the gravity-model are used to enhance the assessment of local population exposure to parks by factoring in park service capacity and attractiveness to residents (Wang et al., 2021). **Both studies showed that the theory of gravity-model has proven its relevance in carrying out accessibility assessments, and it is also possible to generalise and apply it to different geographical areas and scales. However, within the scope of guaranteeing climate justice, more specifically the recognition justice dimension, the identification of vulnerable social groups or inequality of opportunities - with which mode of transportation it is possible to access the destination of interest - is missing.**

Network analysis in geographic information systems (GIS) can address this gap left by traditional gravity model approaches, which often focus more broadly on the flow between points without delving into the specifics of individual accessibility based on transportation mode. Network analysis is a GIS method used to evaluate the efficiency and accessibility of

various routes within a transportation network (Kalpana et al., 2020; Comber et al., 2008). It considers the connectivity between nodes (points) and edges (paths) within the network, enabling the analysis of the most efficient routes from origin to destination based on specified criteria like distance, time, or even cost (Karamitov & Petrova-Antonova, 2022; Porta et al., 2008).

While gravity models predict interactions based on the mass (population size, economic activity) of locations and the distance between them, they may not adequately account for individual access challenges faced by vulnerable groups, especially in terms of transportation options (Wang et al., 2021). **Network analysis fills this gap by providing detailed insights into how different modes of transportation—such as walking, cycling, public transit, and driving—affect accessibility to crucial services and amenities** (Wang et al., 2021)**.**

By integrating network analysis with gravity model insights, urban planners and policymakers can gain a more nuanced understanding of accessibility challenges and work towards solutions that ensure equitable access for all community members, thus supporting broader goals of climate justice. This approach not only identifies the physical barriers to access but also highlights the socio-economic dimensions of accessibility, ensuring that interventions are both effective and equitable (Deliry & Uyguçgil, 2023; Karamitov & Petrova-Antonova, 2022).

Defining Accessibility within the Context of this Research

The focus of the Conceptual Framework is defining accessibility to align the concept to the scope of this research.

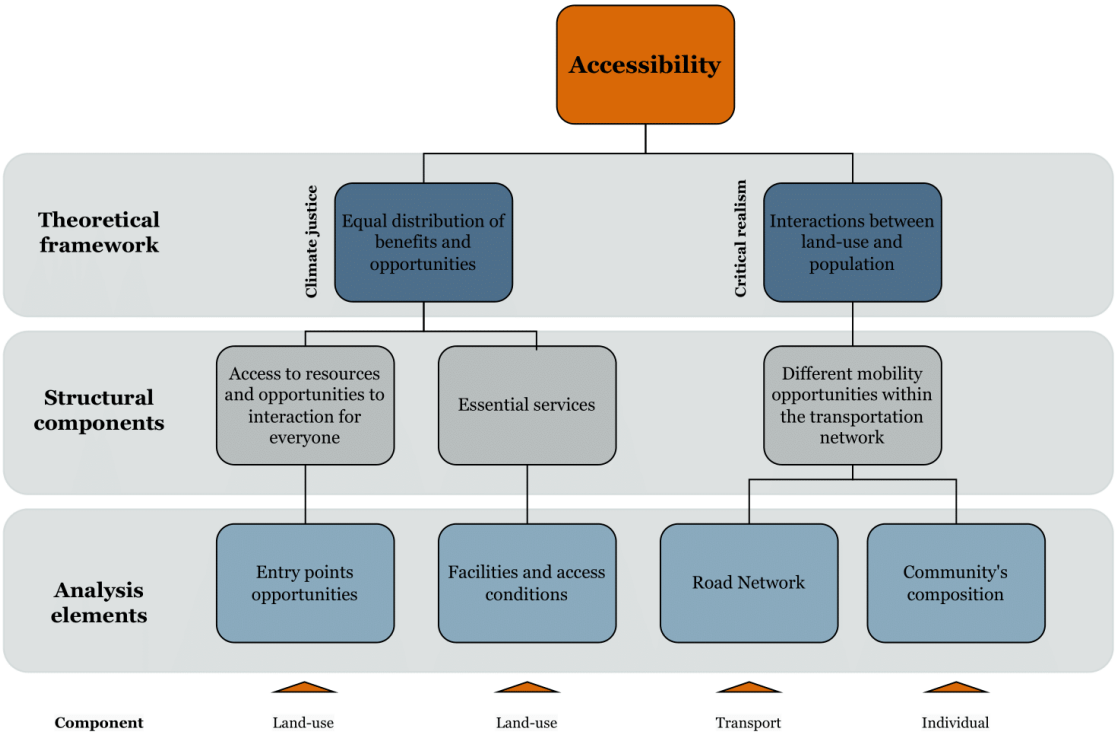


Figure 7. The concept of accessibility defined within this research. Created by the authors

As depicted in the figure above (Figure 7), the concept of accessibility is understood through various layers. This multifaceted understanding is enabled by acknowledging the complexities inherent in systems, which is thoroughly explored and framed by the theory of critical realism. Accessibility is in fact one of the many elements of reality that could explain why the composition of Strandparken' users is like it is now, but thanks to a critical realist lens, it is possible to explore this particular aspect to underscore other potential correlations.

The Theoretical Framework establishes two foundational aspects for studying accessibility. Firstly, accessibility is perceived as one of the outcomes (event) of numerous interactions between land use (structure) and the actual utility derived by people (agents), particularly in the context of NbS, where several relationships are created thanks to its different objectives. In this context, critical realism theory aids in uncovering hidden structures that may perpetuate inequalities. Furthermore, as NbS are inherently providers of embedded benefits, these must adhere to principles of climate justice, thereby ensuring universal access.

Accessibility is a broad concept, and reviewing multiple studies on this subject has helped to delineate and define its structural components. These components—diverse mobility opportunities within the transportation network, access to essential services, and access to resources and opportunities for interaction—are aligned with the research objectives. Although accessibility can also relate to participatory processes or inclusion within economic dynamics, such aspects were deemed beyond the scope of this study due to constraints on time and resources.

Furthermore, this research aims to conduct an empirical analysis to deepen the understanding of accessibility. This choice is justified by the added value that such analysis can bring. Measuring phenomena connected to accessibility could in fact undercover one of the many patterns and phenomena that can lead to different uses or levels of benefit to the population from NbS. By using data to observe how different populations access and benefit from NbS, and by theorising the underlying mechanisms, the study seeks to propose more equitable NbS designs and implementations, further addressing the research question. The analysis elements were chosen based on previous studies, aiming to cover location-based measurements of accessibility (and its three components – transport, land-use and individual), informed by findings from the initial site visit. Literature suggests that entry points and nearby facilities significantly enhance accessibility levels (Cousins, 2021; Wang et al., 2021). Given its size, Strandparken, with its numerous entry points and varied facilities, warrants a detailed analysis of how these features may enhance or impede local residents' ability to benefit. On the infrastructure measurement front, the analysis will employ the gravity model performing network analysis—a well-established method to assess travel costs and proximity (Páez et al., 2012; Wang et al., 2021). To maintain a focus on justice, the individual component of the

location-based approach should examine the composition of the resident community to identify potential vulnerabilities.

Analytical Framework

We cannot have complete knowledge of complex systems; we can only have knowledge in terms of a certain framework. There is no stepping outside of complexity (we are finite beings), thus there is no framework for frameworks. We choose our frameworks. This choice need not be arbitrary in any way, but it does mean that the status of the framework (and the framework itself) will have to be continually revised. Our knowledge of complex systems is always provisional. We have to be modest about the claims we make about such knowledge (Cilliers, 2005, p.258-259).

The integration of an analytical framework can offer several opportunities for the organisation of the research, particularly when conducting empirical studies (Coral & Bokelmann, 2017). It helps to clarify the goals of the study and the relationships between each of its components. Moreover, it serves as a link between theoretical foundations and empirical analysis, describing the assumptions or theoretical understandings of relevant phenomena that require verification through evidence (Coral & Bokelmann, 2017). For these reasons, and as well explicated by Cillers (2005), the overall aim of the analytical framework within this research is to guide the data-collection process and set the perspective of how the results will be obtained, and analysed and which are the limitations.

Role of Chosen Theories

This research is based on two theories: critical realism and climate justice, each providing valuable insights into the interpretation of the results.

Critical realism offers a broad perspective, covering multiple disciplines, to address complex issues such as climate justice. It reminds one that even if the world exists independently, social, cultural, and personal beliefs are the ones that shape perceptions of it. In this research, critical realism highlights the ontological perspective or the underlying structural conditions that influence accessibility and justice, which may not always be obvious. From an epistemological point of view, critical realism encourages in-depth examination of assumptions and biases while recognising the limitations of the results. This means looking at different perspectives and acknowledging both the inductiveness and uncertainty of the findings. In addition, it encourages a look at how different socio-economic factors could affect the relationship between accessibility and justice in the specific context. Central to the critical realist approach is the recognition of human agency and the potential for transformative change. Considering this, the analysis focuses on looking at planning documents to assess how the five municipalities plan to address challenges related to accessibility. This will help to gain an understanding of the strategies used so far and what other obstacles might be faced.

Critical realism recognises that climate change impacts and responses vary across contexts. Case study methodology complements this approach by focusing on learning from unique cases rather than seeking generalisations. Embracing critical realism will lead to a deeper understanding of the complex dynamics by paving the way for more effective and just responses. Moreover, critical realism inspires the incorporation of triangulation, utilising multiple data collection and processing methods as well as different data sources to investigate the complex problem of accessibility and justice.

As critical realism highlights the structural conditions that affect accessibility, climate justice can provide a new lens through which accessibility challenges can be examined, particularly addressing it in the broader context of climate change and the importance of accessing NbS. This study emphasises factors related to recognitional and distributive justice, with equity as a central focus. As part of the research, the aim is to identify diversity, particularly highlighting marginalised groups given income levels, which may affect their mobility choices and potential opportunities, ultimately affecting their travel patterns and ultimately reducing their accessibility to the opportunities provided by Køge Bugt Strandpark. This holistic perspective guides discussions of justice by offering insights into how the recognition of individual needs and habits shapes experiences and societal dynamics. In addition, spatial aspects play an important role in the analysis of the results of this research. Factors such as the distance between different geographical areas and Køge Bugt Strandpark, the scale of municipalities, land use patterns including residential areas and green spaces, and connectivity facilitated by different transport networks are core elements of the assessments contained in the research.

In a broader context, distributive justice refers to the equitable distribution of the positive and negative impacts of climate change on society (Juhola et al., 2022). To assess how adaptation policies are implemented and affect the distribution of climate change impacts, it is important to recognise Strandparken's historical role as a site for social interaction and leisure. While adaptive policies have the potential to create new opportunities, they can inadvertently exacerbate existing inequalities and injustices (Juhola et al., 2022). This dynamic transformation of socio-spatial landscapes emphasises the importance of improving accessibility. The study aims to highlight any differences in accessibility to the NbS from different geographic locations and to assess if accessibility affects usage and benefits to society. The analysis of this study covers different modes of transportation in an attempt to better capture the modes of access and their impact on distributive justice.

Case Study Research Design

The case study research design is the central element of the analytical framework, serving as a basis for problem identification and further investigation. The research strategy is characterised by the detailed study of accessibility challenges and its role in ensuring climate

justice of Køge Bugt Strandpark in its natural environment. Deploying a case study allows flexibility in the use of multiple data collection and processing methods and ensures feasibility. Køge Bugt Strandpark, with its coastal challenges and opportunities, serves as an ideal location for exploring how NbS approaches can be designed to benefit both the environment and local communities. This case study was provided as part of the Just Adaptation lab, in which the authors took part during the research process.

Incorporating a case study allowed the authors to delve deeper into various dimensions of accessibility. This structured approach allows for solving complex, multidimensional problems, providing a comprehensive understanding of how different dimensions of accessibility, focusing directly on the ones that are important in terms of Køge Bugt Strandpark, can allow for evaluating the benefits of its provision.

During the process, three site visits were conducted. **The first site visit** conducted between February 22nd and February 26th, 2024, involved non-participant observations, where the authors observed who and how the area was being used, without becoming a part of the group that is being studied. During observations field notes were taken, by listing how many people visit the specific park area, demographics, language spoken, gender and approximate age. This initial site visit provided a real-life grasp of the NbS and its surroundings, leading to the identification of potential accessibility issues, particularly noting the differences between groups near the central area of Ishøj and the NbS. The first site visit helped to formulate a hypothesis and further lead the problem analysis.

The second site visit conducted a few months later, on April 21st, 2024, focused on collecting the data needed for building the composite accessibility index. By this stage, the research goals were more defined, and the observation was directly related to assessing accessibility, more specifically looking at the condition of the entry points. The data on coordinates of the entry points, facilities at every entry point and accessibility features such as mode of transportation were collected using a comprehensive factsheet.

The third site visit was conducted towards the end of the research development process, from May 26th to May 27th, 2024. Similar to the first visit, the authors participated as non-participant observers, focusing on observing activities and counting people within the area. Like the first, the third visit was organised within the scope of the Just Adaptation Lab. The main takeaways from this observation are not included in the results presented later in this research, however, it provided new perspectives for discussion and further research directions.

Utilisation of Methods to Answer Sub-RQs

This research is supported by three sub-research questions, which will ultimately lead to the answer to the main research question: *How can assessing the challenges related to*

accessibility contribute to promoting justice in Nature-based Solutions projects for climate adaptation?

Further, a detailed description of methods, data sources used and expected outcomes is given, according to each sub-research question.

Sub-RQ1: How can the link between accessibility and justice be measured?

The results to answer this sub-research question were drawn from what is defined in the Conceptual Framework to fulfil the need for a more in-depth understanding of the different dimensions encompassing the concept of accessibility and to define a clear connection between accessibility and justice.

To do so, **literature review** was used as a method, for which the following strategy was applied:

- Step 1: Searching for the ground theory of how accessibility is defined, which mostly included scientific papers from the field of land use and transport planning. The literature review of definitions also looked at how to make a clear line between different characteristics of accessibility and mobility. Further, different ways of how to measure accessibility were identified.
- Step 2: A deeper investigation of the four main approaches of accessibility measures – infrastructure-based, location-based, people-based, and utility-based, was conducted. This helped to understand what kind of components each of these approaches encompasses, what kind of data is needed, as well as what is the main focus, output, usability, and scale. This step also helped to identify the most suitable approach in the specific context of Koge Bay Strandparken and research focus: location-based approach, with a human-oriented point of view.
- Step 3: Next, a literature review was used to look for other cases that have been assessing accessibility, with a focus on urban areas more specifically open, green spaces. This led to the gravity model as a broader theory and network analysis as one of the methods that can be used to provide main calculation, such as distance between origin and destination based on a road network. Its suitability in this case can be characterised by the flexibility of the method to adapt it to different problem focuses and input data to which most have access.
- Step 4: An in-depth investigation of other cases was then carried out to see how accessibility assessments can be linked to the challenges posed by the justice. Emphasising the different dimensions of accessibility, including transport networks, distance, time, marginalised groups, access, and the equity characteristics of these entry points.

Sub-RQ2: What are the existing accessibility challenges that Køge Bugt Strandpark faces?

To answer Sub-RQ2, three methods were used – observations, network analysis and linear regression. To better understand how each of the methods supplemented the other and what are inputs and outputs, the logical sequence is presented below.

Observations created an input for the analysis in this research were conducted during the second site visit, which already had a specific objective - to observe and evaluate direct access points to Køge Bugt Strandpark. For this purpose, an entry point evaluation template was prepared (Figure 13), which included all the information about the mode of transportation and nearby facilities, aligning with distributive justice and the provision of equal access to opportunities. Pathway conditions were also considered, acknowledging equal access for people with disabilities and other important aspects derived from the literature review. This structured approach ensured that observations were thorough and aligned with the research objectives.

Further, this process is continued by data processing in GIS environment. The data sources used, and their purpose is described in Table 3.

Table 3. Data sources used, type and application

Data source	Data	Application
Second site visit	Coordinates of the entry points	To measure the shortest distance from the origin to the entry point (network analysis) and later to build the index
	Facilities at every entry point	To build the accessibility index
	Accessibility features	To build the accessibility index
Nabolags Atlas	Neighbourhoods	Can be also considered as service areas for which calculations were conducted and statistical relationships investigated
Nabolags Atlas	Average gross income	To perform linear regression between minimal distance and income and evaluate the index's results
OpenStreet map	Road network: walking pathways, biking lines, roads	To measure the shortest distance from the origin to the entry point (network analysis) and later to build an index
	Bus stops	To measure the presence of bus stops in the neighbourhoods nearby

As part of this analysis, the neighbourhood's subdivision proposed by Nabolags Atlas was used as representative service areas to ensure an accurate representation of average gross income distribution across municipalities. Thanks to the specific methodology[3] that Nabolags Atlas uses, municipalities were subdivided to visualise data at a smaller scale. 151 spatial features were selected from Nabolags Atlas, choosing them considering the relevance of the area and using the highway as a limitation of the residential areas that are benefitting the park. The decision to focus on income levels derives from the literature review and the theory of climate

[3] To explore the full explained methodology used for neighbourhoods' repartition https://www.nabolagsatlas.dk/en/about/#hvordan-nabolagene-skabt

justice, which underscores that marginalised groups, such as those with lower income levels, are more frequently subject to inequalities. This decision allows the authors to specifically address how income disparities influence accessibility and climate justice in the context of the Køge Bugt Strandpark project. It was not possible to retrieve other data with the same granularity that could provide further vulnerability elements (for example, gender, age, ethnicity and other demographic data). After extensive searches of different data sources at various institutional-level databases, data on income emerged as the most suitable due to its completeness and high resolution. This ensured that the analysis was based on reliable and detailed information, enhancing the robustness of the findings.

In this phase, **network analysis** was conducted as part of one of the two sub-research questions, aimed at measuring the distance between origin and destination using various modes of transportation. Initially, the process involved calculating the shortest walking distance between neighbourhoods and the park's access points. This preliminary step was crucial for further conducting **linear regression** analysis to determine the correlation between gross income as an independent variable and walking distance as a dependent variable. The analysis was performed for every entry point, considering the neighbourhoods closest to that entry point. This ensured that the regression actually underscored the relationship with the closest distance. If the regression was performed for every feature, regardless of which one was the closest point it was going to be affected negatively by absolute distant neighbourhood. Linear regression, chosen for its ability to quantify the relationship between variables, particularly income levels and walking distance, allowed for an assessment of potential accessibility disparities. By modelling this relationship, the study could discover whether income significantly influences the distance individuals must walk to access the park, thus enlightening socioeconomic factors impacting spatial accessibility.

Sub-RQ3: How do the identified accessibility challenges in Køge Bugt Strandpark promote injustice?

To address sub-RQ3, a **composite accessibility index** was developed, covering the entire process from accessibility definition and conceptualisation to weighting, aggregation, and finally calculation of values. Before creating the index, it was ensured that all the dimensions identified in this study were included in the concept of accessibility. Continuing the **network**

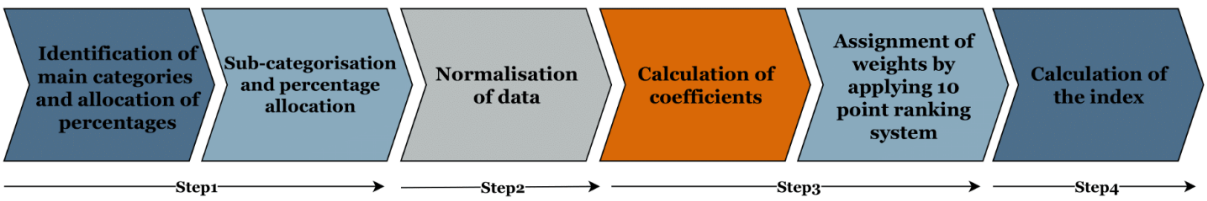


Figure 8. Schematic representation composite index building process

analysis, measurements were extended to include not only walking but also biking distance. This involved measuring the distance between neighbourhoods and the park's access points for both walking (outputs from the sub-RQ here worked as inputs) and biking routes. By incorporating biking distance alongside walking, the analysis provided a more comprehensive understanding of accessibility for different modes of transportation, thereby enriching the assessment of spatial accessibility. In addition, public transport stops were identified, and buffer zones were created around them. Additionally, **literature review** was used to argue the values and importance assigned for each e sub-category.

Figure 8 outlines the structure of the process for constructing the composite index within this study. First, the main dimensions or categories of accessibility were identified. These categories represent broad themes related to accessibility. The relative importance of each category was assigned, showing the contribution to the overall index. The relative importance is the combination of literature review and observations, which also considered the specific context of the Strandparken. In addition, each category has specific sub-categories to cover more detailed aspects of accessibility. Each assigned sub-category's relative importance shows the contribution to the respective category. For each sub-category, coefficients are calculated to quantify the contribution of that sub-category to its respective category and the overall score of the index. Weights are then assigned to each subcategory based on predefined criteria. This exercise uses a 10-point rating scale, where higher weights indicate greater importance or significance of the sub-category in influencing overall accessibility. The composite accessibility index is calculated as the sum of the coefficients and weights of each sub-category. This process aggregates the contributions of all sub-categories across different dimensions of accessibility to generate one comprehensive index value.

