University of Stavanger

JOSÉ BROEKEMA (250996)
SUPERVISORS: DIEUWER TEN BRAAK AND CARL CHINEME OKAFOR

BIOPHILIA IN THE CITY:

The Psychological Pathways from Norwegian Blue Space to Sustainable Transformations

Master thesis - 2026

Energy, Environment and Society

Department of Media and Social Sciences

Faculty of Social Sciences

Cover image: The cover photograph, taken by the author, shows Madlabekken rensepark, a nature-based solution in Stavanger, an artificial wetland that contributes to rainwater runoff, water filtration and biodiversity while also offering recreational opportunities.

For Michiel and Zola

"*No water, no life. No blue, no green*"

— Sylvia Earle

Table of Contents

List of Tables 7

Abstract 8

Acknowledgment 9

Chapter 1 10

Biophilia in the City 10

1.1 Urbanisation, Nature Contact and Preventive Health 10

1.2 Social Interaction as an Underexplored Mechanism 11

1.3 Aims and Objectives 12

1.4 Research Questions and Hypotheses 13

1.5 Thesis Structure 14

Chapter 2 15

Literature Review 15

2.1 Mental Health and Well-Being: Conceptual Foundations 15

2.2 Perceived Restoration: Conceptual Foundations 15

2.3 Urbanisation, Natural Environments and Well-being 16

2.4 Blue Space Research: Evidence and Limitations 17

2.4.1 Blue Space Exposure: Individual and Contextual Factors 18

2.5 Everyday Exposure and Short-Term Interaction 19

2.6 Social Interaction in Natural Environments 20

2.7 Nature-Based Solutions and the Climate Health Nexus 21

2.8 Urban Blue Spaces, Planning and the Norwegian Policy Context 22

2.9 Summary and Research Gap 23

Chapter 3 24

Theoretical Framework 24

3.1 Psychological Theories 24

3.2 Three Spheres of Transformation Framework 25

3.3 Nature-Based Solutions and Urban Sustainability 27

3.4 An Integrated Model of Incidental Blue Space Exposure, Social Interaction and Well-Being 27

Chapter 4 29

Research Methodology 29

4.1 Research Design 29

4.2 Research Population 30

4.3 Procedure 30

4.4 Measuring Instruments 30

4.4.1 Blue Space Exposure 31

4.4.2 Social Interaction 31

4.4.3 Mental Well-Being 32

4.4.4 Perceived Restoration 33

4.5 Reliability, Validity and Research Credibility 34

4.6 Privacy and Ethics 35

Chapter 5 36

Data Analysis 36

5.1 Descriptive Analyses 36

5.2 Reliability Analyses 36

5.3 Correlation 36

5.4 Linear Regression Models 36

5.5 Mediation Analysis 37

Chapter 6 38

Results 38

6.1 Sample Characteristics 38

6.2 Descriptive Analyses 38

6.3 Correlation 39

6.4 Linear Regression Models 40

6.5 Mediation Analysis 41

Chapter 7 43
Discussion: Interpreting the Findings 43
7.1 Blue Space Exposure and Perceived Restoration 43
7.2 Blue Space Exposure and Mental Well-Being 44
7.3 The Role of Social Interaction 45
7.4 Integrating Findings: Multiple Pathways to Well-Being 46
7.4.1 Theoretical Integration: From Restoration to Sustainability Transformation 46
7.5 Norway in the Socio-Ecological and Planning Context 50
7.5.1 Regulatory Frameworks and Planning Barriers for Nature-Based Solutions in Norway 50
7.6 Sustainability Implications Through the Three Spheres of Transformation Framework 51
7.6.1 Personal Sphere: Values, Beliefs and Emotions 51
7.6.2 Political Sphere: Environmental Justice and Access Inequalities 52
7.6.3 Practical Sphere: Systems, Infrastructure and Technical Solutions 54
7.6.4 Solutions and Strategies 55
Chapter 8 57
Conclusion 57
8.1 Main Conclusion 57
8.2 Contributions 57
8.2.1 Empirical Contributions 58
8.2.2 Theoretical Contributions 58
8.2.3 Policy and Practical Contributions 59
8.3 Limitations of the Study 59
8.4 Future Research 60
8.5 Final Reflection 62
References 63
Appendix A 74
Appendix B 76