To truly answer Sub-RQ3, **document analysis** is an integral part as it provides qualitative information from more a strategic point of view. Furthermore, it allowed the analysis of what kind of challenges the bordered municipalities with the Køge Bugt Strandpark have identified and how they are planned to be solved. Moreover, this showed what is the future vision of the site.

Within this research a top-down approach for document analysis is applied, meaning that the focus starts by looking at the "bigger picture" or what are the broader visions that municipalities have identified. Further, focusing on already specific actions and their expected outcomes. When analysing documents, the following keywords were applied: access, accessibility, accessible, climate, adaptation, justice, and equity. It is important to mention that all planning documents were in Danish, and the authors used Google Translate to translate them in English, meaning, there might be some limitations of how things were interpreted.

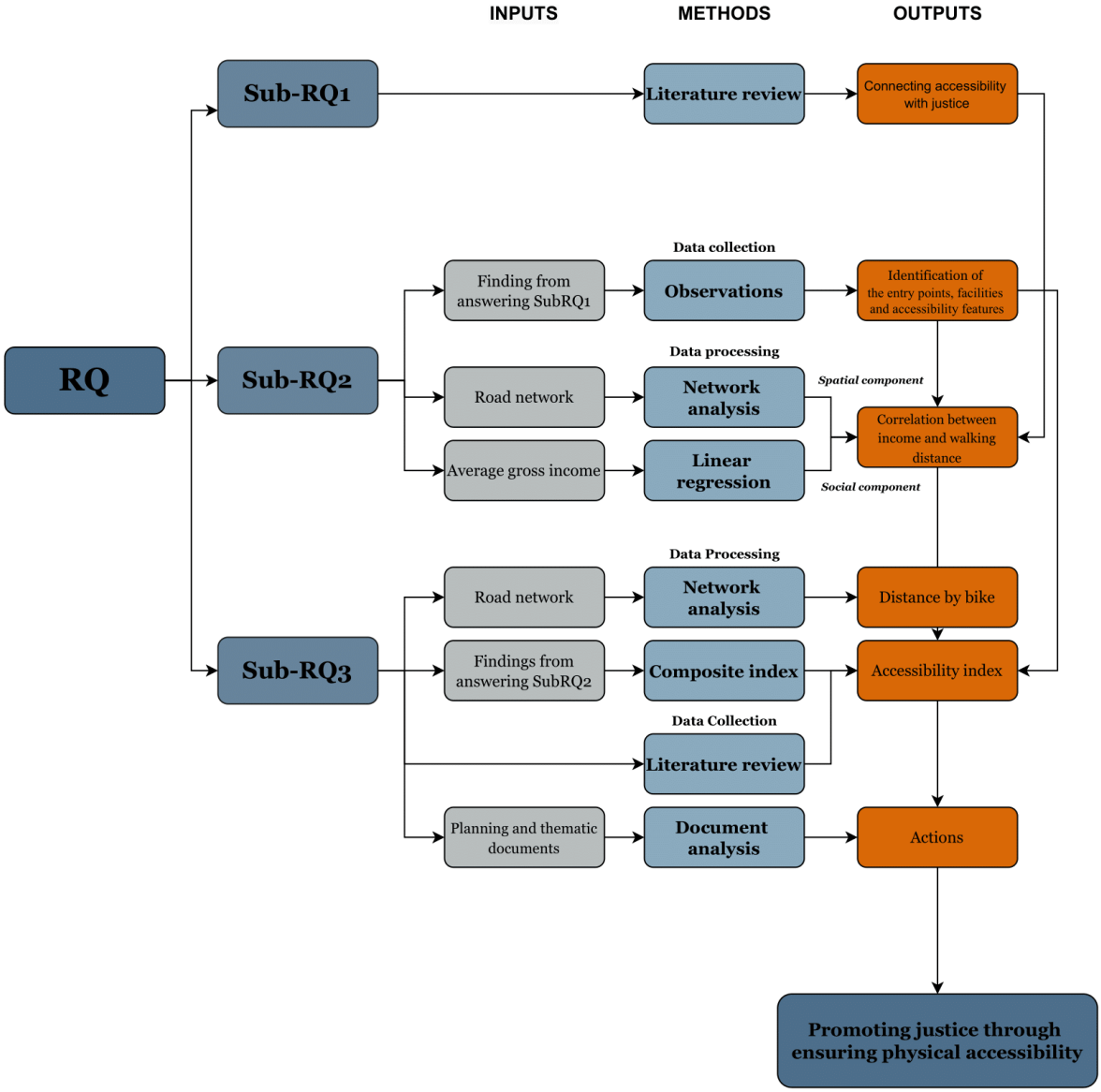


Figure 9. Schematic representation of the analytical framework

To summarise everything mentioned above, a schematic representation of the research structure defined in the Analytical framework is provided. Figure 9 illustrates the structural pathway for addressing the research question, highlighting the interaction between the proposed sub-RQs, their inputs, methods used, and outputs. Ultimately, this framework embraces several aspects of accessibility with the goal of promoting justice.

Methodology

The methodology serves as a compass that guides the complex process of investigation. In urban planning, case studies are invaluable, providing a deep understanding of complex phenomena within their natural environment. Here triangulation is used as a methodological strategy. Instead of relying solely on one data collection or processing method, the data is obtained by utilising various ones, each of them complementing the other, to examine problems from different perspectives. This approach helps to validate the findings and ensure they are comprehensive and reliable.

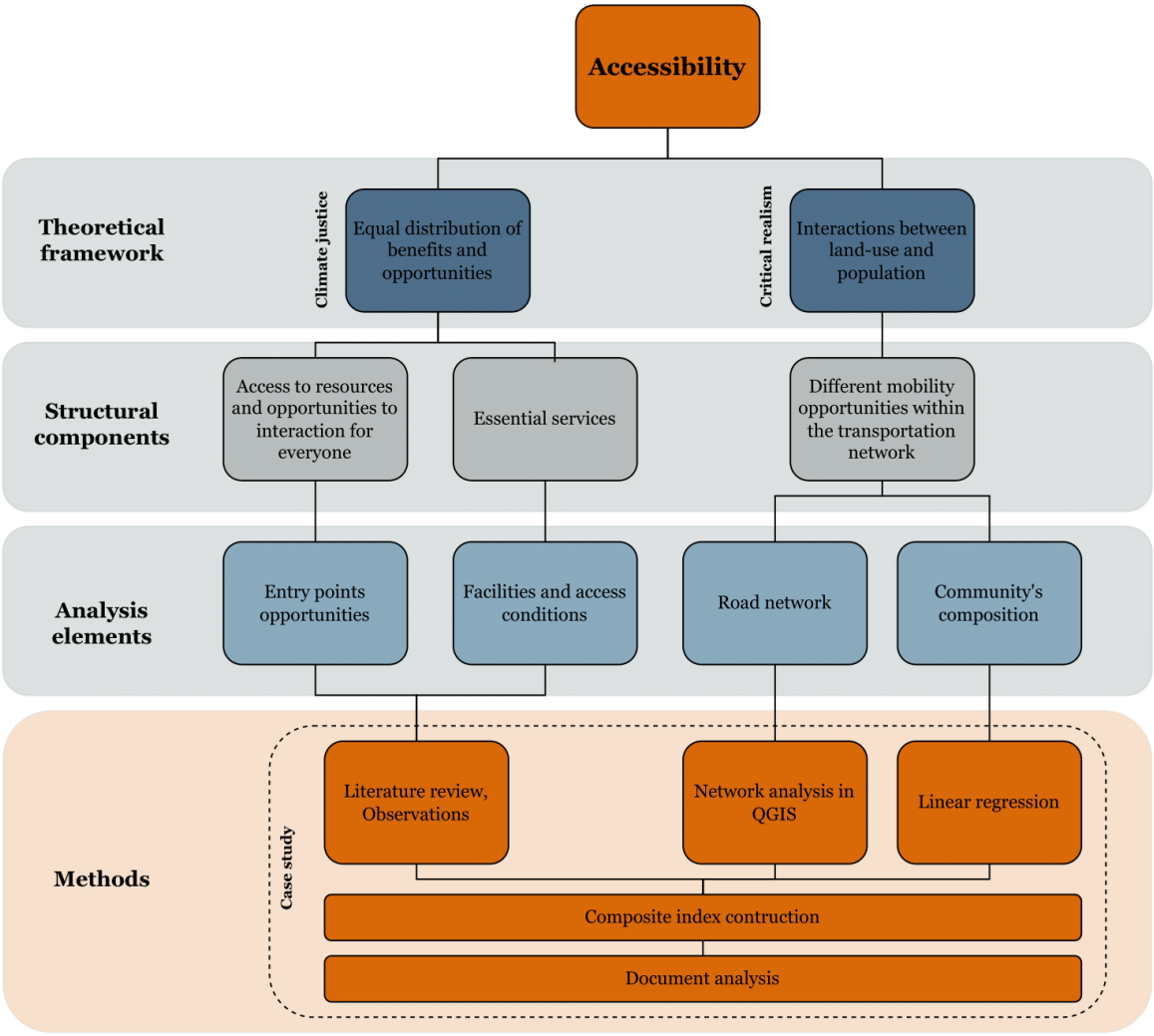


Figure 10. The concept of accessibility defined within this research supplemented with selected methods

This chapter is designed to explain the methodological framework used in this study. The methods presented here aligns with the concept of accessibility, which was built as part of the Conceptual Framework (see Figure 10). It begins with a description of the case study and a rationale behind triangulation, followed by data collection and data processing methods,

where each approach is thoroughly explained, highlighting its respective advantages and limitations in the scope of this research.

Case Study

A case study is more than just a method or approach, Tellis (1997) & Priya (2020) describe it as an ideal research methodology when aiming for a holistic, in-depth investigation of the problem at hand. A research strategy that can be described by the following characteristics – involves a detailed study of the particular phenomena within its natural settings; it allows the researcher the freedom to utilise any method, given its feasibility and ethical considerations; the unit that is analysed within the case study research can be individuals, group of individuals, communities, organisations etc. (Priya, 2020). In this research the detail study of physical accessibility of group of individuals (neighbourhood level) has been carried out using Strandparken as a case study. By incorporating this particular methodological approach, it allows the authors to use further described methods, chosen given their feasibility in the particular context.

A case study is known as a methodology that encompasses a triangulated research strategy. Multiple methods of data collection and processing are used to achieve objectives set within the study (Priya, 2020; Bryman 2016). According to Tellis (1997), the applicability of triangulation arises from the ethical need to confirm the validity of the processes. Another important side of research employing case study methodology is the relationship with theory. Priya (2020) discusses that methodology can be used for testing different theories or even hypotheses. Single cases are the most common ones, and their applicability is justified when the case is unique or atypical, when it is used to test a hypothesis or when the specific phenomenon is under investigation (Priya, 2020). The hypothesis raised within this study posits that accessibility plays a crucial role in fulfilling the potential of NbS and enhancing climate justice in climate adaptation projects. In this case, Strandparken particularly well-suited for testing such hypothesis as it enables a deep understanding of complex issue at hand.

According to the literature the most common forms of case studies are descriptive, explanatory, or exploratory (Priya, 2020; Bryman, 2016; Tellis, 1997). In this research explanatory case study type has been employed. Explanatory cases seek causal factors to explain a particular phenomenon, focusing on understanding ‘why’ and ‘how’ certain conditions occur (Priya, 2020). The exploratory type aims to investigate a phenomenon to identify new research questions for broader social research (Priya, 2020; Tellis, 1997).

Any research methodology, especially in the social sciences, has two elements to consider – ontology, or the nature of reality and epistemology, which refers to the theory of knowledge, or how we know what we know (Priya, 2020). Critical realism argues that the researcher's

conceptualisation is only one way of knowing reality, recognising that explanations of social reality are likely to be tentative (Priya, 2020).

The generalisation of findings has a great role in a discussion of case study methodology. Bryman (2016) asks an important question of how a single case study can produce findings that could be used in other cases. Priya (2020) argues that since a case typically represents a specific class of phenomena, a thorough examination can develop important hypotheses, which can then be tested in other similar settings. If these hypotheses are confirmed or replicated in multiple comparable cases, this can lead the researcher to theory building or generalisation. Furthermore, Priya (2020) argues that case studies allow for analytic generalisations, and it enhances the explanatory capacity of the case study. Additionally, Tellis (1997) supports the argument that even a single case study can lead to generalisation, as the data generated by case studies often resonate experientially with a wide range of readers, thereby facilitating a deeper understanding of the phenomenon.

Priya (2020) emphasises that maintaining objectivity and mitigating bias pose significant challenges in case study research. Researchers must control the values, attitudes, and perceptions they bring from their social environment. This requires a critical understanding of one's social position, including factors such as class, gender, and race, and how these elements may influence the investigative process (Priya, 2020). In addition, researchers must identify personal preferences that may affect their objectivity and thus the bias of the results.

In this research, to mitigate the bias and subjectivity, methodological triangulations, which is explained further in this chapter, has been employed. By using multiple data collection methods, such as literature review, observations and document analysis, the authors cross-validated findings and reduce the impact of individual biases.

Triangulation

Triangulation is an approach or also called methodological strategy where the researcher aims for different perspectives by mixing several methods and/or theoretical approaches, data sources and investigators (Flick, 2018). In other words, when using triangulation, the results should produce knowledge at different levels that could not be achieved by only using one method (Flick, 2018). In academic research, triangulation is also used to expand knowledge about the real world. The realist position was put forward as a methodologically pluralistic approach to research (Olsen, 2004). For example, different groups of society have their own needs, opinions, and interests about governance, politics, and culture, showing the broader context of different problems. Olsen (2004) suggests that triangulation through realist views is best suited to mixing methods. However, triangulation does not mean using one method (for example, observations) to gather data and another one (for example, coding) to analyse it.

Triangulation means mixing approaches to get two or three different points of view about the same phenomena under the study.

In this research methodological triangulation is applied, which is described as the most common form, where it often combines qualitative and quantitative research methods in one study (Thurmond, 2001). Meaning that there are multiple methods used to collect and process the data, where both types ultimately help to answer the question proposed by the researcher. Thurmond (2001) as one of the advantages of methodologic triangulation mentions its ability to combine qualitative and quantitative approaches in one study, which it helps to better understand and explain behaviours and events, their causes, and consequences. As suggested by Thurmond (2001), combining various approaches can unveil unique differences or significant insights that might otherwise go unnoticed if only one method were employed. Nonetheless, there are limitations to consider, such as the requirement for a diverse skill set to employ various methods within a single study, potential increases in research and development costs, and the challenges of integrating qualitative and quantitative data to grasp the complexity of the issue (Thurmond, 2001).

Overall, triangulation provides a more holistic perspective on a research question, credibility, and validity (Thurmond, 2001), reducing any systematic error that can occur at various stages of research. However, there are some disadvantages related to the adoption of this methodological strategy that can be mentioned. Triangulation may be more time-consuming than using only one method; this can lead to inconsistency and the need for large amounts of data (Thurmond, 2001).

Designing a mixed methods study involves several steps, many of which align with those in traditional research methods, such as defining the study's purpose, research questions, and the type of data to collect (Migiro & Magangi, 2011). However, mixed methods design encompasses at least three additional steps. According to Migiro & Magangi (2011), these include deciding whether to adopt an explicit theoretical framework, identifying data sources and collection procedures, and determining data analysis and integration procedures (Migiro & Magangi, 2011). These steps typically progress sequentially, with each informing and influencing the others. Additionally, decisions must be made regarding when data analysis and integration will take place (Migiro & Magangi, 2011). In mixed methods studies, data analysis and integration may occur by analysing the data separately, transforming them, or connecting the analyses in some way (Migiro & Magangi, 2011).

The need to build an analytical framework in this research was rooted in the principles of mixed methods design, as outlined by Migiro & Magangi (2011). The analytical framework served several crucial take aways from the theory of triangulation –integrates theoretical perspectives; inform data collection process and analysis (identification of data sources,

collection procedures and processing methods); ensured robust data integration and mitigates bias.

Further the description of methods is provided by separating them in data collection and processing ones.

Data Collection Methods

Literature review

Building research by integrating existing knowledge and findings remains a cornerstone of academic research across disciplines. A literature review is an essential step in any study, regardless of its subject area. In this research literature review involves a systematic approach to summarising and synthesising previous studies. It serves several important purposes: first, literature review offers a panoramic view, highlighting areas where research is dispersed and interdisciplinary; in addition, it serves as a powerful tool for pooling research results, thereby revealing gaps in the existing literature and informing the development of theoretical and conceptual frameworks (Snyder, 2019).

An effective literature review should demonstrate certain characteristics: help the researcher understand existing knowledge, establish a solid foundation for the research problem, and show how the proposed study contributes to or improves the existing body of knowledge in the field (Snyder, 2019). In addition, it provides insight into issues related to the research topic and the background of the problem, promoting a more interdisciplinary perspective (Snyder, 2019).

However, conducting a literature review has become increasingly difficult. Fields such as urban studies, especially those focusing on climate-related challenges, show a rapid increase in knowledge production. However, this knowledge is often fragmented and interdisciplinary, creating challenges in keeping up with research and evaluating the body of evidence in a particular field (Snyder, 2019). Fortunately, various approaches and strategies have emerged to facilitate an effective literature review, including focusing on methods and findings from other studies (Snyder, 2019). By incorporating such a strategy in this research, it helps to navigate the complexities of the ever-changing scientific landscape and make meaningful contributions to the respective field.

When conducting a literature review, it should be considered that the process can be time-consuming, especially in cases where the research topic is complex and covers several fields. The process as a whole - identification of literature, evaluation of topicality and linking with other scientific articles, requires a significant time investment from the researcher's point of view. To minimise this limitation, specific steps within the analytical framework were outlined to detail how the literature review was conducted in this research.

The literature review is built up of academic research such as papers, books, reports, and internet sources (for example, the European Commission, the Intergovernmental Panel on Climate Change etc.). To obtain the necessary information various databases were used, including Aalborg University Library through their webpage and Google Scholar.

Observations

Observation is a commonly used method and as part of the research design, which is structured around a case study, can provide additional qualitative data and insights into the phenomena under investigation (Ciesielska & Jemielniak, 2018). The method can be described in various types, techniques, and approaches, where the usage depends on the aim of the study (Ciesielska & Jemielniak, 2018). Site visits and taking field notes are part of the observation method used in this research and are valuable sources of qualitative data collection, that complement other methods used in the research.

In this research, site visits were conducted by the authors thorough pre-established preparation to directly observe the phenomena of interest at Køge Bugt Strandpark. These visits involved detailed observations of specific behaviours, physical characteristics, and other relevant factors. Field notes were utilised as an effective instrument for capturing and documenting these observations. This approach ensured a comprehensive understanding of the accessibility challenges faced by the people living in neighbouring areas.

In the research design, observation can be used either as the main or complementary method (Ciesielska & Jemielniak, 2018). Conducting observations involves several necessary steps both before and after the observation itself. However, despite these steps, the level of control over the results obtained from observations is relatively low (Ciesielska & Jemielniak, 2018). Given that the researcher adapts to the context and interaction and tries not to influence the course of events and to exert minimal influence on the environment, thus often facing unforeseen situations (Ciesielska & Jemielniak, 2018). Therefore, it is recommended thoroughly familiarise oneself with the site through methods such as document analysis before conducting an in-person visit (Lawrenz et al., 2003; Ciesielska & Jemielniak, 2018).

The are three main types of how observations can be conducted: participant, non-participant, and indirect observations. Within the first one, researcher immerses themselves in the natural environment or social setting of the subjects they are studying, preferably for a longer period; in non-participant observation, the researcher tries to understand the world, relationships, and interactions in a new way, without prevalent categorisations and evaluations; finally, within indirect observation, the researcher relies on observations done by others (Ciesielska & Jemielniak, 2018). In this case, non-participant type of observations was applied.

While observations in general may take a long time of period to get valuable insight (Ciesielska & Jemielniak, 2018), site visits as a part of observations, are designed to produce evaluative

information after a visit of generally 1–3 days (Lawrenz et al., 2003). This time frame, however, does not necessarily include the preparation time or the time involved in developing a report of the results of the site visit, especially in the case of written reports. Within this research, time of period for conducting observations varied from one to five days (see Analytical Framework for more detailed explanation)

What is important to highlight here, is that even a careful and attending observer has access to only one situation at a time and there might be a chance to miss out on some valuable or interesting information (Ciesielska & Jemielniak, 2018). Moreover, it is important to narrow the field of observation based on criteria that correspond to the research problem (Ciesielska & Jemielniak, 2018). Furthermore, while the relatively short duration of site visits may provide some advantages, it may also present limitations, potentially hindering observers' ability to fully understand the complexities of the site within a limited time frame (Lawrenz et al., 2003). Observations during site visits allowed the authors to gain a comprehensive understanding of the context in which the Køge Bugt Strandpark is situated. By directly observing the environment, behaviours, interactions, and other relevant factors, the authors had a chance to gather rich, contextualised data that may not be captured through other methods alone. It also served as a means of validating other data sources, such as document analysis.

Document analysis

Document analysis is often used in qualitative research to complement other data collection methods, for example, interviews and observations, which is the rationale behind incorporating it as a means of triangulation (Bowen, 2009). Document analysis can be a part of research that combines quantitative and qualitative research techniques and provides valuable context, background information, or historical perspectives on the subject of study (Bowen, 2009), such as the development of Køge Bugt Strandpark The nature of the method lies in the systematic procedure for reviewing or evaluating documents in different forms, including strategic development plans and other organisational or institutional reports, maps and charts, etc. (Bowen, 2009). All types of documents just mentioned can help the researcher develop an understanding and uncover insights into the problem identified (Bowen, 2009). Table 4 summarises planning and thematical documents analysed within this study with their brief description

Table 4. Planning and thematical documents analysed in this research

Document original name	Translation in English	Year	Brief description
Strandparkens visionsplan – 2021	Strandparken's vision plan - 2021	2021	The plan focuses on the newly introduced facilities' design aspects, locations, and purposes. Most of the document is about what kind of opportunities new facilities will bring in terms of leisure, sports activities and for educational purposes.
Principaftale af 7. september 2022 om Køge Bugt Strandpark	Agreement in principle of 7 September 2022 on Køge Bay Strandpark	2022	The document very briefly introduces the history of the park, its geographical location, and bordering municipalities. The main focus is on a broader vision of its further development and modernisation, and the opportunities and obligations that municipalities have according to the Construction Act.
Modernisering af Strandparken – Input til en anlægslov	Modernisation of Køge Bay Beach Park - Input to a Construction law	2023	The plan mainly focuses on specific areas within the park, what is the current situation, the desired use of them and what kind of construction work needed to further modernise it. Also touches on topics such as citizens' involvement and nature protection.

Analysing documents can have different purposes, which all depend on the context of the study. As mentioned before, information obtained from documents can offer context and historical insights. This can help researchers understand the historical roots of specific issues and can indicate the conditions that affect the phenomena currently under investigation (Bowen, 2009). Moreover, documents can contain the track of development changes and as a tool for verifying findings from other sources (Bowen, 2009).

Bowen (2009) argues that the limitations of the method are insignificant and outweighed by its advantages. Documents, especially development or action plans, most of the time are produced with specific objectives, meaning that they cannot provide sufficient details to directly answer the research question (Bowen, 2009), showing why document analysis is mainly used in combination with other methods. Additionally, when working with case studies in specific locations, the only documents available can be in a language that researchers are not familiar with. This has been identified as a limitation also within this research, where Google Translate, acknowledged as a reliable translation tool, was used. On the other hand, document analysis is less time-consuming and therefore more efficient than other research methods, like surveys and interviews, which also makes it cost-effective (Bowen, 2009).

Conducting document analysis in the scope of this research also involved the thematic analysis approach, by categorising the data into themes or in this case – keywords. By carefully and

deliberately re-examining the data, the researcher seeks out themes relevant to the phenomenon that is being investigated (Bowen, 2009). To do this, the researcher codes the selected information and creates categories depending on its qualities (Bowen, 2009).

Document analysis is particularly relevant in this research for several reasons. Firstly, it aligns with the field of urban planning, where planning document analysis is essential, providing a deeper understanding of the local context. Secondly, the study also focuses on the interaction between land use, municipal visions, and strategic perspectives, where planning documents come in handy. Third, as this study is based on case studies, the document analysis provides valuable insights and qualitative data specific to the context. Thus, it enables a comprehensive understanding of the planning context and strategic directions influencing the problem under investigation.

Data Processing Methods

Network analysis

Road network analysis (also called network analysis) is a commonly used method to calculate distance-based measurements between a set of origin and destination points (Comber et al., 2008; La Rosa, 2014). In simple terms, it determines how far the destination (or set of destinations) is from the origin (or set of origins), with the measurement provided in conventional distance units (e.g., meters, kilometres) or transformed into time-based measures. Network analysis can be applied to identify the closest facilities by travel time or distance and for calculating service areas (e.g., areas within a 10-minute walk of a bus stop) (La Rosa, 2014; Comber et al., 2008).

In the context of urban planning and transportation, network analysis assesses the connectivity and efficiency of transportation networks, including roadways, public transport systems, pedestrian pathways, and bike routes (ArcGIS Developers, n.d.). In the scope of this research, it helps determine how far different neighbouring areas are from Strandparken. This type of analysis is important for improving urban mobility and ensuring equitable access to essential services (Comber et al., 2008).

Network analysis can be performed on various transportation networks and common applications include finding the best route across the study area, identifying the closest facilities, or determining a service area around a location (ArcGIS Developers, n.d.). According to La Rosa (2014), three fundamental variables must be considered in modelling accessibility indicators, and all of them are included in the further analysis in this research:

- Origin - the location of the population potentially accessing the services or facilities;
- Destination - the location of the services or facilities that the population can access;
- Distance Measure - the distance between the origin and destination places.

In practice, the location of destinations, such as green spaces, is often represented by geographical points or polygons. Typically, the geometric centroids of these polygons or the specific entrances and access points are used to define green spaces (La Rosa, 2014).
In this research, network distance was used to ensure a more precise analysis of accessibility, despite the higher data requirements compared. Network distance often provides greater accuracy compared to Euclidean distance, as it considers actual travel paths along a road network. Fortunately, the necessary geographical datasets, such as road network layers and public transport stops, are typically freely available through sources like Open Street Map (OSM). This allowed for a detailed and accurate assessment of the accessibility challenges at Køge Bugt Strandpark.
Within the scope of this research, network analysis was performed using GIS environments tools. Most GIS software already encompasses this tool, making the calculation less time and resource-consuming. The minimum distances were calculated in QGIS using the Network analysis tool – shortest path feature. The "cost" of travel is in this case the distance, which can be transformed in time if average walking or biking speed is considered.

Linear regression

Linear regression is a statistical technique used to model the relationship between dependent and independent variable(s) (Li & Zhang, 2022). Linear regression is also widely used in the field of urban planning, especially in empirical studies, making it possible, for example, to evaluate and predict trends. Using this method, field experts and researchers have the opportunity to make data-driven decisions, promoting both sustainable and equitable development. In this section, only the form of simple regression involving a single independent variable will be considered.
The general formula (Formula 1) for simple linear regression is:

$$Y = a + bX$$ *Formula 1*

Where:

- Y is the dependent variable;
- X is the independent variable;
- a is the intercept or the starting point of the line on the y-axis;
- b independent variable coefficient, if positive indicates a direct correlation, a negative one if it is a negative value (Li & Zhang, 2022).

Excel was used to perform linear regression, as it is described as one of the most used statistical analysis software to perform linear regression due to its user-friendly interface. There are two ways to perform linear regression using Excel: (1) create a graph by adding the trend line and finally the regression equation and R-squared; (2) Excel also offers additional tool packages such as data analysis toolkit (Li & Zhang, 2022). The possibility of using the data

analysis toolkit offered by Excel was also used in this case, as it helped to save time and resources on the application of this method.

Before applying regression analysis, it is important to understand which are the dependent and independent variables in a particular study. Urban planners and researchers are directly interested in the dependent variable because it is the result of many other factors (Li & Zhang, 2022). However, the independent variable is the variable that will affect the dependent variable (Li & Zhang, 2022). In their handbook, Li & Zhang (2022) provide an example of individual income research, where when collecting information, for example, gender, education, and age should be characterised as independent variables in this case. In this research, the independent variable is income level, and the dependent one is the shortest walking distance to the entry points.

When reading the results, two parameters were considered. The main parameter is *R-squared* – it shows how well the independent variable in the statistical model explains the variation in the dependent variable (Li & Zhang, 2022). It ranges from 0 to 1, where, for example, if R-square =0.50, then about half of the observed variation can be explained by the model input (Fernando, 2024). The second parameter is the regression coefficient (*b* in the formula above), used to understand if distance was influenced positively or negatively by the income variable.

This linear regression is a valuable method in the scope of this research as it provides a clear and interpretable way to examine the impact of socioeconomic factors on spatial accessibility, its quantitative results align with critical realism by uncovering underlying patterns and potential causal mechanisms.

Composite index construction

Undeniably, a single indicator cannot adequately describe many complex phenomena; rather, they require a multidimensional approach. Urban development, social inequality, well-being, quality of life and even the provision of infrastructure require a combination of different dimensions (Mazziotta & Pareto, 2013). This combination of various aspects of the studied phenomena can be called a Composite Index (Mazziotta & Pareto, 2013).

In 2015, the Organisation for Economic Co-operation and Development (OECD) issued a guide to constructing composite indices that outlined several advantages of a particular method. Composite indexes can aggregate complex or multidimensional issues to support decision-makers; are easier to interpret compared to trend analysis using several individual indicators and can help track progress over time by highlighting complexity (OECD, 2015). However, some limitations are worth mentioning, such as sending misleading messages if they are poorly constructed or misinterpreted (OECD, 2015).

In the further analysis, the following formula (Formula 2), originally presented by (European Union, & Joint Research Centre, 2008) but adapted to the context of this research, was used:

$$Ai = \sum_{i=0}^{n} (Weight_i \times Coefficient_i) \qquad \textit{Formula 2}$$

Where:

- Ai – accessibility index;
- $Weight_i$ represents the weight assigned to each sub-category;
- $Coefficient_i$ is the normalised value for each of the sub-categories;
- N is the total number of indicators or its sub-components (European Union, & Joint Research Centre, 2008)

Several authors and organisations have outlined steps to construct a composite index to ensure it is well-structured and accurately interpreted. These steps were also applied in this research and are as follows:

Step 1. Definition of the problem under investigation

OECD (2015) identifies a theoretical framework as a starting point for constructing composite indicators. This is followed by a definition of the concept, giving the reader a clear idea of what is being measured by the composite indicator (OECD, 2015). The definition should refer to a theoretical framework linking different sub-categories and underlying indicators (Mazziotta & Pareto, 2013; OECD, 2015). Ideally, after this step, a clear understanding and definition of the research problem have been established.

Step 2. Selection of variables

How well the index is constructed, and the reliability of the output values is based on the selection of variables. In an ideal scenario, variables should be selected based on relevance, analytical validity, time frame and availability (Mazziotta & Pareto, 2013; OECD, 2015). The selection step is a trade-off between potential redundancy due to information overlap and the risk of information loss (Mazziotta & Pareto, 2013). At the end of the second stage, a summary of the data characteristics is provided, including information about the sources, types, etc. (OECD, 2015).

Step 3. Normalisation of data

Data normalisation ensures that different measurement scales do not disproportionately influence the composite index, allowing for balanced and fair comparisons between categories and subcategories (Mazziotta & Pareto, 2013; OECD, 2015). Before any data aggregation, normalization is necessary because indicators often have different units of measurement in a data set (Mazziotta & Pareto, 2013). Thus, bringing indicators to a single standard by transforming them into pure, dimensionless numbers is essential (Mazziotta & Pareto, 2013).

Step 4. Weighting and aggregation

Aggregation involves combining individual indicators or sub-components into broader categories or dimensions (Mazziotta & Pareto, 2013). For example, if there are multiple indicators related to social inequality (e.g. income, education, employment) or well-being (e.g. physical and mental health), aggregating these indicators can produce an overall measure of social inequality or well-being. After aggregating the indicators, weights are assigned within each indicator sub-category based on their relative importance (Mazziotta & Pareto, 2013; OECD, 2015).

Step 5. Presentation and dissemination

Visual presentations of composite indicators can offer valuable insights from the user's perspective, such as highlighting problem areas that require policy intervention (OECD, 2015). There are several ways to display and visualise composite indicators, ranging from simple tabular tools to more sophisticated maps and interactive software (OECD, 2015).

Building a composite index is relevant in assessing accessibility because it allows for the integration of various dimensions that define accessibility. In the case of accessibility assessment, data may come from different sources each providing unique insights, where a composite index combines these diverse data points into a single, comprehensive measure. This method offers a holistic view of accessibility, which aligns with the core principles of climate justice and critical realism theories.

Analysis

Linking Accessibility and Justice

As the term Accessibility encompasses several interpretations and fields of application, in the scope of this research there was a need to clearly state what was the connection between the concept and the universe of Justice. To answer the first sub-research question "*How can the link between accessibility and justice be measured?*" the Conceptual Framework served as a crucial step in defining this link.

Establishing the link between accessibility and justice serves as a reference for the future steps of this research, aiming to assess accessibility conditions of the case study. Providing this allows to better generalise case study findings in order to get deeper insights on the considerations that bring accessibility to serve as a provider of justice and ultimately answer the research question.

The literature review conducted within the Conceptual Framework allowed to gain a more in-depth understanding of what are the concepts, definitions and perspectives referring to physical accessibility and ways of how to measure it.

The connection between accessibility and justice, as defined in the Conceptual Framework (see Defining Accessibility) touches base on the concept of equity.

Equity, as defined in Theoretical Framework (see Equity in climate justice), refers to the fair and just distribution of resources and opportunities across different segments of society (Tahmasbi et al., 2019). In the context of accessibility and justice, equity becomes a pivotal concept, ensuring that all individuals, regardless of their socio-economic status, physical ability, or geographical location, have equal access to the benefits provided by NbS like those in Køge Bugt Strandpark. This emphasis on equity is particularly significant in urban planning and climate justice studies, where accessibility can often be skewed by urban development that does not consider the needs of marginalised or less advantaged groups (Tahmasbi et al., 2019; UNDP, n.d.).

The operationalisation of equity within this research framework involves examining how accessible the park is to various community groups, particularly those who might be physically disabled, economically disadvantaged, or geographically isolated. It investigates whether these groups can equally benefit from the park's facilities and natural resources, which are crucial for enhancing community health, well-being, and resilience against climate impacts (IPCC, 2023; Kingsley & Ontario, 2019).

Further, the link between accessibility and justice encompasses not only physical access but also the inclusivity of planning processes. This means that community engagement and participatory planning play essential roles in ensuring that the voices of all community members are heard and integrated into the development of accessibility strategies. By doing

so, the planning process itself becomes a tool for advancing justice, promoting not just physical but also procedural equity (EC, 2023; Pineda-Pinto et al., 2021).

Thus, in this research, establishing a clear link between accessibility and justice through the lens of equity enables a comprehensive analysis of how well the infrastructure and services within Køge Bugt Strandpark meet the diverse needs of the community. This analysis seeks to highlight areas where improvements are necessary and to recommend strategies that ensure that all community members can share in the park's benefits.

Particularly relevant in measuring this interconnection in urban planning studies is to link spatial and statistical analysis, where equity is measured by integrating spatial and social dimensions (Pereira & Herszenhut, 2023; Geurs & Van Wee, 2004). The spatial analysis looks at how easy it is for people to access the place, basing its conceptualisation on the location-based approach to compute accessibility measurements to various facilities such as parks and green spaces.

The applied theory of the gravity model allows the use of network analysis, integrating the spatial and social dimensions (Wang et al., 2021). The gravity model, widely used in geography and urban planning, predicts interactions between locations based on their attributes—such as population size—and the distance between them (Kalpana et al., 2020; Porta et al., 2008). This model suggests that interaction is directly proportional to the attributes of the locations and inversely proportional to the square of the distance between them. In examining accessibility and justice, for instance, the "mass" might be interpreted as the availability and quality of facilities in a park, while "distance" is defined by the physical or travel distance from population centres to the park (Karamitov & Petrova-Antonova, 2022; Porta et al., 2008). Closely, network analysis complements this by providing tools to accurately calculate real travel distances and times using actual transportation networks. This methodology considers the intricacies of roads, paths, and various transportation modes, which are essential for a realistic assessment of physical accessibility (Wang et al., 2021). By applying network analysis, researchers can quantify the actual impedance or costs associated with reaching a location, factoring in elements like travel time, energy use, or economic costs (Deliry & Uyguçgil, 2023; Karamitov & Petrova-Antonova, 2022).

Incorporating network analysis outputs, such as travel time or distance matrices, into the gravity model enriches the analysis. This integration allows for a nuanced understanding of how physical access to public spaces like parks is influenced by urban infrastructure and layout. It reveals disparities in accessibility, especially for disadvantaged or marginalised groups who might live further from parks or lack sufficient public transportation options.

This integrated approach has significant implications for justice. It enables an evaluation of whether all community members, regardless of their socioeconomic status or geographic

location, have equitable access to green spaces. This consideration is vital in discussions of distributive justice, where equitable access to NbS benefits is a fundamental concern.

Practically, this methodology assists in pinpointing neighbourhoods with deficient access to NbS by analysing the origins and destinations of travel, travel times, and the social categorisation of geographic units, such as income levels. Access points are critical; they substantially influence how easily and through which modalities specific areas can be accessed. By synthesising different aspects of spatial distribution, it is possible to construct indices that provide a detailed picture of accessibility across different demographics (Páez et al., 2012; Wang et al., 2021).

To elucidate the correlations between various variables, additional statistical methods like regression analysis can be utilised, a technique also prevalent in social sciences. These analyses help determine the strength and nature of the relationships between accessibility and socioeconomic factors (Li & Zhang, 2022).

In the context of climate justice, the principles of distributive and recognitional justice are particularly pertinent. Spatial analysis and the development of accessibility indices can demonstrate how opportunities are apportioned across different social groups, highlighting any discrepancies in access (Wang et al., 2021). This approach ensures that the benefits of NbS are not disproportionately enjoyed by certain groups over others. Meanwhile, recognitional justice requires us to acknowledge these disparities explicitly. By integrating statistical measures, it is possible to identify and address any advantages that some groups might have, ensuring a fairer distribution of environmental benefits and recognizing the unique challenges faced by marginalised communities. This comprehensive approach not only promotes fairness but also enhances the efficacy of NbS in achieving sustainable urban develop.

Accessibility Challenges in Køge Bugt Strandpark

The previous section underlined the link between accessibility and justice and highlighted the potential methods that can be used to measure it. The Conceptual Framework served as a crucial step in defining this link, and Analytical Framework clearly defined how this link it is integrated into the data collection and analysis processes of this research. The following section aims at illustrating the results from a combination of methods used to explore accessibility challenges in the case study, ultimately answering the following sub-research question: *What are the existing accessibility challenges that Køge Bugt Strandpark faces*?

Observations provided the first insights into the accessibility features of the area. Given the extension of the park, there are several entry points with different features.

As mentioned before, during the site visit conducted in February 2024, it was possible to observe different patterns in area utilisation as well as the demographic composition of people accessing the park. As specified in the Conceptual Framework (see Measuring Accessibility), analysis of the entry points is one of the key elements of analysis. In fact, following the first observation, the research focused clearly on understanding the entry condition of every part of the park, the facilities around them and the different modes of transportation connected to every entry point.

The second site visit mapped and assessed the condition of 14 entry points that were considered relevant for their accessibility features and entry point of the park area (Figure 11). This choice is made reflecting on one of the many components of accessibility, the possibility to access a specific service and/or facility (see Measuring Accessibility).

Entry points were considered based on land access, and not including boat/via sea access. This reflects the land-based approach of this research but it is also justified by two elements: a) as the driver of this research is ensuring justice in adaptation, boat ownership is considered quite a luxurious asset (*Oceanswavesail*, 2023) so it was not included as an element that could facilitate access to vulnerable groups; b) retrieving data on boat ownership is quite hard and it would be hard to establish a correlation to a specific group of population accessing the park via sea.

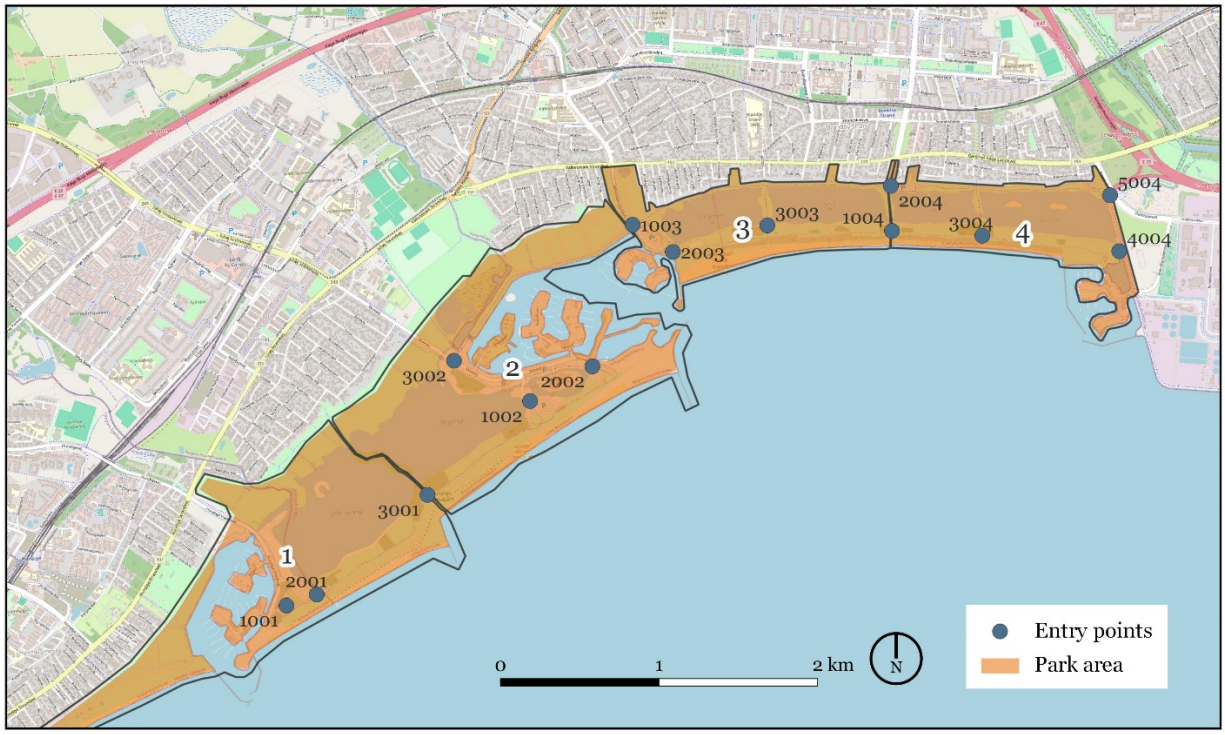


Figure 11. Park area with its four 4 subdivisions and 14 entry points mapped during the second site visit. Source of base map: OSM

The entry point ID was given according to the following system (Figure 12):

Figure 12. Explanation of entry point ID

Area subdivision was established for a mere organisational and readability of the results purpose, it does not reflect any functional aspect.