List of Figures

Figure 1 Model of blue space exposure as predictor for mental well-being and restoration, mediated by social interaction 14
Figure 2 The three spheres of transformation 26
Figure 3 Model of blue space exposure as predictor for mental well-being, mediated by social interaction 41
Figure 4 Model of blue space exposure as predictor for restoration, mediated by social interaction 42

List of Tables

Table 1 Descriptives 39
Table 2 Pearson correlations for the variables blue space exposure, mental well-being, perceived restoration and social interaction 40
Table 3 Interpreting the findings across psychological and sustainability dimensions 49

Abstract

Urban blue spaces, such as rivers, lakes and coastal environments, may contribute to mental and social health by providing opportunities for restoration, everyday nature contact and social interaction. This thesis examines how everyday accessible urban blue space exposure relates to mental well-being and perceived restoration among adults in Norway, and whether social interaction during blue space exposure mediates these relationships. Taking an interdisciplinary sustainability studies perspective, the thesis combines environmental psychology with sustainable urban development, nature-based solutions and climate adaptation. It is guided by attention restoration theory, the biophilia hypothesis, broaden-and-build theory and the three spheres of transformation framework.

This study addresses gaps in blue space research by focussing on brief, routine and often incidental exposure, rather than deliberate recreational use in large natural areas. It also contributes to the limited research on social interaction as a possible mechanism linking blue space exposure to well-being in a Norwegian context.

A quantitative cross-sectional survey design was used. Data were collected from adults residing in Norway and analysed using IBM SPSS statistics. The analyses included reliability analyses, multiple linear regression models and mediation analyses. Blue space exposure and social interaction were assessed using theoretically informed items developed for this study, while mental well-being and perceived restoration were measured using established psychological scales.

The findings showed that blue space exposure was positively associated to perceived restoration, but not with broader mental-well-being. Perceived accessibility to blue spaces, rather than exposure itself, was positively associated with mental well-being. Social interaction did not significantly mediate the relationship between blue space exposure and either outcome. These findings suggest that the benefits of urban blue spaces may operate through multiple but distinct pathways: Direct environmental exposure appears most relevant for restoration; perceived accessibility may be more relevant for broader mental well-being and social interaction may function more as a contextual or complementary pathway rather than as a mediation mechanism.

This thesis contributes to blue space and sustainability research by connecting individual psychological outcomes to questions of urban planning, environmental justice and nature-based solutions. It argues that accessible urban blue spaces should be understood not only as aesthetic, recreational or technical elements of urban development, but also as restorative socio-ecological infrastructure. For municipalities, planners and real estate developers, this highlights the importance of integrating accessible and high-quality blue spaces into urban environments as part of sustainable and health-supportive development.

Acknowledgment

I would like to express my sincere gratitude to everyone who supported me throughout this thesis process.

First, I would like to thank my supervisors for their constructive feedback, guidance and encouragement. Your input helped me shape this thesis and continue developing my ideas with more clarity and confidence.

I am also grateful to Eiendombransjens stipendordning and the jury for awarding me the stipend and for believing in the relevance of this thesis. This recognition strengthened my motivation tremendously and gave me extra encouragement to continue this work.

I would also like to thank the anonymous respondents who participated in the survey and shared it with their networks. Without your contribution this study would not have been possible.

I am also thankful to my professors and fellow students, who kept me inspired and motivated. Knowing that we were on a similar path made the process feel less lonely.

I would like to thank my colleagues at the research department for their support, encouragement and interest in my work. It was wonderful to be able to discuss a subject I care deeply about with colleagues, supervisors, fellow students and others who shared curiosity and engagement. I am grateful that the conversations about this thesis, and even the survey itself, encouraged reflection on nature, well-being and everyday surroundings. These moments reminded me of the value of research, collaboration and curiosity.