During the observation, a factsheet for every point was filled in real time to record specific features predefined according to what was observed already in the previous site visit in February. Below is an example of a filled factsheet (Figure 13). See Appendices 1-14 for the full stack for every 14 points.

<table>
<tr><td>Entry point id</td><td colspan="3">2001</td><td colspan="2">Site map</td></tr>
<tr><td colspan="4">Pictures</td><td rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1376179</td><td colspan="2">Long 7478175</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Easy access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td>Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td></td><td>Other</td><td colspan="3"></td></tr>
<tr><td>Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td>(By car)</td></tr>
<tr><td>Hundige</td><td>32 min</td><td>~~min~~</td><td>9 min</td><td>(6 min)</td></tr>
<tr><td>Additional information</td><td colspan="4">The access to the main path is quite large at this point but there is no designed area for cars to stop, making it hard for wheelchairs to easily get here.</td></tr>
</table>

Figure 13. Entry point 2001 factsheet

The factsheet reflects the element of analysis defined in the Conceptual Framework (see

Defining Accessibility within the Context of this Research

The focus of the Conceptual Framework is defining accessibility to align the concept to the scope of this research.

). The observation provided the list of facilities that would be considered in the analysis. Toilets provide an additional functional and well-being element to a service (EEA, n.d.), while recreational facilities such as playgrounds, cafés and beach stalls are facilities that contribute to deliver some of the co-benefits that a NbS can provide compared to a “traditional” adaptation solution.

It is important to note that within this research, accessibility is considered as accessibility *to* the area and not *within* the area. As explained in the Conceptual Framework, services and facilities play an important role in influencing one’s accessibility level to a specific destination. In this case, this is explicated by analysis of how facilities around a specific entry point add value to that entry point by delivering more co-benefits compared to a simple entrance with no additional facilities. This is where the analysis virtually stops, although it is acknowledged that simply being able to access the park doesn’t automatically ensure the perfect enjoyment of the park as a whole. There might be many other features that could jeopardise one’s

experience once inside the park area. For instance, a park could be perfectly accessible to wheelchairs, but internal paths' conditions could make it very hard for wheelchairs to smoothly run on it. This is not the scope of this research as the goal is broader in terms of the connection between land use planning and demographic distribution of levels of justice rather than an urban designer approach that evaluates path conditions. This provided an overview of how and from where it is possible to access the park with different modes of transportation. Each entry point is valued based on the cumulative offer of different modes of transportation to access the park via that specific point (Table 5).

Table 5. Entry points modes of transportation and its cumulative value

Entry point	Accessibility				
	By car	By foot	By bike	By bus	Sum
1001	1	1	1	0	3
2001	0	1	1	0	2
3001	0	1	1	0	2
1002	1	1	1	1	4
2002	1	1	1	0	3
3002	0	1	1	1	3
1003	1	1	1	0	3
2003	1	1	1	0	3
3003	0	1	1	0	2
1004	0	1	1	0	2
2004	1	1	1	0	3
3004	0	1	1	0	2
4004	0	1	1	0	2
5004	0	1	1	0	2

It is possible to notice from the Table 5 that every entry point is accessible by foot and by bike – although we didn't always find two separate paths/lanes.

1002 is the entry point with the highest value. Overall, area 2 is the only area accessible by bus, featuring three bus stops. While parking lots are scattered mostly everywhere, only parking lots located in entry points 1002, 2003 and 2004 are equipped with designated wheelchair parking lots (Figure 14). In point 1002, the location of these parking spots allows a closer access to the beach area of the park.

Figure 14. Examples of wheelchair dedicated parking lots. From left to right, access point 1002, 2003 and 2004. Stranparken, April 2024. (Photos taken by the authors)

The observations also revealed how facilities are distributed in the area. Toilets are well distributed -even if many of them are locked in the winter season (Strandparken I/S, 2024). There is a totality of 3 cafes, leaving Area 1 without this type of service. There are 4 "marinas", two of them welcome restaurants and other activities. In Area 2, close to entry points 1002 and 3002, there is a camping park and between points 2002 and 1002, there is the Arken Museum.

The area has a totality of 4 playgrounds, in correspondence of entry points 2001, 1002, 2003 and 1004. It is important to note that playgrounds, toilets, and cafes are placed in the most "internal" part of the park, this poses some accessibility challenges for disabled people considering that in areas 3 and 4 parking lots remain only on the side of the park next to the residential areas.

These disparities in how the park is accessible and from where demand for an analysis of distances to the closest entry point for the residents of the area. To be fully able to benefit from the recreational and enhanced quality of life that the NbS provides, it is in fact crucial that everyone has the same opportunities on how to get there and enter the area.

To simplify the calculations, only one single entry point per area was chosen (Table 6). This choice was based on the overall accessibility value given by the means of transportation possible in that specific point and distance from the residential areas[4].

[4] The outlier entry point 1002 was not considered because, compared to the other entry points, the distance from the residential area was too large, considering that the "park area" actually can be delimitated by entry point 3002.

Table 6. Selected entry point for each area

Area	Selected entry point
1	1001
2	3002
3	1003
4	2004

To understand the relations between population and accessibility possibilities in terms of justice, a set of 4 regression analyses were performed between the minimum distance from the centroid of each of 151 selected neighbourhoods (Figure 15) and the average income of each neighbourhood.

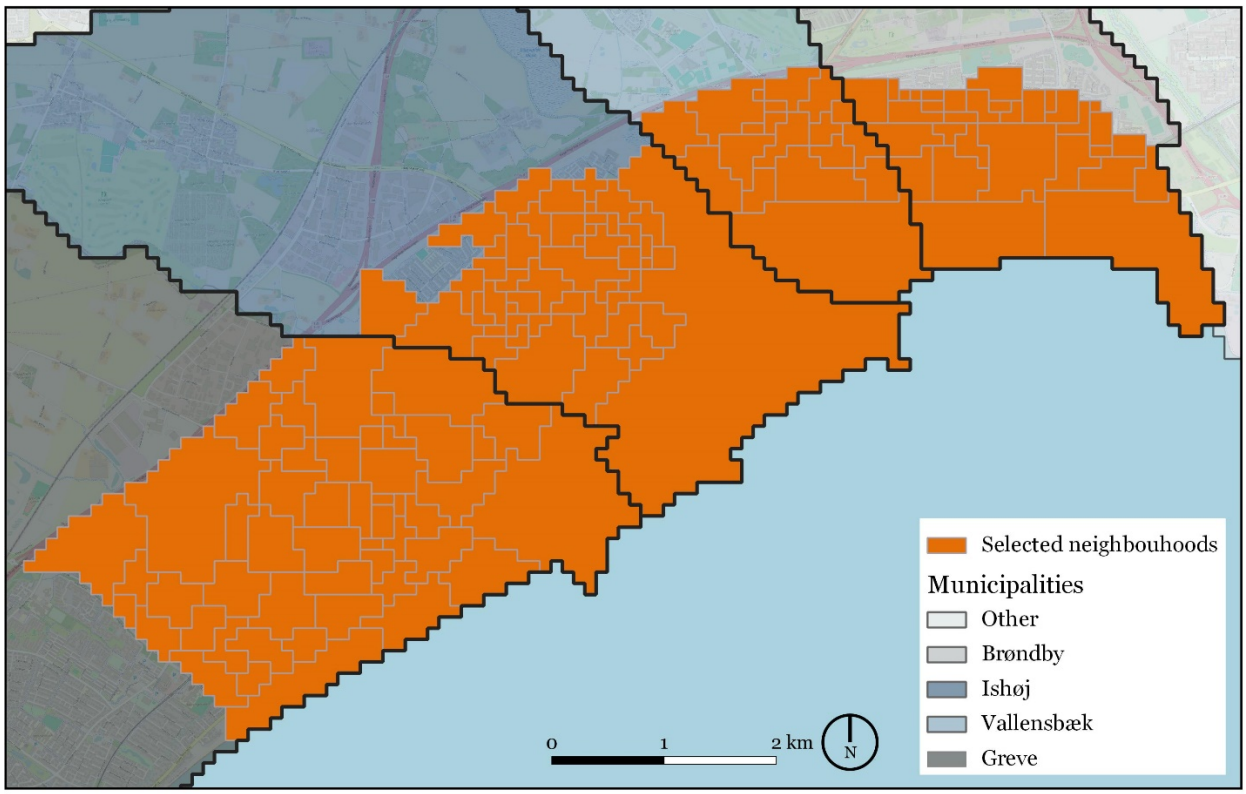


Figure 15. Selected 151 neighbourhoods from the 4 municipalities. Data source: Nabolag Atlas, 2020. Source of base map: OSM

The 151 are the neighbourhoods of the municipalities of Brøndby, Ishøj, Vallensbæk and Greve. Respectively 32 neighbourhoods in Brøndby, 52 in Greve, 48 in Ishøj and 19 in Vallensbæk. The calculations for Network analysis were performed for every neighbourhood's centroid for every 4 selected entry points. Then, the shortest distance was selected (Figure 17), and the correspondent entry point was individuated (Figure 16).

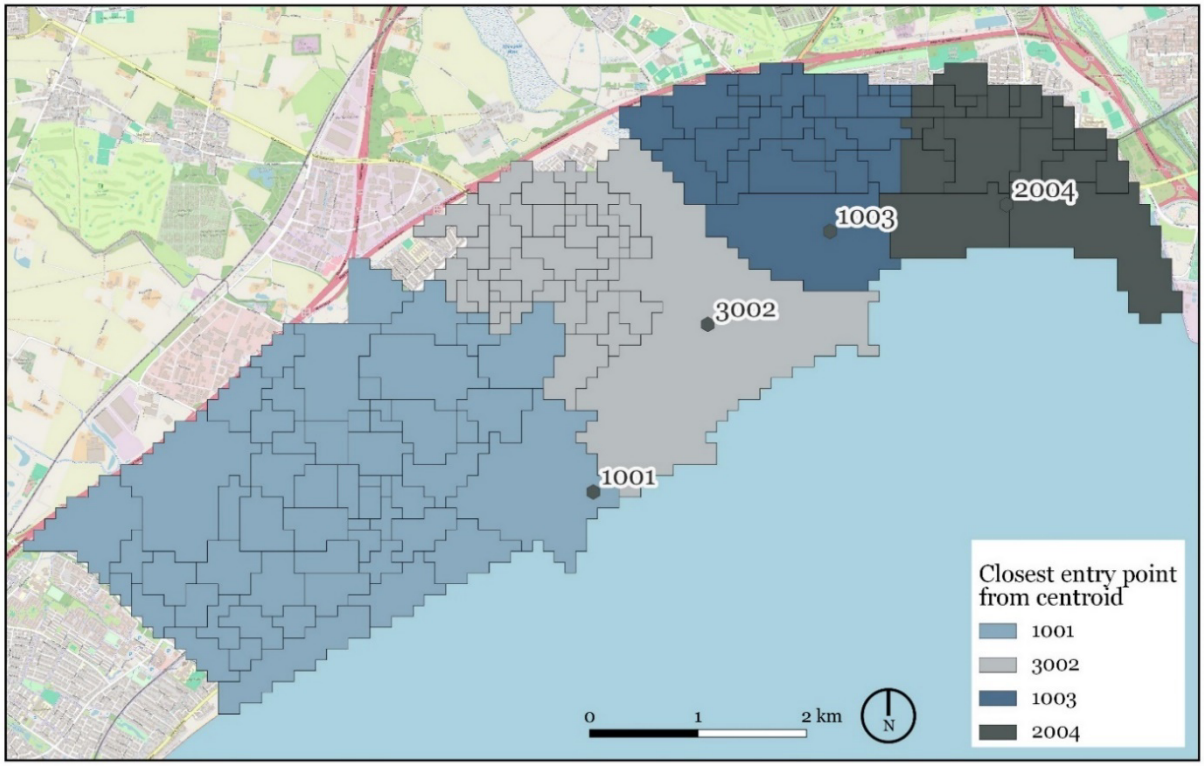


Figure 16. Neighbourhoods divided according to their closest entry points as a result of network analysis calculations. Source of base map: OSM

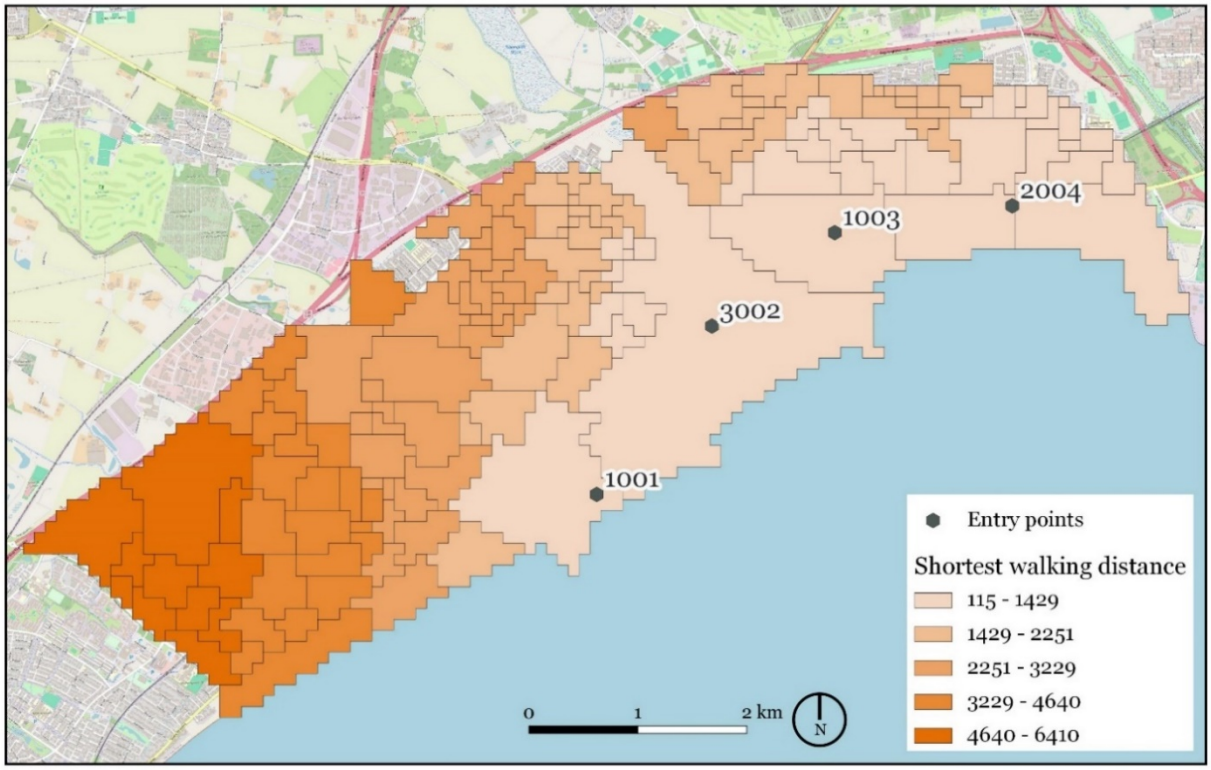


Figure 17. Shortest walking distance in meters from neighbourhoods' centroids to the clostest entry point. Source of base map: OSM

While performing 4 regressions, the relation between distance – relative to the closest entry point and income was analysed.

The following (Table 7) are the linear regression results for each entry point:

Table 7. Linear regressions results

Entry points	Number of features	R^2	Coefficient
1001	57	0,095	0,006
3002	43	0,104	-0,005
1003	28	0,552	-0,005
2004	23	0,144	-0,002

The results (Table 7) showed negative correlations between gross incomes and distance to the closest entry point for areas 2, 3 and 4. This approach highlights how geographic and socioeconomic disparities may influence access to entry points, as the distance increases, income levels of neighbourhoods closest to entry points 3002, 1003 and 2004 decrease. The R-squared values obtained ranged from as low as 0.0947 for entry point 1001 to a high of 0.5521 for entry point 1003, indicating the percentage of variance in distance that can be explained by differences in gross income. These values suggest a variable but generally low degree of correlation between income levels and distance to entry points, with entry point 1003 showing a moderately strong relationship.

This analysis shows that while there is some correlation between income levels and the distance to respective entry points, it is not consistently strong across all areas. The findings also suggest a potentially uneven distribution of income across neighbourhoods (Figure 18), which may influence accessibility to these entry points. This aspect was briefly noted in the case study description, indicating a need for more granular socioeconomic data to better understand and address accessibility disparities.

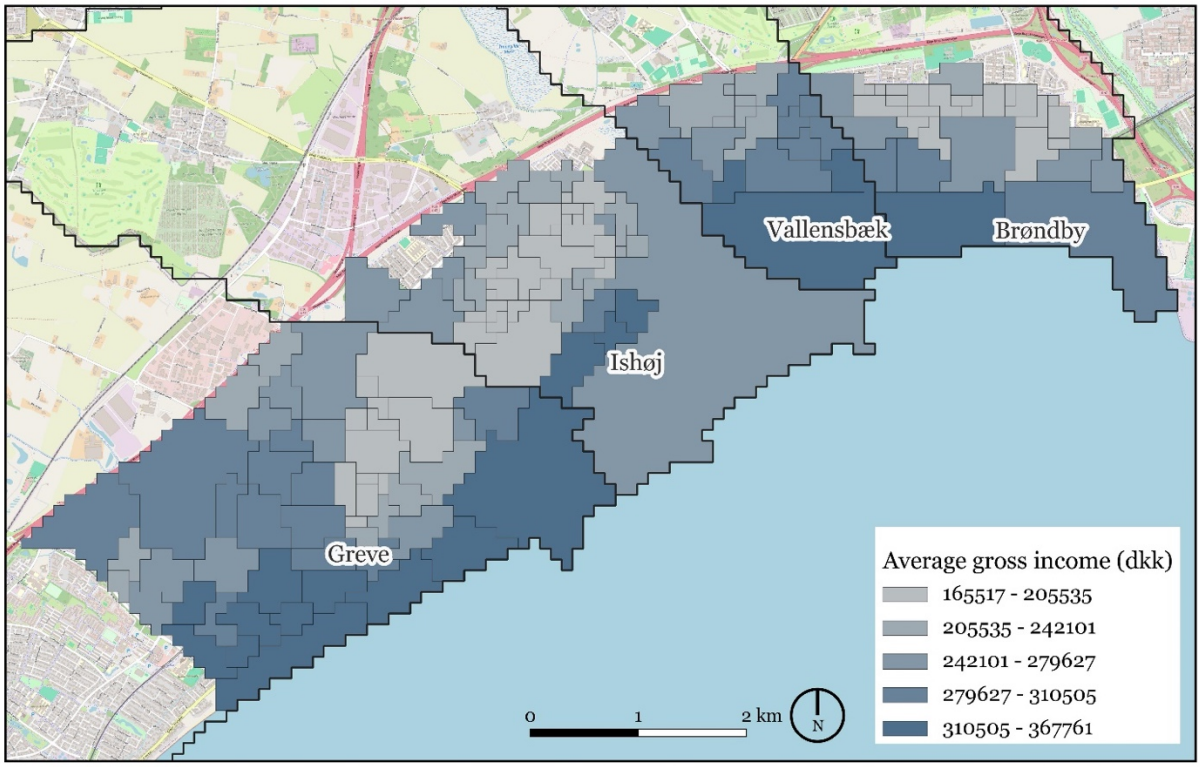


Figure 18. Average gross income. Data source: Naboglas Atlas, 2020. Source of base map: OSM

Average incomes seem to be distributed along the coastline while the area around the train stations reveals a higher concentration of lower income levels (Figure 18).

The lack of detailed demographic data with the same level of granularity prevented a deeper exploration of potential correlations with walking distance. With this limitation in mind, the result from this analysis highlights a unique aspect of Strandparken that exemplifies how accessibility might impede the equitable enjoyment of NbS benefits, posing distinct challenges. Strandparken, being a coastal park, faces inherent accessibility issues due to its geographical location along the coast, which restricts entry to a specific side of the area. Unlike a centrally located park within a residential area, Strandparken is peripheral, creating a significant barrier for residents living around the urban core. This presents a primary accessibility challenge for Strandparken: ensuring that, despite its peripheral location and the distances from residential zones, all residents have equal and fair opportunities to access the park.