Finally, I want to thank my family. Without your support I may not have been on this path. Thank you for believing in me, encouraging me and standing by me throughout this journey. I am also grateful to everyone I have not mentioned by name, but who I encountered along the way and who, in one way or another, helped lead me here.

Chapter 1

Biophilia in the City

"How can everyday exposure to urban blue spaces contribute to mental and social health?" This question motivates this thesis, which explores how everyday access to and engagement with local urban natural environments, in Norway, can contribute to mental and social health, more specifically well-being. Currently more than 55% of the global population lives in cities and this is expected to rise to 68% by 2050 (Callaghan et al., 2021; Rapp, 2024; World Health Organization [WHO], 2025b). In Norway urban populations are increasing and over 83% of the country's inhabitants currently live in densely populated areas (Rapp, 2024). Urban life can be stressful, due to increased exposure to stressors such as noise and pollution, and people often experience reduced well-being due to increasing pace and pressures of urban life (Callaghan et al., 2021; WHO, 2025b).

Even though the quality of living is high in Norway, mental health challenges are increasing, this is particularly high amongst young adults with a higher prevalence among women (Helse- og omsorgsdepartementet, 2023; Tesli, 2023; WHO, 2022b). Current responses to this crisis largely focus on curative approaches, including medication and psychosocial interventions, which are often costly and time-consuming (Tesli, 2023). Consequently, there is a growing recognition of the need to identify preventive factors that strengthen mental health and resilience over time (Callaghan et al., 2021; Helse- og omsorgsdepartementet, 2023; Tesli, 2023; WHO, 2022b).

This study addresses the need for context-specific evidence on how urban blue spaces support mental well-being and restoration in the Norwegian climate and social setting (Janeka et al., 2025). Norway provides an important context for this research due to its leading role in the global green transition and its unique cultural relation with nature (Ditlev-Simonsen, 2022; Marino et al., 2025; Normann, 2015). The extreme seasonal variations, darker winters and light summers, are possibly of influence on social behavioural patterns (Ditlev-Simonsen, 2022; Gehl, 2011; Labib et al., 2020).

1.1 Urbanisation, Nature Contact and Preventive Health

Alongside increased exposure to stressors, urbanisation simultaneously reduces regular contact with natural environments. However, these natural surroundings have received increasing attention as preventive factors for well-being, particularly access to natural spaces, often referred to as green and blue spaces, such as parks, rivers and waterfronts. These environments have been linked to restorative experiences, stress reduction and opportunities for social interaction, suggesting a potential pathway to enhance mental and social well-being (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Kellert & Wilson, 1993; Ulrich et al., 1991).

However, existing research has predominantly focussed on green spaces, with considerably less attention given to blue spaces such as rivers, lakes, canals and coastal environments (Georgiou et al., 2021; K. Wang et al., 2024). Although studies examining blue spaces indicate beneficial effects on mental and physical health, research here remains relatively limited (Geneshka et al., 2021; Georgiou et al., 2021; K. Wang et al., 2024).

Additionally, much of the literature focuses on large natural areas used for deliberate recreational activities and overlooks short-term daily, and often unintentional, interactions with nearby nature, which may be increasingly degraded or limited by urbanisation (Britton et al., 2020; R. Kaplan & Kaplan, 1989; Labib et al., 2020; K. Wang et al., 2022, 2024). Understanding how these brief exposures affect mental well-being is therefore essential for assessing whether everyday contact with urban blue spaces can contribute to long-term health, restoration and sustainable urban development.