On another note, during the second site visit, conducted on foot, the extensive size of the park was evident. Particularly regarding the substantial distances between areas 1 and 2 to the nearest residential neighbourhoods. This visit highlighted the scale of walking accessibility challenges. However, the park does offer considerable benefits in terms of amenities; facilities such as toilets and playgrounds are well distributed throughout the park, enhancing its value and accessibility for visitors across its expanse.

It is quite evident though that area 2 is the most accessible one, thanks to several elements. It is the only one served by the public transportation service, featuring 3 bus stops, two of them designed in a more user-friendly way, providing shade and seating (Figure 19).

Figure 19. Bus stops within area 2. Strandparken, April 2024. (Photos taken by the authors)

Area 2 hosts many other facilities as the Arken Museum and the camping site. As these two can definitely increase the attractiveness of the area, they represent a more exceptional feature of the composition of an NbS that can offer recreational benefits like Strandparken. Even if this is considered an additional value for area 2, the fact that these types of services are not present in areas 1, 3 and 4 is not considered an impediment to accessibility. What constitutes a challenge though, is the fact that public transportation only serves this area, precluding more equitable access to areas 1, 3 and 4 besides reaching them by car. Car ownership is in fact another aspect that could promote discriminated access. Public transportation promotes economic and social equity by providing affordable and reliable mobility options for all individuals, especially those who cannot afford or do not have access to private vehicles. It creates a level playing field for communities, connecting people to jobs, education, healthcare, and essential services regardless of their income or car ownership status (Reckien et al., 2018). Furthermore, public transportation plays a crucial role in reducing GHG emissions. It provides an alternative to individual car usage, which is a significant source of emissions in the transportation sector (EC, 2024). By encouraging more people to use public transportation, emissions per passenger mile can be significantly lower compared to single-occupancy vehicles (Stein & Dorner, 2024). If NbS is a solution used to establish virtual cycles and additional climate benefits (thanks to an increased number of trees), increasing CO_2 emissions by guaranteeing and privileging car access could jeopardise NbS's additional value overall.
The inputs provided by the on-site data collection and the off-site data analysis provided the answer to the sub-research question 2.

Challenges related to accessibility touch several components of equitable access. Overall, it is clear that the closest areas to the park are higher-income neighbourhoods. In Ishoj and Brondby, lower-income neighbourhoods are actually further away from the area and the correlation between these two elements is well explained by the results of the linear regressions.

Area 2 also hosts many other facilities as the Arken Museum and the camping site. As these two can definitely increase the attractiveness of the area, they represent a more exceptional feature of the composition of an NbS that can offer recreational benefits like Strandparken. While these amenities add value to Area 2, their absence in Areas 1, 3, and 4 does not necessarily hinder accessibility. However, a real challenge to equitable access arises due to the fact that public transportation services are predominantly available to Area 2, limiting access to the other areas unless by private car (or by bike and foot). This situation underscores the role of car ownership in potentially creating disparities in park access.

Public transportation is vital for promoting economic and social equity, offering a cost-effective and dependable way for all community members to access essential services, jobs, and educational opportunities. It levels the playing field for individuals across different income brackets and reduces dependence on private vehicles. Furthermore, public transportation is crucial for environmental sustainability. By providing a communal travel option, it significantly cuts down GHG emissions per passenger mile compared to single-occupancy vehicles, thus supporting climate action initiatives by reducing the transportation sector's overall carbon footprint.

Despite the general provision of amenities, the park's design does not uniformly accommodate wheelchair users; although some parking areas have designated accessible spots, these are either poorly paved or located too far from the main recreational areas of the park. This uneven accessibility can diminish the usability of the park for individuals with mobility challenges.

This spatial and economic divide emphasises the need for a more inclusive approach in urban planning and the implementation of NbS to ensure that benefits are distributed more equitably across different social groups.

Injustices Drivers in Køge Bugt Strandpark

Having identified which are the accessibility challenges in Strandparken, a specific index was created to comprehensively assess all the individuated features related to the entry points and to ultimately answer the third sub-research question: *How do the identified accessibility challenges in Køge Bugt Strandpark promote injustice?*

As specified in the methods chapter (see Composite index construction), a composite index allows to merge different aspects into one final value that can help visualise a specific phenomenon. The built index reflected the analysis components of accessibility defined in the Conceptual Framework that allows to establish the link between accessibility and justice (see Linking Accessibility and Justice), based on the data gathered during observations that highlighted accessibility-related challenges (see Accessibility Challenges in Køge Bugt Strandpark).

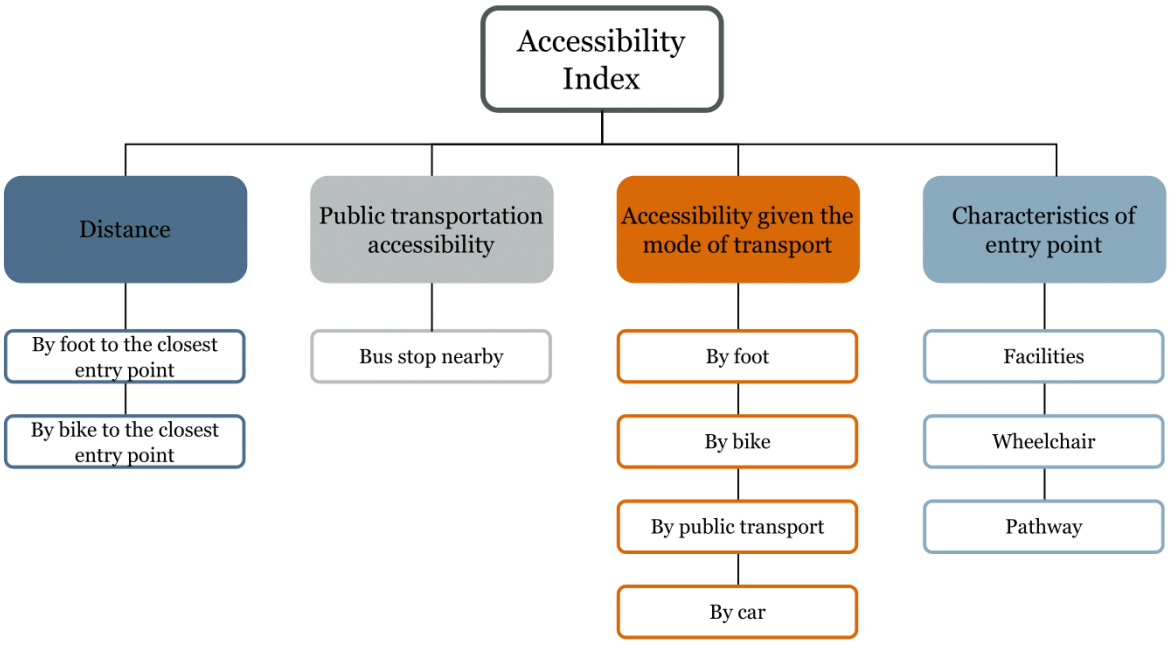


Figure 20. Conceptual model for the Accessibility Index. Created by the authors

The diagram (Figure 20) presents a conceptual model for the created "Accessibility Index," calculated for each neighbourhood. It is designed to evaluate how accessible a specific neighbourhood in the four municipalities is based on various transport and infrastructure parameters. It encompasses the following elements:

1. **Distance by foot from the closest entry point**: This element measures the distance to the location from the nearest entry point considering all road networks, as

established in the previous chapter. It's crucial because pedestrian access is often the most basic and universally available means of reaching a location, particularly in urban settings. Ensuring short walking distances promotes inclusivity and convenience, making the site accessible to those without vehicles and supporting healthy, active lifestyles.

2. **Distance by bike from the closest entry point**: Including biking distance is important as cycling is an environmentally friendly transportation method that can cover greater distances than walking. This factor helps evaluate if the location supports sustainable travel options and if it is accessible via safe and efficient bike routes, which are essential for reducing traffic congestion and pollution.
3. **Public transportation accessibility**: This factor assesses the availability of public transit stops in the nearby of every neighbourhood. Effective public transportation links are vital for reducing car dependency, enhancing the sustainability of urban environments, and ensuring that people of all income levels have equitable access to the location. As only one entry point is served by public transportation, this factor was determined by the presence or absence of a public transport stop 500 m distant from every neighbourhood, considering the road network that could connect to entry point 3002 by bus (or combination of bus and train, or bus and walking).
4. **Transportation mode**: As assessed previously (Table 5) each entry point is given a value corresponding to the cumulative number of ways that it can be accessed (by car, by foot, by bike and by public transport).
5. **Facilities of the entry points**: As already mentioned, the quality and variety of facilities available at entry points, such as restrooms, playgrounds and cafes, can significantly enhance the user experience. This aspect of the index ensures that entry points are well-equipped to meet the needs of diverse users, including families and elderly visitors.
6. **Wheelchair accessibility**: Accessibility for wheelchair users to the area is primarily determined by two factors: the availability of designated parking spots for disabled users and the presence of a bus stop area well-connected to the main path, ideally featuring a paved pathway (Figure 21). While the design specifics of bus stops are somewhat beyond the scope of this research, they remain a crucial element for evaluation. The authors considered this aspect significant enough to include because it highlights inconsistencies in design and implementation across the area.

Figure 21. Representation of a wheelchair-friendly bus stop design. National Aging and Disability Transportation Center, 2014

7. **Pavement conditions**: The condition of pavements affects accessibility, especially for those using wheelchairs, other mobility aids or strollers. Well-maintained and paved pavements without obstructions are essential for safe and comfortable access, reflecting an area's overall accessibility and commitment to inclusivity. In this case, paved paths are particularly advantageous for users over alternatives like gravel, which can become uneven and waterlogged, leading to the formation of holes and other barriers. Figure 22 shows examples of pictures taken in Strandparken of deteriorated gravel-paved paths.

Figure 22. Examples of gravel-paved paths in Strandparken. Strandparken, April 2024. (Photos taken by the authors)

Each of these components is considered crucial for building a robust Accessibility Index that accurately reflects the ease with which different population groups can access Strandparken. According to what was observed, and the results obtained by the calculations, these five

elements play a different role in influencing the overall accessibility level of every neighbourhood.

Walking distance plays a crucial role in determining the accessibility of a green area and can significantly influence how often and by whom these spaces are used (Zhou & Rana, 2012; Jalkanen et al., 2020). The closer a green space is to where people live, the more likely they are to visit it frequently. Research shows a clear decline in the frequency of visits to parks and green areas as the walking distance increases (Giles-Corti et al., 2005; Neuvonen et al., 2007). Moreover, shorter walking distances make parks more accessible to a broader range of people, including children, elderly individuals, and those with limited mobility. Longer distances can be a significant barrier for these groups, potentially excluding them from enjoying the benefits of green spaces. In fact, has been proven by several studies, that the perceived effort required to reach a green space can affect whether individuals decide to use it (Neuvonen et al., 2007). Even if a park is physically within reach, the prospect of a long walk might deter visits, especially if the path involves crossing busy roads, navigating poor sidewalks, or dealing with unsafe conditions. Walking distance from a green area is linked to improved mental health, reduced stress, and physical health benefits, therefor, easier walking access encourages more frequent use, which can amplify these health benefits for the community (Stoia et al., 2022). Finally, ensuring that green areas are within comfortable walking distance helps promote social inclusion (Jalkanen et al., 2020; Stoia et al., 2022). It allows people from various socio-economic backgrounds, especially those who may not have access to private vehicles, to access natural spaces, thereby providing equal opportunities for recreation and relaxation, and it reduces the reliance on cars, contributing to an enhancing NbS mitigation benefit (Iacono et al., 2010).

Considering all this, walking is seen as the primary mode of access to green spaces from a climate justice perspective, for this reason, this indicator was given the higher contribution in the index composition (see Table 11).

The walking distances (see Analytical Framework for the explanation of the method used for calculations) were categorised into 3 classes according to the findings of Giles-Corti et al. study (2005). The study analysed the impact on health of walking to public open spaces and found out that for example, a person living within a 5-minute walk of a park might visit it several times a week, whereas someone living a 20-minute walk away might only go once a week or less. This shows how walking distance is a key accessibility element. Considering that an average human being walks 5 km per hour (Browning et al., 2006), walking distances from neighbourhoods' centroids to their closest entry point were classified according to what is displayed in Table 8.

Table 8. Walking distance classes and respective weights

Class	Value (m)	Weight in the Accessibility Index
1	0-1346	10
2	1346-2000	5
3	<2000	0

Bike distances to Strandparken were determined using QGIS's network analysis tool, similar to the method used for calculating walking distances. These calculations specifically considered the designated bike lane infrastructure, ensuring a safer route to the park. The distances were classified into two categories. With the longest biking distance measured at 6981 meters and an average biking speed of 14 km/h (Thompson et al., 1997), this distance is deemed reasonable for individuals cycling to the park and returning home. If the bike lane infrastructure did not extend into a neighbourhood, that particular area received a weight of 0 in the index calculation, indicating no direct bike access (Table 9).

Table 9. Biking distance classes and respective weight

Class	Value (m)	Weight in the Accessibility Index
1	1-6981	10
2	None	0

Public transport accessibility focused on assessing the presence of a bus stop in a buffer of 500 m from the neighbourhoods' centroids, considering the road network. This calculation method was chosen considering the incapability of calculating accurate distance by public transportation. The presence of a good network of public transportation seemed adequate to assess accessibility by this means. Only two neighbourhoods, in fact, were unequipped with a nearby bus stop. If the neighbourhood was equipped with a bus stop the weight given was 10, if otherwise 0.

Even if public transportation can be an equitable and just mobility option (EU Urban Mobility Observatory, 2022), the fact that Strandparken is only accessible by bus from one area generates long routes for those residents who live far away from this. For this reason, public transportation accessibility per se was not given a big contribution in the overall index composition (see Table 11).

Entry points were classified based on their transportation access options (mode) – as explained before (see Table 5). The fact that an area is reachable by diverse transportation and mobility options increases its accessibility value.

"Characteristics of the entry points" is based on the qualitative results of the second site visits. Facilities availability was weighted based on their relevance on justice principles, toilets were considered the most important one, followed by playgrounds, cafés, and access to the water. The table (Table 10) below reports each entry point's facilities provision connected to the specific value given to the single facilities.

Table 10. Classification of entry points based on available facilities

Value \ Entry Point		1001	3002	1003	2004
Toilet	4	4	0	4	0
Playground	3	0	0	0	0
Café	2	0	0	2	0
Access to water	1	1	0	0	0

As is possible to see from the Table 10, entry points 3002, and 2004 don't record any facilities in their immediate surroundings as they are placed in most "perimetric" parts of the park. As entry point 1003 registered the highest value it was given the value of 10 in the index, 1001 was given the value of 5 and 3002 and 2004 were weighted 0.

Pathway conditions and wheelchair accessibility were binary elements in the index. If the entry point presents a paved pathway, it is given the value of 10, if otherwise 0. Likewise, if the entry point is considered accessible to a wheelchair it was weighted 10, if otherwise 0.

Overall facilities accounted for 15% of the index composition as it is possible to see in Table 11.

Table 11. Accessibility index categories and sub-categories

Category	Categories importance	Sub-Category	Sub-Categories importance
Distance	0.30	By foot	0.50
	0.20	By bike	0.50
Public transportation accessibility	0.15	Bus stop nearby	1.00
Accessibility given the mode of transport	0.20	By foot	0.25
		By bike	0.25
		By public transport	0.25
		By car	0.25

Category	Categories importance	Sub-Category	Sub-Categories importance
Characteristics of entry point	0.15	Facilities	0.40
		Wheelchair	0.30
		Pathway	0.30

The index was calculated for each neighbourhood according to the respective closest entry point, except for the element of "Public transportation accessibility" which looked at overall conditions for each neighbourhood. The applied formula (Formula 2), explained in detail in the Analytical Framework (see Utilisation of Methods to Answer Sub-RQs), gave back results presented in the map (Figure 23) (see Annex 1 for full Index results).

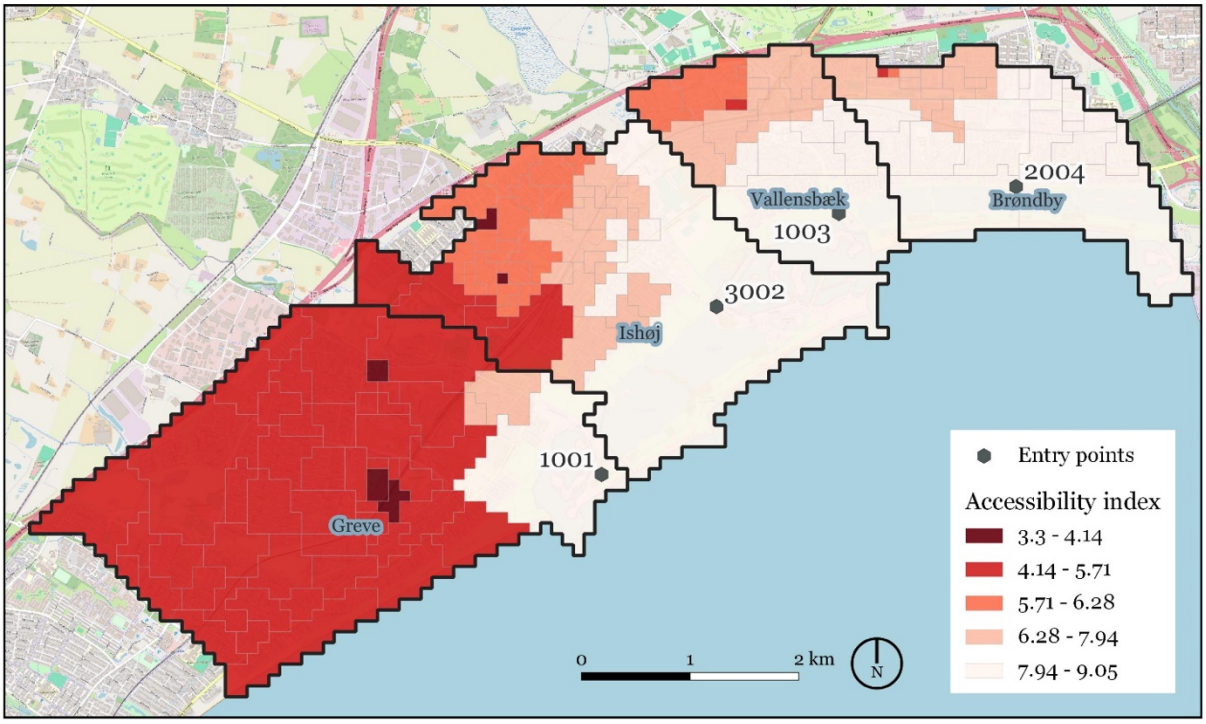


Figure 23. Accessibility Index results. Source of base map: OSM

Distance evidently plays a critical role in determining the overall accessibility index to Strandparken, highlighted by higher index values in neighbourhoods closer to the park. Conversely, neighbourhoods in the southwestern part of Greve exhibit lower accessibility values, predominantly due to their substantial distance from the primary entry point 1001, which at 5000-6500 meters significantly exceeds the average distance of 2417 meters.

The accessibility index graph (Figure 24) segregates the cumulative values by municipality, revealing a prevalent index score of around 5.4, with 46 neighbourhoods in Greve and 5 in Ishøj, collectively accounting for 51 features. Notably, the highest values on the index, those above 8, predominantly belong to neighbourhoods in close proximity to the park, especially in

Brøndby. This value suggests a potential baseline of access that could guide planning standards for Strandparken.

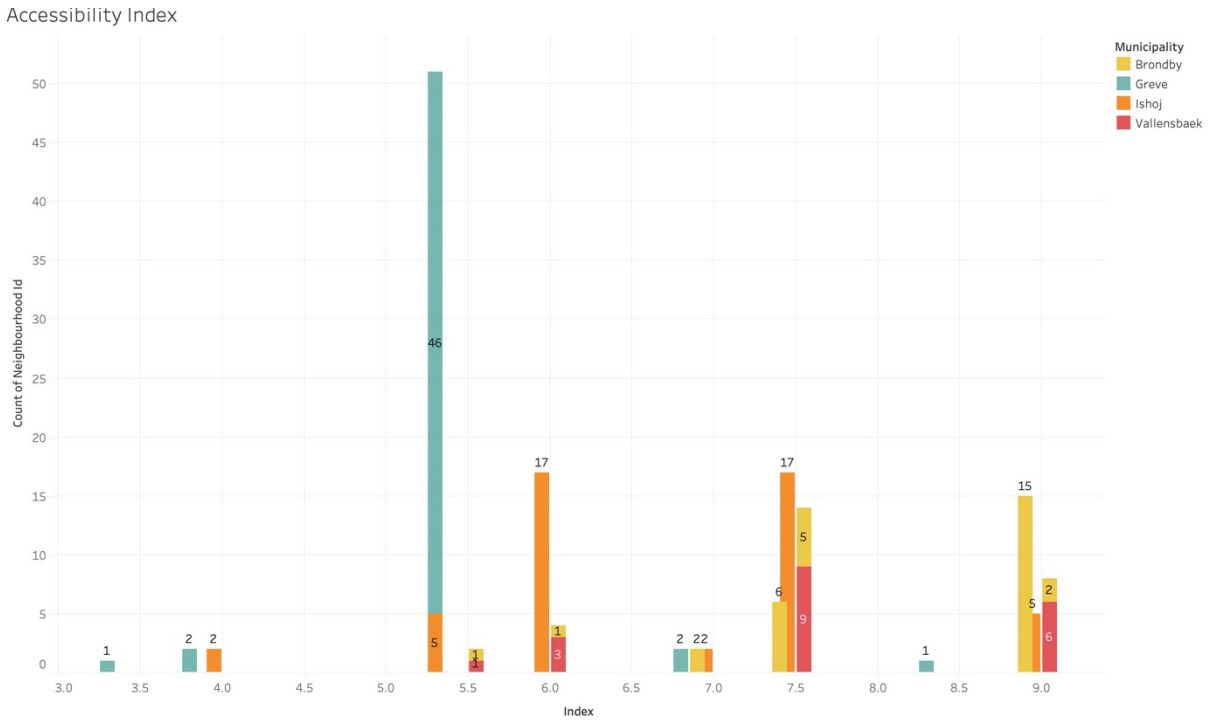


Figure 24. Accessibility Index results counted by neighbourhood and classified by municipality

Examining the map (Figure 23) and the graph (Figure 24) simultaneously clarifies the locations of the five neighbourhoods with the lowest accessibility indices—three in Greve and two in Ishøj. Interestingly, those in Greve are not the furthest ones from entry point 1001. Factors contributing to their low scores include the lack of bike lane infrastructure and nearby bus stops, compounded by poor wheelchair accessibility at entry points 1001 and 3002.

In contrast, the high accessibility scores can be attributed to the favourable conditions at entry point 1003, which is situated nearest to the residential sectors of the municipalities. This proximity, coupled with well-maintained access features, underscores the pivotal role of strategic entry point placement and infrastructure in enhancing park accessibility.

Lastly, the graph (Figure 24) and map (Figure 23) draw attention to the role of infrastructure in determining access levels. Lower accessibility in certain areas, as identified through the data, could be linked to inadequate infrastructure, such as a lack of bike lanes or poorly connected public transport options.

The index can highlight disparities in access among different neighbourhoods. It is possible to identify certain areas that score lower on the accessibility index, this could disproportionately affect less mobile populations such as the elderly or those with disabilities. Including different modes of transportation (walking, cycling, public transit, and driving) in the index reflects the varied preferences and needs of park users. This can show which entry points are well-serviced

by multiple transportation modes and which are not, helping to identify areas where transportation infrastructure improvements could enhance accessibility.

The disparities highlighted by the composite accessibility index in Strandparken pose significant implications for climate justice, underscoring a pressing need for comprehensive and inclusive planning. Regarding this, analysing the accessibility index results alongside average income levels reveals a concerning trend: the 5 neighbourhoods with the lowest accessibility scores tend to fall within the lowest income brackets (Figure 25). This correlation suggests that the most economically vulnerable communities are disproportionately affected by limited access to Køge Bugt Strandpark. Such disparities highlight significant issues of climate justice, as these communities are deprived of the park's multiple benefits, which include not only recreational opportunities but also health advantages associated with access to green spaces.

The implications for climate justice are profound, this includes providing all community members, regardless of economic status, with the means to enjoy the park's ecosystem services—services that can offer considerable enhancements to the quality of life. Moreover, limited access for lower-income neighbourhoods could exacerbate existing health disparities, as these areas miss out on the psychological and physical health benefits that accessible natural spaces provide.

Effective measures to improve access could involve enhancing public transportation links to the park, improving infrastructure for pedestrians and cyclists, connecting public transportation to more areas of the park, and ensuring that facilities within the park are accessible to everyone, including those with disabilities. Such initiatives would help bridge the gap between different community segments, ensuring that the advantages of NbS reach all residents, particularly those in lower-income neighbourhoods.

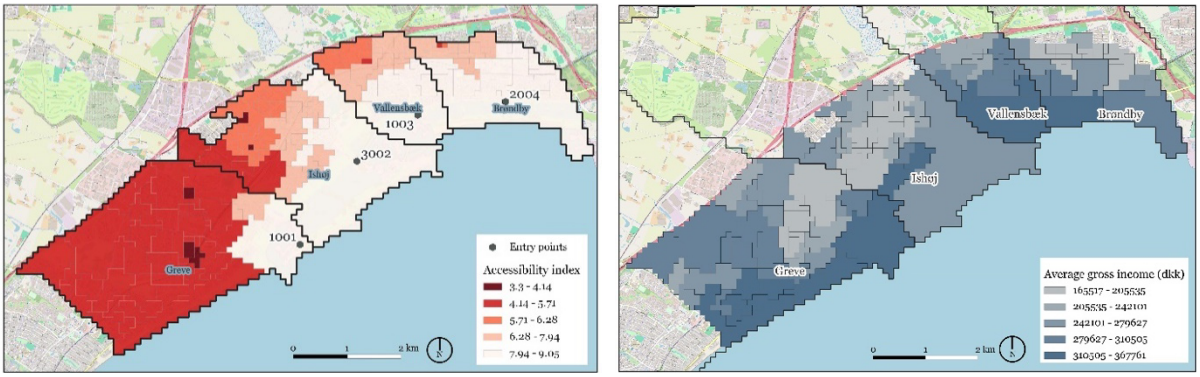


Figure 25. Visualisation of the Accessibility Index results map and Average gross income map. Source of base map: OSM

As Strandparken embarks on a modernisation initiative, the actions envisioned must be rigorously analysed to ensure that accessibility enhancements are a fundamental component. This focus is vital not only for rectifying current inequities in park access but also for harnessing the full potential of the NbS within the park's ecosystem.

Therefore, it is imperative that the modernisation plans for Strandparken meticulously integrate measures to improve access from all neighbourhoods, particularly those currently poorly served. This should include enhancements to multimodal transport links, the quality of entry points, and the internal circulation within the park to ensure that all visitors can enjoy the park's full range of benefits. Additionally, these plans should be developed through a participatory process, involving community stakeholders especially those from marginalised groups, to ensure that their needs and insights shape the future of Strandparken.

The three analysed planning documents, presented in the Analytical Framework (see Document analysis), set the foundation for understanding the broader vision for the modernisation of Koge Bay Strandparken. The documents highlight the importance of Strandparken as a recreational and coastal protection area, emphasising the need to adapt to changing outdoor life demands. In 2019, Strandparken's board started visioning work, which resulted in an identity and development plan and a vision plan. Strandparken's board finally approved the vision plan in December 2020. In 2021, city councils and municipal councils in Brøndby, Greve, Hvidovre, Ishøj and Vallensbæk approved the main principles in the prepared vision plan, as inspiration for more detailed planning for the modernisation of the beach park.

The list of documents analysed within this research included:

1. Strandparkens visionsplan – 2021 (STRANDPARKEN I/S, 2021) (see Annex 2);
2. Principaftale af 7. september 2022 om Køge Bugt Strandpark (Ministry of the Interior and Health, 2022) (see Annex 3);
3. Modernisering af Strandparken – Input til en anlægslov (Modernisation of Køge Bugt Strandpark, 2023) (see Anex 4).

The vision underlines the necessity to secure Strandparken's role in facilitating future needs, ensuring that it remains a vital space for outdoor activities and public enjoyment.

Three main focus areas related to the objectives of this work are:

- Enhancing accessibility - outlines principles aimed at enhancing public use and accessibility of the park.
- Making space for the population - ensuring that new measures continue to provide accessibility and encourage public use, so as many people as possible can benefit from the park's facilities and natural environment.
- Involvement - engaging with stakeholders to incorporate their input on nature conservation, wildlife protection, and accessibility, contributing to a well-rounded project that considers diverse needs and perspectives.

The 5 city councils and municipal councils in Brøndby, Greve, Hvidovre, Ishøj and Vallensbæk have entered into an agreement in principle with the Minister of the Interior and Housing on the framework for a new Construction act. The agreement entered into force on 7 September

2022 and was signed by the 5 mayors on 21 September 2022. The Modernisation of Koge Bay Beach Park (2023) document detail specific actions to be taken in line with the broader vision and the Agreement in Principle. These actions focus on futureproofing the beach park against climate change, modernising facilities, and improving physical accessibility.

The plan designates 23 development areas throughout Strandparken, divided into 7 themes:

A. Entrances to Strandparken and the water
B. Support points
C. Teaching and communication
D. THE ARKEN
E. Recreational construction in harbour basins
F. Extensive activities
G. Development of nature

The framework for the 23 areas in the plan must allow the municipalities to design concrete construction projects that can modernise Strandparken for the benefit of all. Moreover, the single municipalities are committed to developing coastal protection that considers individual and regional needs, adapting solutions over time to address rising sea levels and extreme weather events. This approach aligns with climate justice principles by ensuring that the beach park remains resilient and accessible to all communities, mitigating the disproportionate impact of climate change.

Efforts to maintain and enhance the connection between the beach park and surrounding urban areas are central to these plans. Specific actions include:

- Traffic Hubs - enhancing path connections to integrate traffic hubs and regional access points, promoting the use of public transport;
- Path Design - ensuring paths are accessible to all, including those with disabilities;
- Regional Connections - creating coherent path networks across municipal boundaries, fostering a seamless recreational area.

The annex to the modernisation plan further details the interventions envisioned for each theme, providing the connection with local municipal plans, and highlighting the quantities for each intervention.

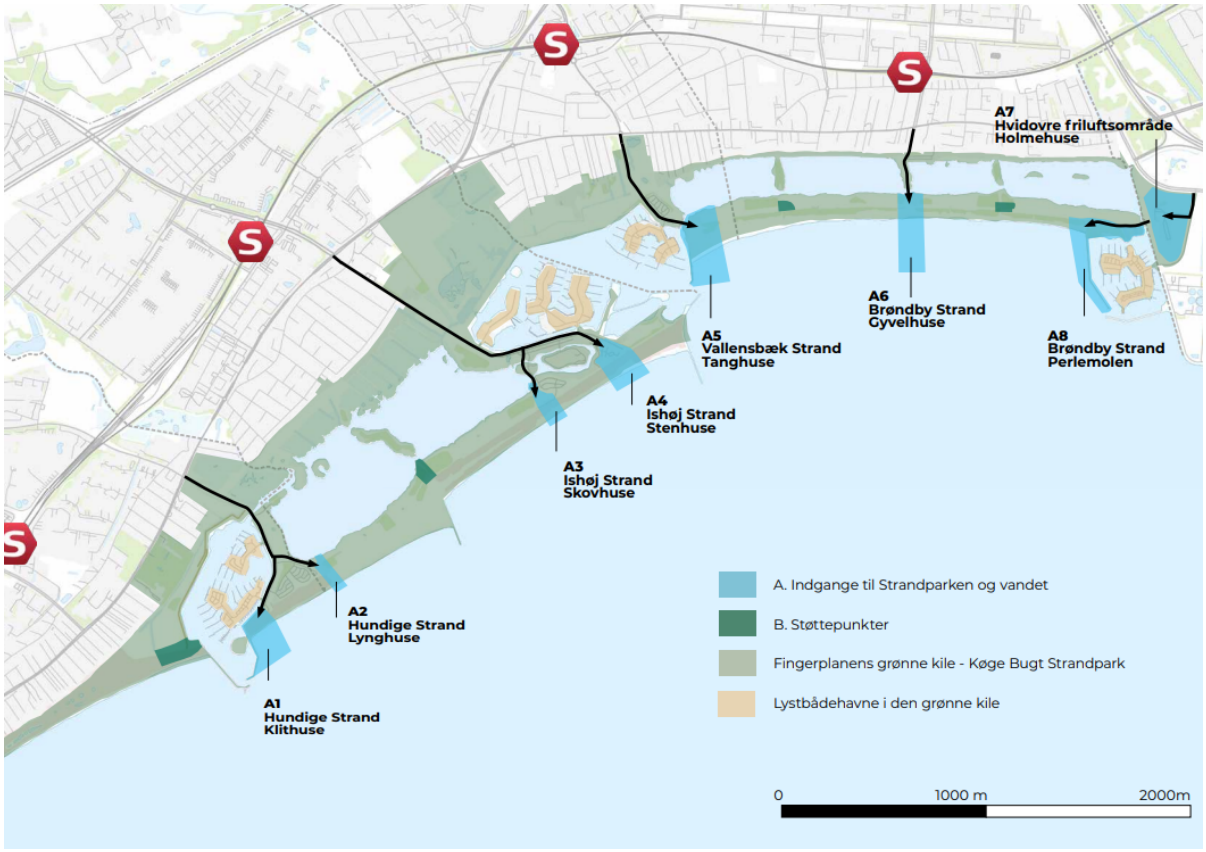


Figure 26. Map illustrating entrances to Strandparken and the water A1-A8. Translating the legend from top to bottom lables: A. Entrances to Strandparken and the water; B. Support points. Fingerplan's green points. Marinas and nearby areas. Source: Modernisation of Køge Bugt Strandpark (2023)

The modernisation plan (2023) includes 8 main entrances to Strandparken and the water (Figure 26), the following table (Table 12) summarises what has been mentioned within the current situation and desirable use in terms of accessibility.

Table 12. Description of entrances - current situation and vision for the future in terms of accessibility. Created by the authors, according to Modernisation of Køge Bugt Strandpark (2023)

No.	Name of the entrance point	Description of the current situation	Vision for the future
A1	Hundige Strand *Klithuse*	Two summer-open toilet buildings	The area is to be developed for a wider, recreational use with a café/restaurant, maritime shops, toilets etc.
A2	Hundige Strand *Lynghuse*	The area is adjacent to the large parking lot and serves as the primary descent to Hundige Strand. On the area today there are three toilet buildings, kiosk, and playground	As a meeting point with playground, toilets, kiosk
A3	Ishøj Strand *Skovhuse*	To the east of the area is a large parking lot, which borders a larger living area and summer open toilets	Expanded with new activities and facilities: year-round toilets, changing facilities, and cafe
A4	Ishøj Strand *Stenhuse*	There is a parking space nearby and summer-open toilets	Expanded with new activities and facilities: year-round toilets, changing facilities, and sauna

No.	Name of the entrance point	Description of the current situation	Vision for the future
A5	Vallensbæk Strand *Tanghuse*	The primary access to the area is from the parking lot in the north and down towards the beach. On the site are two buildings with toilets, a building with a café and a playground	Expanded with new activities and facilities: year-round toilets, changing facilities, and cafe
A6	Brøndby Strand *Gyvelhuse*	The primary access to the area is from the parking lot at Strandporten. On the site are three buildings with toilets, a building with a café and a playground	Expanded with new activities and facilities: year-round toilets, changing facilities, and café. Improve the accessibility for people with disabilities
A7	Hvidovre Friluftsområde *Holmehuse*	On the site there are two toilet buildings	Construction of a cycling and walking paths, year-round toilets
A8	Brøndby Strand *Perlemolen*	Nothing particular mentioned	Possibility of constructing public toilets and changing facilities

The eight Actions A are further defined in the annex of the Modernisation Plan. Here, specific details on the scope of each action, the provisions on nature protection and coastal protection indications are given.

Of the eight defined actions focusing on the entrance points to the park and water only one of them addresses the action of constructing a bike track as a vision for future development. The main focus while addressing the current situation is around the parking lots, toilets, changing stalls and improvement of the playground conditions. Overall, connection and improvement of other transportation options are not explored, clearly stating that accessibility by car is seen as a priority.

Figure 27. Vallensbæk Beach entry point described under the theme F. Source: Modernisation of Køge Bugt Strandpark (2023)

Under the theme F "Extensive activities" 4 actions are identified (Modernisation of Køge Bugt Strandpark, 2023). In this section of the plan, Vallensbæk Beach is described as an entry point (Figure 27) with good access to the area for pedestrians, cyclists, and cars via Vallensbęk

Havnevej and Tangstien. The description of this area identified by entry point 1003 in this research, aligns with the findings from the accessibility index.

As of today (May 2024), the modernisation plan has been submitted to the Planning and Rural District Agency and it is pending approval from the Danish Parliament in the fall of 2024 (Strandparken I/S, n.d.). Municipalities will then follow their process according to the law with municipal plans.

Despite the ambitious plans and clear intentions, the documents reveal gaps in providing concrete action for improvement in addressing physical accessibility comprehensively. While the broader vision and principles emphasise accessibility, specific actions sometimes lack detailed design implementation guidelines. For example, the description of entrances and paths occasionally mentions accessibility but does not always provide comprehensive strategies or feature for ensuring access for all users.

The focus on climate adaptation and coastal protection aligns well with climate justice principles. However, the documents could further emphasise equitable access to ensure that all community members, particularly those from marginalised groups, can benefit from the park's facilities.

The planning documents for Køge Bugt Strandpark present a strong vision for enhancing accessibility and resilience in the face of climate change. While the broad goals and principles are commendable, there is a need for more detailed and actionable plans to ensure that physical accessibility is thoroughly addressed. By critically examining and refining these plans, the project can better align with the principles of climate justice, ultimately creating a more inclusive and resilient recreational area for all.

The construction of the accessibility index and the subsequent analysis of Strandparken's modernisation plan provide critical insights into how accessibility challenges can precipitate injustices. Initially, the index synthesised various accessibility features of Strandparken, previously identified as potential challenges in the initial phase of the assessment (Accessibility Challenges in Køge Bugt Strandpark). This compilation provided a spatial depiction of how such challenges could engender disparities in park accessibility among different community groups.

The results from the index calculations highlighted that certain neighbourhoods in Greve and Ishøj face significant accessibility limitations to their nearest park access points. Notably, these neighbourhoods predominantly consist of lower-income groups, indicating that the residents who are already potentially vulnerable are further disadvantaged in terms of accessibility. Conversely, neighbourhoods in Vallensbæk displayed the highest potential for park accessibility, with most areas within this municipality registering high values on the accessibility index.

On the other side, the detailed examination of Strandparken's modernisation plans aimed to identify whether these plans address the resolution of the highlighted accessibility challenges. Unfortunately, the analysis revealed a considerable oversight in the plan's approach to enhancing physical connectivity between the park and adjacent residential areas. The primary objective of the modernisation plan is to transform Strandparken into an attractive recreational destination that draws visitors from across various municipalities. However, the plan lacks specific strategies to improve physical access from nearby neighbourhoods, neglecting the accessibility barriers identified in the previous analysis of this research.

This oversight suggests that the modernisation plan may inadvertently exacerbate existing vulnerabilities in accessing the park's benefits, further imbedding inequalities. Without deliberate efforts to integrate accessibility improvements, particularly for the more isolated and lower-income neighbourhoods, the modernisation of Strandparken risks perpetuating and potentially intensifying injustices in the fruition of the NbS' natural and recreational benefits.

Conclusions

Discussion

This research aims to investigate the role of accessibility in providing justice in climate adaptation projects that adopt Nature-based Solutions. As climate change is a global challenge that requires tailored solutions to match local needs, a case study was deployed to explore this particular research focus. Køge Bugt Strandpark provided a strong example to explore accessibility issues given its size, different uses and purposes that have constantly adapted to the changing needs since its creation in the 70s of the last century.
Findings from the literature review and this case study helped build an overview on these issues to answer the research question:

How can assessing the challenges related to accessibility contribute to promoting justice in Nature-based Solutions projects for climate adaptation?

The design of this research focused on selecting theories, methods and approaches that could provide a solid foundation to assess accessibility challenges. This was then translated into analysis elements that could detect patterns and practices that focused on delivering justice in a geographical context affected by the impacts of climate change.
At first, relevant studies were investigated to clearly understand how accessibility could be measured under the notion defined in the Conceptual Framework. Gravity-model theory based on a location-based approach operationalised with a Network analysis fits the purpose of this research project, whose first step required establishing a clear measurable link between accessibility and justice.
Accessibility in this context is linked to justice through the concept of equity, which involves the fair and just distribution of resources and opportunities. Equity ensures that all individuals, irrespective of socio-economic status, physical ability, or geographic location, have equal access to NbS benefits. This is essential in discussions about distributive justice, where equitable access to resources like those provided by NbS is a central concern. The operationalisation of equity in this research involves evaluating how accessible the NbS is to various community groups, including those who are physically disabled, economically disadvantaged, or geographically isolated. It looks at whether these groups can equally benefit from the park's amenities and natural resources, which are vital for enhancing community health, well-being, and resilience against climate impacts.
By establishing a clear connection between accessibility and justice through the lens of equity, the analysis shifted to identifying potential challenges in terms of accessibility in Køge Bugt Strandpark.

The challenges identified were based on data and observations gathered during the site visit to Køge Bugt Strandpark. The visit focused on assessing the characteristics of entry points and the distribution of facilities throughout the park. A crucial aspect of this process was the data processing phase, which involved transforming both qualitative and quantitative information into a detailed analysis. The analysis was conducted using various software tools, including QGIS and Excel, allowing for a comprehensive examination of the park's accessibility and facilities layout.