For this study, urban blue spaces are defined as outdoor environments, either natural or man-made, that prominently feature water (K. Wang et al., 2024). This includes accessible water bodies within or near built urban environments, including rivers, lakes, canals, and coastal areas, as well as engineered or recreationally designed water features (Chowdhury et al., 2025; Gascon et al., 2015). Man-made swimming pools are excluded. Water environments that are prepared for human activity may serve as resources for both psychological restoration and social interaction (Roba et al., 2025; The Ministry of Local Government and Modernisation, 2019; K. Wang et al., 2022). Focusing on these types of blue spaces, both natural and intentionally designed, provides an opportunity to examine everyday interactions with water that may support well-being. This study focuses on brief, everyday interactions with blue spaces in urban contexts, rather than intentional or long-term recreational use. In doing so, this study addresses important gaps in the literature related to short-term exposure, limited standardisation of measurement methods and understudied role of social health mechanisms.

Although the primary focus is on how urban blue spaces can influence human beings, participants from proximate suburban and rural areas are also included to capture a more extensive range of daily experiences with water environments.

1.2 Social Interaction as an Underexplored Mechanism

Another important gap concerns the mechanisms underlying the relationship between blue space exposure and mental well-being. In particular, the role of social health, such as opportunities for social interaction and the experience of social connectedness, has received limited empirical attention and is often not clearly examined (Gascon et al., 2015; Georgiou et al., 2021; K. Wang et al., 2024). This is notable, as definitions of health and mental well-being consistently identify social

well-being as a core dimension. Additionally, feeling socially connected and capable of engaging in meaningful social interaction is considered fundamental to overall well-being (Kaplan & Kaplan, 1989; Keyes, 2002; C. Wang et al., 2023; K. Wang et al., 2022).

Emerging evidence suggests that social interaction may function as a mediating mechanism in the association between exposure to blue spaces and mental well-being (Georgiou et al., 2021; Shrestha et al., 2025; K. Wang et al., 2024). Engagement with others in natural environments may directly promote mental well-being and enhance both restorative experiences and social resources, although existing findings remain mixed and require further empirical investigation (Georgiou et al., 2021; Shrestha et al., 2025).

In this study, social interaction is therefore examined as a potential mediator between blue space exposure and both mental well-being and perceived restoration.

Together, these gaps form the basis for the research problem addressed in this thesis. Although, urban blue spaces may support both mental well-being and restoration, less is known about how everyday exposure and social interaction contribute to these outcomes, particularly in the Norwegian context.

1.3 Aims and Objectives

The overall aim of this thesis is to examine the relationship between everyday exposure to accessible urban blue spaces and mental well-being and restoration, and to explore the role of social well-being, more specifically social interaction, in this relationship. The thesis takes an interdisciplinary approach, in which psychological perspectives on well-being are examined within a wider sustainability and urban development context. It aims to provide insight relevant to urban planning and development actors, including municipalities, planners and real estate developers, by examining how health-related outcomes, such as mental well-being and restoration, can be understood as part of wider climate and sustainability transitions. In doing so, it places urban blue spaces within discussions of climate adaptation, nature-based solutions and sustainable urban development.

Nature-based solutions (NBS), including blue-green infrastructure, are increasingly recognised as multifunctional approaches that can, aside from addressing human well-being, mitigate climate change and combat biodiversity loss (Alves et al., 2024; Chatzimentor et al., 2020). Integrating such approaches into urban development is therefore relevant, not only for public health, but also in the context of the ongoing green transition. After all, urban development must shift from often grey infrastructure to the integration of blue and green solutions, thereby promoting sustainable and climate change resilient cities (Hohmann et al., 2025).

The thesis takes an interdisciplinary approach, where psychological perspectives on well-being are examined within a wider sustainability and urban development context.

For urban development actors, including the real estate industry, there is a growing need for knowledge about how physical environments affect people's health, well-being and use of places over time (Gehl, 2011; Marino et al., 2025; The Ministry of Local Government and Modernisation, 2019). Blue spaces represent an important, but still underexplored, resource in the development of attractive and sustainable urban areas.

The results of this study will contribute knowledge about:

- how the design and accessibility of water environments can support both individual well-being and social use.
- how blue spaces can function as multifunctional nature-based solutions by combining climate adaptation, health promotion, and social and environmental sustainability at the same time.
- why investments in blue-green infrastructure should be understood as a long-term societal investment, rather than only as technical or aesthetic planning measure.
- how real estate development can contribute to public health, social sustainability and place attractiveness.