This analysis revealed disparities in the accessibility and conditions of facilities at different entry points. Focusing on selected entry points, a regression analysis between the shortest walking distances and the income levels of each neighbourhood demonstrated a correlation between distance variability and income disparities, suggesting potential inequalities in accessing the NbS. The regression analysis supported this finding showing coefficients from three out of four regressions with negative values, indicating that income levels decrease as distance to the park increases. Conversely, Area 1 exhibited a positive coefficient, though its impact was considered minimal due to its low R-squared value. Moreover, this area, part of the Greve, features neighbourhoods farther from Strandparken compared to those in the other three municipalities.

The analysis reveals that Strandparken, despite its diverse offerings, faces challenges in ensuring equitable access, particularly for wheelchair users. Some designated parking spots are available but are either poorly maintained or inconveniently located, impacting accessibility for individuals with mobility impairments. Furthermore, the distribution of facilities such as the Arken Museum and the camping site in Area 2 enhances its attractive value, but it creates an imbalanced situation compared to other park areas. Moreover, public transportation only serves Area 2, limiting access to other parts with other options than private transportation. This emphasises the disparity in access influenced by car ownership posing a threat to the reduction of GHG emissions.

The last phase of the research focused on investigating whether these challenges lead to potential injustices in Strandparken. The results provided by the accessibility index and the analysis of the planning documents documented a discrepancy between what is actually the situation in the park and the modernisation plan.

The accessibility index results revealed that few lower-income neighbourhoods in Greve and Ishøj experience notable challenges in accessing the closest park’s entry points, suggesting that these vulnerable communities face additional disadvantages. In contrast, Vallensbæk neighbourhoods showed the highest levels of park accessibility, reflecting a disparity in access across different socio-economic groups.

The creation of the accessibility index for this study was uniquely tailored to the specific characteristics observed in Køge Bugt Strandpark, without relying on predefined theoretical

frameworks or literature-derived elements of analysis. The list of facilities included in the index was comprehensive of the facilities included in Strandparken and did not include others that could of course have a positive effect on overall accessibility. This bespoke approach ensured that the index directly reflected the real-world conditions of Strandparken and nuances of the park as encountered during site visits. To ensure the correct relevancy, the parameters for the index were developed based on direct observations of the park's accessibility features, according to thresholds presented in the literature. This empirical method of parameter selection allowed for a grounded assessment of accessibility tailored to the park's actual conditions.

Consequently, the majority of the results from this index presented an "average" value, indicative of the park's general accessibility level. This average is a product of aggregating individual scores from various observed elements within the park, each weighted according to their impact on accessibility according to the literature's findings. This approach has the advantage of closely aligning the index with the specific accessibility challenges and opportunities within Strandparken, but it may also limit the comparability of the results with other studies that might use more standardised or theoretically driven metrics.

Further analysis of Strandparken's modernisation plan indicated a significant gap: the plans do not sufficiently address how to improve physical connections between the park and surrounding residential areas. Despite the goal of making Strandparken a major recreational attraction, the plans fail to include specific measures to enhance accessibility for nearby neighbourhoods, particularly those that are economically disadvantaged and geographically isolated. This neglect could worsen existing disparities, as the modernisation might benefit those who already have better access to the park, deepening the inequalities in enjoying the natural and recreational opportunities provided by the park.

The findings point to a crucial need for modernisation efforts to prioritise equitable access to ensure that all community members can share in the benefits of the park.

To address the research question of how assessing the challenges related to accessibility can contribute to promoting justice in NbS projects for climate adaptation, findings from the analysis of Køge Bay Strandparken are considerably relevant.

The research revealed substantial accessibility disparities, particularly affecting lower-income neighbourhoods in Greve and Ishøj, which face significant barriers to reaching park entry points. This analysis not only underscores the physical barriers but also highlights a broader issue of distributive justice—ensuring that NbS benefits are accessible to all, regardless of socio-economic status. The accessibility index developed during the research acted as a critical tool in quantifying these disparities. By providing a clear metric that integrates both the physical distance to park entry points and the quality of these access points, the index illuminated areas where interventions are needed. For instance, neighbourhoods in

Vallensbæk showed high accessibility scores, due to the pretty well-equipped entry point, also underscored in the modernisation plan that states area 3 as the most accessible one. This disparity points to a need for targeted strategies to enhance access in underserved areas, thereby promoting equity in the enjoyment of NbS.

Moreover, the analysis of Strandparken's modernisation plans revealed a significant oversight: despite having included citizens in the planning process, the plans lacked specific strategies to improve physical access from nearby economically disadvantaged and geographically isolated neighbourhoods. This gap in the planning process suggests a missed opportunity to use NbS as a tool for advancing procedural justice. By integrating community input and focusing on equitable access in the planning stages, projects can better ensure that NbS serve as a lever for social equity, addressing both environmental and socio-economic challenges concurrently.

Moreover, the modernisation plan for Strandparken is primarily designed to segment the park into distinct areas based on their respective uses, facilities, and recreational purposes. This approach aims to enhance the functionality and appeal of each area, tailoring recreational spaces to specific activities and uses. For example, one area will be developed with extensive children's play equipment, while another will focus on water sports or active spaces equipped with sports facilities. Such segmentation, while beneficial for catering to diverse visitor needs, risks creating spatial disparities in terms of access and enjoyment of the park's offerings, especially for those who live close to the area and use it as a primary source of connection to the green and nature.

In contrast to what is aimed by the plan, the overarching goal of this research and the accompanying accessibility study is to assess and promote a more balanced, equitable distribution of access and facilities across all four areas of Strandparken. This effort is grounded in the principles of distributive justice, which seeks to ensure that all community members, regardless of their socioeconomic status or physical abilities, have equal opportunities to benefit from the park's resources. The accessibility index developed as part of this study serves as a crucial tool in this endeavour, providing a detailed measure of how accessible each part of the park is for various population groups.

By focusing on distributive justice, the research aims to challenge and potentially reshape the planned segmentation in the modernisation plan. It advocates for a design philosophy that not only respects the unique character of each park area but also ensures that all segments are equally welcoming and accessible to everyone. This involves rethinking how facilities are distributed, ensuring that all areas have a mix of attractions and amenities that cater to a wide range of needs and preferences. The ultimate objective is to prevent any form of segregation that could lead to inequality in access and enjoyment, ensuring that the park's benefits are fairly shared among all visitors. This approach not only enhances the inclusivity of the park

but also aligns with broader urban planning goals of fostering cohesive, resilient communities through equitable public spaces.

In conclusion, by systematically assessing accessibility challenges and their implications on equity, researchers and planners can ensure that NbS projects like Strandparken do not merely enhance ecological and recreational benefits for a few but promote broad-based climate resilience and equity. This approach aligns with the principles of climate justice, ensuring that adaptation measures contribute to a fair and equal distribution of benefits and burdens, particularly for those who are most vulnerable to climate impacts. Therefore, assessing accessibility provides a first step in considering how the physical infrastructure directly affects the population's right to NbS enjoyment. Embedding justice in the framework of NbS projects, through accessing who has the right and equal opportunity to access them, is the first step in making them truly inclusive and effective in meeting the challenges of climate change adaptation.

This research recognises that accessibility alone does not guarantee justice; rather, it unveils potential risks of maladaptation when equal accessibility is not addressed that often lurk within various phases of project development. Adopting a critical realist perspective, this study endeavours to uncover deeper explanations which extend beyond mere observable events. The phenomenon observed during the first site visit —distinct population groups experiencing differential use of Strandparken— has been contextualised within a broader framework to find a possible explanation. This approach aims to elucidate underlying issues without assuming a comprehensive resolution of all problems associated with potential maladaptation.

By examining these deeper structural and contextual factors, the research seeks to reveal the complex interplay between accessibility, use, and equity, emphasising the importance of a nuanced understanding in addressing and mitigating issues of justice within NbS projects.

In fact, according to the critical realist view of the world, we must admit the existence of real entities, events, agents, and structures that interact in complex ways (Banai, 1995; Easton, 2010). For Banai (1995), this is the “integration of social and spatial systems”. Understanding how this integration requires delving into the critical realist ontology, which emphasises the complexity and layered nature of reality. As underscored by Bhaskar (1978), social structures, unlike natural structures, do not exist independently of the agents' conceptions of what they are doing in their activity. The concept of maladaptation in NbS for climate adaptation can be profoundly influenced by the properties of social structures as highlighted by Bhaskar (2013). His delineation of these structures underscores a fundamental aspect of climate change interventions: the entwined relationship between human activities and the overarching societal frameworks in which they operate (Bashkar, 2013). This relationship is essential for understanding the risks of maladaptation in implementing NbS.

The implementation of NbS and broader climate adaptation initiatives highlights the intricate link between human behaviour and climate change. Social practices, economic systems, and political decisions have a profound impact on the environment (Bashkar et al., 2010). This interconnectedness implies that changes in social structures can significantly affect communities, often in ways that are not uniformly experienced across different segments of the population.

Incorporating a justice perspective is crucial in ensuring that the impacts of climate adaptation strategies, including NbS, do not disproportionately burden or benefit specific groups. Given the varied vulnerabilities to climate change, which depend on both geographical and societal contexts, it is essential to tailor adaptation strategies to meet the distinct needs of different societal groups.

While Strandparken NbS effectively[5] safeguard the coastline from storm surges and floodings, the additional benefits it provides, such as recreational spaces and ecosystem services, are not equitably accessible to all. This disparity in accessibility can lead to uneven distribution of these benefits, underscoring the importance of integrating justice into the planning and implementation of such projects to ensure fair access for all community members.

Climate change adaptation planning must prioritise understanding the relationship between climate change and equity. It is crucial to recognise how different individuals and communities experience varying levels of exposure to climate impacts, influenced by factors like income, education, race, gender, age, and disability (Swanson, 2021). This understanding is fundamental to ensuring that adaptation strategies are equitable and inclusive. Therefore, addressing accessibility issues is not just a matter of urban planning but also a crucial aspect of achieving broader climate justice goals. Ensuring that environmental benefits are shared equitably across different socio-economic groups aligns with principles of distributive and recognitional justice, which demand that benefits and burdens be allocated in a fair and just manner.

In this context, the EU Horizon-funded project Regions4Climate provides a promising space for further implementation in the context of justice for the region part of the project. Koge Bay is one of the 12 regions that will plan and implement real climate-resilient innovations that will be created by and for people in response to the EU mission Adaptation to Climate Change. Strong pillar of this project is the creation of a Just Transition framework. This is intended to provide context for the integration of human needs while unlocking talent within regional

[5] This research does not investigate the actual capability of the NbS storm surge protection under the current nor the future climate scenarios. It is recognised that, at present time, the Strandparken modernisation plan includes actions aimed at raising the level of the dikes to further protect the coastline. It is therefore assumed that this function (flood protection) is well-addressed and covered by planning authorities.

planning and development strategies (Regions4Climate, 2023). Implementing these strategies induces co-creation processes that support equitable and accessible urban development where all citizens are equally able to contribute (Regions4Climate, 2023).

The project will identify social inequalities and the most vulnerable groups within its demo regions, and map how different adaptation measures might disproportionately affect vulnerable groups to prevent such adverse impacts (Regions4Climate, 2023). This will be achieved through robust assessment frameworks paired with structured stakeholder engagement and policy evaluations will highlight the existing local adaptation capacity and its inherent vulnerabilities (Regions4Climate, 2023). These insights and data will contribute to the creation of full-scale technological and social innovation solutions, in line with the Paris Agreement and the European Climate Law.

In Køge Bay, Regions4Climate will communicate about the impacts of climate change through immersive virtual and augmented reality visualisation tools, build social and health resilience plans adapted to dynamic coastal changes, and provide business models for multifunctional coastal landscapes. Ideally, this will provide an opportunity, facilitated by the congregation of several stakeholders, for the inclusion of the concept of accessibility in the development of Strandparken (Regions4Climate, 2023).

These possibilities and inspiring new conceptions of justice within the application of NbS for climate resilience assume longer implementation times, vaster resources, and competencies. Therefore, in the realm of the five-month research, the methodology applied, data availability and findings obtained encountered some limitations.

Firstly, data availability posed some limitations in terms of the completeness of results interpretation and versatility. When performing network analysis, the main purpose is to measure the distance between origin and destination points. Since the objective of this research was to assess accessibility and investigate inequalities between different residential areas and their access to the park, data at the neighbourhood level was necessary. After an intensive search, Nabolags Atlas was identified as the only source providing various demographic data at a smaller scale than, for example, postal codes, which in some cases cover the entire area of a municipality.

Among the datasets available to quantify vulnerabilities, average gross income was the only one representing the entire population within specific neighbourhoods and aligning with the principles of justice, where evaluation based on income level is relevant in terms of recognising marginalised groups and their opportunities. Nabolags Atlas also provided data on age, but this dataset lacked an important distribution unit relevant to this research objective—particularly, people older than 69. According to the literature, people older than 65 years are the most vulnerable to the challenges posed by climate change and the most likely to be affected by inequalities in opportunity distribution (IPCC, 2023; EEA, n.d.).

In this case, using data on average gross income allowed to perform a linear regression to detect if there was a correlation between income levels and walking distance to the nearest entry point of the park. While average gross income can be useful in many analyses, it contains several limitations that might make it less suitable for certain research focuses. For example, this dataset provides a single figure representing the mean income across a population but does not capture the distribution of income, such as how many people fall into each income bracket or the range between the lowest and highest incomes (Testbook, 2023). This would be a critical limitation if the authors had chosen to apply a people-based measure for accessibility assessment, as detailed data at the individual level would be needed.

Furthermore, having additional data at the same resolution on factors like car ownership, unemployment, age, ethnicity, and disability would have allowed to build a more comprehensive index. This, in turn, would enable the deception of results that encompass more facets of vulnerability in terms of climate justice and accessibility.

The authors opted to evaluate public transportation accessibility by simply checking the presence of a bus stop rather than calculating actual travel times, due to the complexity involved in such computations. The park's accessibility is limited to one entry point reachable by bus, complicating the assessment as it would involve analysing various routes and walking segments. The only tool available for such an assessment was Google Maps, which provides trip durations and breakdowns according to selected times and days. Considering the extensive effort and the peripheral relevance of detailed transportation analysis to the core study objectives, the authors decided against undertaking this time-consuming task. A detailed examination of travel times and route combinations could provide invaluable insights into the fairness of the transportation network. By evaluating the travel times for each neighbourhood to access point 3002 using public transportation, researchers could discern disparities based on the mode of trip involved. For instance, if two neighbourhoods exhibit the same travel time to the park via public transport, but one journey consists solely of a bus ride while the other includes a combination of bus rides and walking segments, the neighbourhood with the direct bus route should be considered to have better accessibility. Achieving this level of detail in the analysis could significantly enhance the contribution of public transportation accessibility to the overall accessibility index, providing a more nuanced understanding of equitable access across different neighbourhoods.

Secondly, language posed a further barrier to the interpretation of the results. The three planning documents analysed, as part of answering the third sub-research question, were originally published in Danish. Since the authors are not proficient in Danish, this posed a barrier to fully accurately interpreting the findings. The documents were translated using Google Translate, which can be considered a reliable tool, but there is still a possibility that some words were not translated with their exact original meaning. The authors were aware of

this limitation and took necessary actions to prevent misrepresentation of the results: (1) the translated text within the document analysis was double-checked using the information provided on the Strandparken and municipal website; (2) the research being part of the Just Adaptation lab also helped minimise this limitation, as parts requiring more clarification were discussed and confirmed with other lab participants during monthly meetings and two observation slots.

Additionally, conducting interviews with representatives from the municipalities or other experts directly involved in the modernisation process would have helped validate the proposed assumptions. However, given the time constraints and the already complex structure of the research, it was not feasible to include this method of data collection and validation.

As previously mentioned, this research included three observation site visits. While the activities during these site visits were generally the same, the objectives differed. The main difference between the first and last observation slots was the season of the year (1st slot was organised at the end of February, whereas the 3rd one was at the end of May), which allowed the authors to observe seasonal differences in how people use the area and to see a more diverse demographics.

This seasonal variation is significant because it highlighted potential accessibility challenges and initiated a deeper investigation. During the first observation slot, the authors noticed considerable demographic differences—not only in age but also in ethnicity—between Strandparken "population" and the Ishøj central station area one. However, in the summer season, during the third observation, this difference in demographics between the park's users and the central station area was not that evident and it can only be assumed that it has been affected by the change in temperature. This means that while season and temperature can be considered as a significant factor, influencing which social groups use the area and how they use it, they are certainly not the only ones that describe the accessibility. It therefore raises questions about other, deeper structural issues that could potentially affect this variation in demographics.

In addition, it was observed that the majority of people access the park by car, which, according to the literature, is not the most affordable way of travel (EU Urban Mobility Observatory, 2022). It can be assumed, overall, the accessibility layout of the park is very car-centric. This assumption is also supported by the results from the analysis of the planning documents. In the Modernisation Plan, under Topic A, 5 of the 8 entrances to Strandparken and the water were characterised by nearby parking spaces, highlighting a strong reliance on car access.

Continuing the discussion on the results from the observation slots, it is important to note that during all three site visits, the authors did not observe any people with disabilities using the

park. This is a critical indicator that highlights the need for further investigation into the accessibility to Strandparken and who has the opportunity to go there and further access the area.

This is supported by both municipal planning documents and guidelines developed by independent organisations. Firstly, the Modernisation of Køge Bugt Strandpark (2023) and the Strandparken's vision plan (2021) both emphasise the importance of ensuring accessibility for people with disabilities. The majority of actions planned (including the construction of new buildings and facilities) include the aspect of accessibility in terms of disabilities. Additionally, the working group *"Plads til alle"* (Space for Everyone) has developed guidelines specifically for Køge Bugt Strandpark (Plads til alle, 2022). Their catalogue of ideas contains proposals for general principles on where and how accessibility for people with disabilities can be integrated into both existing and new facilities. All of this mentioned above clearly indicates that there are potential users among this social group who feel the need to gain a securer and more feasible access to Strandparken.

However, the findings suggest that accessibility challenges for people with disabilities are broader than initially considered. As mentioned in the results section, only one entry point (3002) is accessible by public transport, and the bus stops are currently not designed to facilitate, for example, wheelchairs. Moreover, only one entry point (1002) has parking with a designated spot for people with disabilities close enough to access the water. All of this mentioned is even more critical, given the fact, that this social group is well protected by the law. These findings underline the need for a more in-depth investigation into micro-physical accessibility at Strandparken. Ensuring that all entry points and transportation options are accessible is crucial for inclusive use of the park.

During the last observation, it was noticed that the whole park area lacks bike racks. People were using other elements such as benches, informative stands etc. to place their bikes (see Figure 28), creating walking barriers and impedances.

Figure 28. People placing their bikes against information stands, bins and benches. Strandparken, May, 2024. (Photo taken by the authors)

Regardless of this absence, biking was still recorded as one of the most popular activities users were conducting. When it comes to biking to the park to access the beach, using the picnic areas, or playing sports etc, the presence of bike racks could encourage the use of this climate-friendly transportation option, eliminating the risk of creating possible walking hazards.

In terms of the accessibility concept proposed within this research, addressing this issue could enhance the overall inclusivity and usability of the park. This change would support the objectives outlined in the Modernisation Plan, which emphasises the importance of ensuring accessibility for all visitors, including those who use alternative modes of transport.

To conclude this part of the discussion, it is important to highlight Køge Bugt Strandpark primary role. This means that the park not only offers green space, social and ecological benefits but it provides an enjoyable access to the water. This emphasises an even greater need for further accessibility investigations. From a justice perspective, the park embodies the principle of supporting the right to access water, which is a crucial aspect not only from climate but also from environmental justice perspective. Ensuring that all individuals, regardless of their socio-economic status or physical abilities can easily reach and enjoy the water.

In the planning documents, improvements in accessibility are envisioned at both the micro and macro levels. At the micro-level, the plan includes the construction of new paths within the park area aimed at connecting all the bordering municipalities. At the macro-level, the vision is to integrate traffic hubs and regional access points to promote the use of public transport (Modernisation of Køge Bugt Strandpark, 2023). However, the plans fall short of addressing how to effectively link these two scales. Specifically, there is no mention of actions

to provide the principle of "last mile", connecting these possibly new regional traffic hubs and the park. This also leads to assumptions that the focus within these actions is more on those who already use the park regularly or thinking of the potential for tourism attraction, rather than focusing on other social groups and their needs for more equal access opportunities. Bridging this gap is essential to ensure equity and encourage the use of sustainable transport options for all Koge Bay Strandparken visitors.

Concluding the discussion on the findings of this research, emphasis must be placed on the concept of accessibility and its significant influence on the focus and goals of this research. Insights from the literature review, augmented by discussions with peers and professors, highlighted the varied interpretations of accessibility. This focus on accessibility in relation to the benefits of NbS emerged from direct observations within the case study and was further substantiated by the literature. In exploring such a broad concept that intersects various academic disciplines, it is crucial to pinpoint the specific elements or features that the study aims to illuminate. Accessibility is recognised as a crucial factor in delivering justice and is inherently a concept relative to spatial planning and justice. By clarifying the understanding of accessibility within this research, it is possible to open up opportunities to integrate this concept into broader research agendas, aiming to enhance climate adaptation and resilience strategies. This approach not only deepens the understanding of accessibility's role but also fosters a comprehensive framework for future studies to build upon.

Promoting Justice by Ensuring Accessibility

This research examined physical accessibility as part of the broader issues of promoting climate justice, specifically addressing climate adaptation efforts in projects adopting NbS. In recent decades, NbS have been widely used in adaptation efforts, mainly because of its dual role in protecting and restoring the environment while providing additional benefits to society. However, the potential for NbS to be unequally beneficial for different population groups is often overlooked, which may lead to unintended increases in vulnerability. The literature review underscores the significance of public green spaces that prioritise easy accessibility for various activities like walking, cycling and recreation. Such approach enhances mobility and improves access to vital services, especially for marginalised communities. However, to fully tackle these benefits, there is a need for the definitions of how accessibility is understood given different contexts.

The selection of Køge Bugt Strandpark as the case study within the Just Adaptation Lab offers a rich opportunity for assessing accessibility. Its dual function as both a coastal protection and recreation area makes it a compelling site, particularly given the ongoing modernisation efforts. Moreover, the park's strategic location and its role in serving the diverse communities of surrounding municipalities, each with a unique demographic, provide a solid foundation for this research objectives.

In this study, two theories—critical realism and climate justice—were chosen to provide a shared worldview that supports the decisions underlying the chosen approach to problem-solving and data analysis. A critical realist approach offered an opportunity to understand and address the climate crisis by emphasising the contribution of a changing and developing society. It revealed that an objective reality exists independent of human thoughts and beliefs. Moreover, that reality can be discovered and understood through multiple lenses, using different scientific methods. On the other hand, climate justice highlighted the importance of identifying and addressing the needs of vulnerable populations, given that it is becoming a central issue and discourse on climate change-related challenges worldwide. Adaption to climate change from a justice lens recognises past and current disadvantages in society, identifies the potential unequal distribution of climate impacts, calls for inclusive processes in all planning stages and adds the dimension of restoring past inequalities. Both selected theories emphasised the need for diverse knowledge and approaches to address the challenges posed.

The Conceptual Framework provided a structured way to connect theory and the various components of accessibility, ensuring that the research was grounded in established theory

while addressing the specific context of Køge Bugt Strandpark. It also conceptualised how accessibility is understood in this study and provided a link to equity, guiding the selection of relevant elements based on the literature review and site visit results.

The analytical framework provided a clear explanation of how each method was applied according to the sub-research questions and ultimately led to the answer to the main research question. This framework highlighted the coherent approach adopted throughout the research, integrating principles of critical realism and climate justice and highlighting the interconnections between the various dimensions of accessibility, eventually guiding the analysis and interpretation of results.

The findings underscored the necessity of integrating spatial and statistical analysis methods to measure the connection between accessibility and justice effectively. By incorporating this approach, it allowed for the quantification of access disparities and the identification of factors contributing to inequities within NbS projects. Through this integration, the results provided a comprehensive methodology for assessing accessibility and justice concerns.

The results further focused on addressing the existing accessibility challenges faced by Køge Bugt Strandpark by analysing access from 4 (of the 14 initially identified) entry points to the surrounding areas. Using network analysis and linear regression, the study found negative correlations between income level and walking distance to entry points, indicating possible differences in accessibility influenced by geographic and socioeconomic factors. Although the correlations varied across areas, the analysis revealed insights into how income distribution can affect access to different entry points.

The analysis of accessibility challenges in Køge Bugt Strandpark revealed a concerning trend of inequity, particularly evident in the disproportionate impact on the lower-income neighbourhoods of Greve (where the lowest value of 3.3 was observed) and Ishøj. The highest values on the index, those above 8, were mostly identified in neighbourhoods located close to the park, especially in Brøndby. The composite index highlighted significant limitations in accessibility to park access points for lower-income groups, underscoring the need for further investigation to address inequities. Further, despite the modernisation plan's aim to enhance the park's recreational appeal, the oversight in addressing accessibility challenges suggests a critical gap that must be filled to ensure equal access for all residents.

Assessing accessibility challenges within NbS projects for climate adaptation is critical to promoting justice across multiple spheres. By identifying and addressing accessibility challenges, it is possible to ensure that marginalised communities have equal access to the benefits of NbS, such as improved resilience and well-being. Furthermore, understanding the intersection of accessibility and justice highlights broader societal inequities, underscoring the need for an inclusive and participatory approach to climate adaptation planning. Ultimately,

prioritising accessibility has the potential not only to improve the effectiveness of NbS interventions but also to promote a more resilient society in the face of climate change.

Further Research

To better understand the implications of the research results, future studies could address more extensive and complete deployment of the accessibility index. As data availability was identified as one of the research barriers, obtaining new data on accessibility features could enhance index results. This can include characteristics of the quality of the paths, deeper investigation within the network analysis by assessing public transportation connections travel costs and time, analysis of the barriers (fences or steps) or facilitation on the walking paths (for example crossing section hearing aids), weighting of the results based on neighbourhoods' car ownership, accounting of the parking slots availability, number of bus passages for each stop.

Moreover, obtaining more data on demographic characteristics could better exemplify the addressed vulnerabilities. This would include connecting the index results to more data than simply the average gross income. Data on age groups, employment conditions, car ownership, ethnicity groups, or physical disabilities if available could create a more comprehensive view of the area vulnerabilities. This could be achieved through a close partnership with statistical institutions in Denmark or by directly contacting the researchers who worked on the Nabolags Atlas project. Doing so could guide urban planners involved in the modernisation plan for Strandparken in understanding which areas of the surrounding neighbourhoods are more vulnerable and therefore should be more included in the planning and modernisation process. As the modernisation efforts focus now on creating new facilities and recreation opportunities, these could be tailored to address vulnerable population needs and ensure their full enjoyment. Furthermore, the index could be integrated into the park analysis on accessibility to help understand which are the most accessible and to who, to underline which areas may need more attention or development to boost visitor numbers.

For further future studies, conducting interviews with municipal representatives and citizens could help support the findings obtained in this research. Firstly, interviews with municipal experts would validate the assumptions the authors proposed after analysing the planning documents. This would provide more in-depth insights into specific actions, as the Modernisation Plan describes them in relatively broad terms. According to the plan and to the Construction Act mentioned within it, detailed actions are to be set out in plans developed by each of the five municipalities. Interviews could reveal whether there are any intentions to provide more public transportation stops directly adjacent to the park and if they will be upgraded to accommodate people with disabilities. Furthermore, while the Modernisation Plan does not mention the implementation of bike racks, municipalities might have already identified this issue and plan to address it separately.

Additionally, conducting interviews with municipal representatives could provide insights into whether the concept of justice is integrated into their everyday work, not just regarding Strandparken, and how this reflects in the efforts of modernisation. Finally, it would allow the validation of the accessibility index constructed in this research and provide feedback on its usability for future municipal work. This feedback could be crucial for refining the index and ensuring its practical application in improving accessibility and promoting justice in urban planning.

Secondly, the results of this research could be further supplemented with interviews of both park users and residents from surrounding neighbourhoods. Interviews with park users could help understand how they access the NbS, how frequently they visit it, and any challenges they face in doing so. In addition, interviews conducted with residents in areas located further from the park would help identify reasons for lower park usage and the specific accessibility challenges they might encounter.

This aligns with the focus of the PhD research, using participant observations as the main data collection method to gather insights on climate justice. Site visits, in fact, focused on observations and users interviews that were conducted by other collaborators in Danish. Participants were asked about their usual mode of transportation to Strandparken and demographic information. The findings from the PhD study could help validate the results of this research. For instance, understanding who is getting to the park by car could explain lower values for the accessibility index and/or further distances from the park. Contrarily, it could highlight other issues that might drive the choice of reaching the park in a more climate-friendly way.

By conducting interviews with citizens, it would be possible to gain a more comprehensive understanding of the accessibility issues faced by different groups within the case study. This would also offer practical feedback for improving the accessibility index developed in this research and ensure that future efforts to enhance park access are both inclusive and effective.

This research also opened the discussion about the right to access water (intended as an opportunity to reach the coastline and enjoy it). For further research, the same methodological approach, with some minor improvements within the categories of the accessibility index, could be applied. In this case, other entry points closer to the beach area, those located in the dunes, would be used. This perspective would allow further investigation not only into how the core dimensions of climate justice are addressed but also bringing environmental justice into the discussion. Environmental justice addresses the fair distribution of environmental benefits and burdens, ensuring that all communities have equal access to natural resources (in this case water) and are not disproportionately affected by environmental hazards (in this case storm surges as an example).

This is particularly important given the characteristics of NbS, whose function is to provide multiple co-benefits. In this specific case, as the authorities have chosen to use NbS as a climate adaptation tool, further investigation is suggested to ensure that all benefits are delivered equitably. By examining how accessibility to beach areas aligns with the principles of justice, authorities can better understand and address potential disparities, ensuring that NbS effectively contributes to both climate adaptation and broader social equity goals.

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Appendices

Appendix 1. Entry point 1001 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">1001</td><td>Site map</td></tr>
<tr><td colspan="4">Pictures</td><td rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="5">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1375836.9</td><td colspan="2">Long 7478067.6</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Easy Access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td>(By car)</td></tr>
<tr><td>32 min</td><td>~~min~~</td><td>8 min</td><td>(5 min)</td></tr>
<tr><td>Hundige</td><td colspan="3"></td></tr>
<tr><td>Additional information</td><td colspan="4">Two parking lots with high capacity, none specified low ability parking spots. Next to the Greve marina club.</td></tr>
</table>

Appendix 2. Entry point 1002 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">1002</td><td colspan="2">Site map</td></tr>
<tr><td colspan="4">Pictures</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td colspan="4">1.  2.  3.  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1378658</td><td colspan="3">Long 7480217</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4">Arken Museum</td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>By bus</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>29 min</td><td>10 min</td><td>9 min</td><td colspan="2">(6 min)</td></tr>
<tr><td>Ishoj</td><td colspan="5"></td></tr>
<tr><td>Additional information</td><td colspan="5">Big parking lot that serves the Arken Museum too. Three low ability parking lots with closer access to the beach. The area has a big playground, a cafe’ and toilets.</td></tr>
</table>

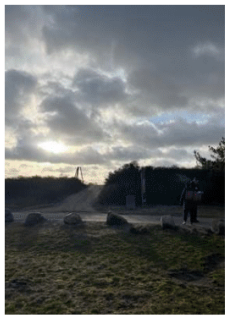
Appendix 3. Entry point 1003 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">1003</td><td colspan="2">Site map</td></tr>
<tr><td colspan="4">Pictures</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1379895</td><td colspan="3">Long 7482126</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Easy access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4">Vallensbæk Havn</td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>18 min</td><td>~~min~~</td><td>4 min</td><td colspan="2">(5 min)</td></tr>
<tr><td>Additional information</td><td colspan="5"></td></tr>
</table>

Appendix 4. Entry point 1004 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">1004</td><td colspan="2" rowspan="2">Site map</td></tr>
<tr><td colspan="4">Pictures</td></tr>
<tr><td>1.
  </td><td colspan="2">2.
  </td><td>3.
  </td><td colspan="2">  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1382778</td><td colspan="3">Long 7481917</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>11 min</td><td>~~min~~</td><td>4 min</td><td colspan="2">(2 min)</td></tr>
<tr><td>Brøndby Strand</td><td colspan="4"></td></tr>
<tr><td>Additional information</td><td colspan="5">This entry point connects with the parking lot (id#2004) by a quite curved bridge that makes it hard to access this area by wheelchair.</td></tr>
</table>

Appendix 5. Entry point 2001 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">2001</td><td>Site map</td></tr>
<tr><td colspan="3">Pictures</td><td rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="5">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1376179</td><td colspan="2">Long 7478175</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Easy access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Distance from train station</td><td>By foot</td><td><s>By bus</s></td><td>By bike</td><td>(By car)</td></tr>
<tr><td>Hundige</td><td>32 min</td><td><s>min</s></td><td>9 min</td><td>(6 min)</td></tr>
<tr><td>Additional information</td><td colspan="4">The access to the main path is quite large at this point but there is no designed area for cars to stop, making it hard for wheelchairs to easily get here.</td></tr>
</table>

Appendix 6. Entry point 2002 factsheet

Entry point id	2002		Site map	
Pictures				
1. 	2. 	3. 		
Description				
Location (coordinates)	Lat 1379895		Long 7482126	
Entry	Foot	Bike	Car (parking lot)	Bus (bus stop)
	Other			
Conditions	Accessible by wheelchair	Easy access to the beach	Gravel-paved	Concrete-paved
Nearby facilities	Toilet	Playground	Cafe'	Beach stall
	Other	Vallensbæk Havn		
Distance from train station	By foot	~~By bus~~	By bike	(By car)
Ishoj	18 min	~~min~~	4 min	(5 min)
Additional information				

Appendix 7. Entry point 2003 factsheet

<table>
<tr><td>Entry point id</td><td colspan="2">2003</td><td colspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="5">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1380328</td><td colspan="2">Long 7481802</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td>(By car)</td></tr>
<tr><td>21 min</td><td>~~min~~</td><td>5 min</td><td>(5 min)</td></tr>
<tr><td>Vallensbæk</td><td></td><td></td><td></td></tr>
<tr><td>Additional information</td><td colspan="4"></td></tr>
</table>

Appendix 8. Entry point 2004 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">2004</td><td colspan="2" rowspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures</td></tr>
<tr><td colspan="3">1.  2.  3.  </td><td colspan="2">  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1382790</td><td colspan="3">Long 7482420</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4">Electric car charging station</td></tr>
<tr><td rowspan="2">Distance from train station
Brøndby Strand</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>7 min</td><td>~~min~~</td><td>3 min</td><td colspan="2">(2 min)</td></tr>
<tr><td>Additional information</td><td colspan="5"></td></tr>
</table>

Appendix 9. Entry point 3001 factsheet

<table>
<tr><td>Entry point id</td><td colspan="2">3001</td><td colspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="5">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1377465</td><td colspan="2">Long 7479226</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Distance from train station
Ishoj</td><td>By foot
29 min</td><td>~~By bus~~
~~min~~</td><td>By bike
7 min</td><td>(By car)
(min)</td></tr>
<tr><td>Additional information</td><td colspan="4"></td></tr>
</table>

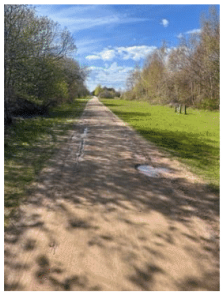
Appendix 10. Entry point 3002 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">3002</td><td colspan="2">Site map</td></tr>
<tr><td colspan="4">Pictures</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1377834</td><td colspan="3">Long 7480708</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>By bus</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>20 min</td><td>11 min</td><td>7 min</td><td colspan="2">(min)</td></tr>
<tr><td>Ishoj</td><td colspan="5"></td></tr>
<tr><td>Additional information</td><td colspan="5"></td></tr>
</table>

Appendix 11. Entry point 3003 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">3003</td><td colspan="2" rowspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures</td></tr>
<tr><td>1.
  </td><td>2.
  </td><td>3.
  </td><td colspan="2">  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1381394</td><td colspan="3">Long 7482046</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td>Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td>Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td>Beach stall</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>~~By bus~~</td><td>By bike</td><td>(By car)</td></tr>
<tr><td>20 min</td><td>~~min~~</td><td>6 min</td><td>(min)</td></tr>
<tr><td>Brøndby Strand</td><td colspan="4"></td></tr>
<tr><td>Additional information</td><td colspan="4"></td></tr>
</table>

Appendix 12. Entry point 3004 factsheet

Entry point id	3004		Site map	
Pictures				
1. 	2. 	3. 		
Description				
Location (coordinates)	Lat 1383781		Long 7481813	
Entry	Foot	Bike	Car (parking lot)	Bus (bus stop)
	Other			
Conditions	Accessible by wheelchair	Direct/Easy Access to the beach	Gravel-paved	Concrete-paved
Nearby facilities	Toilet	Playground	Cafe'	Beach stall
	Other			
Distance from train station	By foot	~~By bus~~	By bike	(By car)
	18 min	~~min~~	5 min	(min)
Brøndby Strand				
Additional information				

Appendix 13. Entry point 4004 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">4004</td><td colspan="2" rowspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures</td></tr>
<tr><td>1.
  </td><td colspan="2">2.
  </td><td>3.
  </td><td colspan="2">  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1385295</td><td colspan="3">Long 7481564</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4">Kayak and Marina Club</td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>By bus</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>29 min</td><td>min</td><td>7 min</td><td colspan="2">(min)</td></tr>
<tr><td>Brøndby Strand</td><td colspan="5"></td></tr>
<tr><td>Additional information</td><td colspan="5">There is a big parking lot in the nearby of the entry point, but it is outside the Strandparken area.</td></tr>
</table>

Appendix 14. Entry point 5004 factsheet

<table>
<tr><td>Entry point id</td><td colspan="3">5004</td><td colspan="2" rowspan="2">Site map</td></tr>
<tr><td colspan="3">Pictures
1.
 
2.
 
3.
  </td><td colspan="2">  </td></tr>
<tr><td colspan="6">Description</td></tr>
<tr><td>Location (coordinates)</td><td colspan="2">Lat 1385225</td><td colspan="3">Long 7482194</td></tr>
<tr><td rowspan="2">Entry</td><td>Foot</td><td>Bike</td><td>Car (parking lot)</td><td colspan="2">Bus (bus stop)</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td>Conditions</td><td>Accessible by wheelchair</td><td>Direct/Easy Access to the beach</td><td>Gravel-paved</td><td colspan="2">Concrete-paved</td></tr>
<tr><td rowspan="2">Nearby facilities</td><td>Toilet</td><td>Playground</td><td>Cafe’</td><td colspan="2">Beach stall</td></tr>
<tr><td>Other</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Distance from train station</td><td>By foot</td><td>By bus</td><td>By bike</td><td colspan="2">(By car)</td></tr>
<tr><td>25 min</td><td>min</td><td>6 min</td><td colspan="2">(min)</td></tr>
<tr><td>Brøndby Strand</td><td colspan="5"></td></tr>
<tr><td>Additional information</td><td colspan="5"></td></tr>
</table>

Questo è il traguardo di un percorso fatto di tante tappe. Città nuove che ho chiamato case, luoghi selvaggi che sono diventati rifugi, persone che parlano lingue sconosciute che sono diventate nuove famiglie.
Grazie innanzitutto alla persona che ha trasformato la fredda Riga in una calda casa per me. Grazie perchè in questi due anni di dubbi, preoccupazioni, ricerche, viaggi, tempeste (emotive e non), la tua amicizia è diventata una certezza su cui posso fare affidamento. Grazie ai nostri caratteri così diversi che insieme funzionano così bene. E grazie per aver donato a me, a questi mesi e a questo progetto tutta la tua bravura, pazienza e forza di volontà che hai dimostrato.
Grazie alla mia Biellese. Sei la mia aurora boreale personale. Al caro amico di Oslo, che è stato al mio fianco da Lisbona fino alle terre danesi. Grazie alla mia compagna di nuoto del cuore, per aver sempre trovato il tempo da dedicarmi nelle mie sporadiche comparse a Torino, incrastrando la tua vita nella mia. Grazie alla mia acquisita sorella a Malaga, all'affetto che mi dimostri e al tuo coraggio nell'affrontare le difficoltà della vita. Grazie allə miə amə del Contrin che mi hanno condotto alle vette più alte. Grazie ai miei cuori americani, lontani nello spazio ma sempre vicini al mio cuore. Grazie a Badehusvej 12, a chi mi ci ha fatta arrivare e a chi mi ci ha fatta rimanere a suon di patate al forno e pierogi. Gracias al valenciano per aver reso tante cose della mia nuova vita più leggere. Grazie per aver condiviso con me i momenti (e i letti) pesanti di questi mesi, la spensieratezza delle classi di bachata e dei pranzi in giardino e per avermi accolto in un abbraccio nel caldo torrido di Valencia. Grazie a mio fratello argentino che mi ha guidata e protetta nel freddo inverno danese. Grazie al mio coinquilino tedesco a Barcellona per avermi sopportata nel caos del Raval. Merci al catalano che mi ha fatto scoprire il Vermouth, regalandomi un assaggio di casa in una città che appariva tanto straniera.
Grazie alla famiglia da cui sono partita, dai più grandi ai più piccini, per darmi sempre tutto l'affetto di cui si ha bisogno quando il Viaggio ti chiede di riposare.
Grazie a chi, con messaggi, abbracci e pensieri, mi dimostra ogni giorno di volermi bene. Grazie per aver trattato i miei amici come se fossero tuoi nipoti. Grazie alla mia zia viaggiatrice, ai viaggi fatti insieme e a quelli che faremo. Sei una continua fonte di ispirazione. Grazie alla mia zia cuoca, per contarmi sempre a tavola.
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Chiara

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Vēl viens liels paldies dodas manas otrās ģimenes virzienā pie Indras un Emila. Paldies, ka uzņēmāt mani tik draudzīgi un sirsnīgi. Paldies par tiem ģimenes brīvdienu izbraucieniem, galda spēlēm un garšīgajām vakariņām. Protams, sarakstā ir vēl daudzi paldies radiniekiem, draugiem un kolēģiem, kurus visus šeit nesanāks pieminēt, bet ziniet, ka domāju un novērtēju.
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Mīlu, Kristīne!