By connecting individual experiences of mental well-being, restoration and social interaction to wider sustainability transformations, this thesis contributes to a more user-centred understanding of how urban development can support more resilient and sustainable futures.

1.4 Research Questions and Hypotheses

Specifically, this thesis examines whether exposure to urban blue spaces is associated with higher levels of mental well-being and restoration, and whether social interaction during blue space exposure helps explain these associations. Figure 1 shows the mediation model of the variables blue space exposure, social interaction and both mental well-being and restoration, as was researched here. By integrating subjective well-being measures with perceptual and restorative evaluations of blue space exposure, the study aims to contribute to a more nuanced understanding of how urban natural environments might support restoration, mental and social well-being.

Based on this aim, this thesis addresses the following research questions:

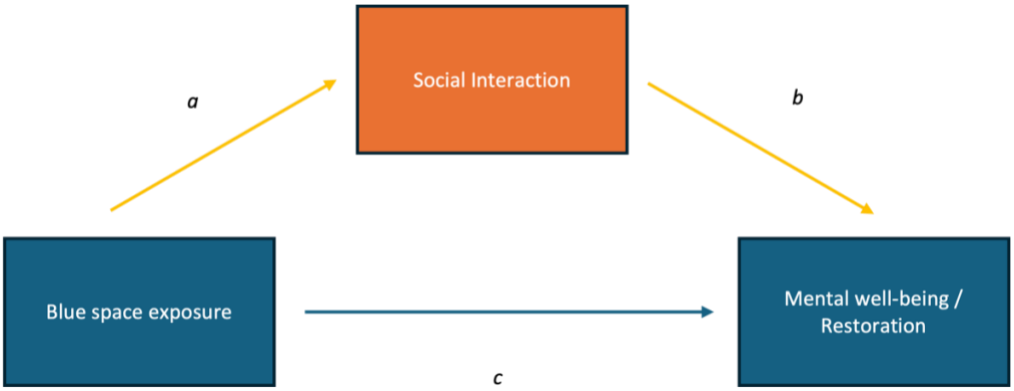
- Is there a relationship between urban blue space exposure and (a) mental well-being and (b) perceived restoration in the adult general population in Norway?
- Does social interaction during blue space exposure mediate the relationship between blue space exposure and (a) mental well-being and (b) perceived restoration?

The hypotheses following from the research questions are:

- H1: Greater exposure to blue spaces is positively associated with mental well-being.
- H2: Greater exposure to blue spaces is positively associated with perceived restoration.
- H3: Social interaction during blue space exposure statistically mediates the relationship between blue space exposure and mental well-being.
- H4: Social interaction during blue space exposure statistically mediates the relationship between blue space exposure and perceived restoration.

Figure 1

Model of blue space exposure as predictor for mental well-being and restoration, mediated by social interaction



Note. Blue space exposure is hypothesized to be associated with mental well-being and perceived restoration both directly (path c) and indirectly via social interaction (paths a and b).

1.5 Thesis Structure

A brief overview of the thesis is as follows: The introduction will be presented in chapter 1, followed by a literature review in chapter 2 outlining current knowledge on urban stressors and the links between nature exposure and well-being. Chapter 3 introduces the theoretical framework, including the attention restoration theory (ART), the stress reduction theory (SRT), the biophilia hypothesis, the broaden-and-build theory and the three spheres framework, which are used to interpret the findings and connect individual outcomes to sustainability implications (Isgett & Fredrickson, 2015; Kaplan & Kaplan, 1989; Kaplan, 1995; Kellert & Wilson, 1995; Leichenko & O'Brien, 2024). Chapter 4 describes the methodology, followed by the presentation of the results in chapter 5. The results are analysed in chapter 6 followed by chapter 7 and 8 which have the findings and discussion and conclusion consecutively.

Chapter 2

Literature Review

This chapter reviews existing research on mental well-being, urbanisation and exposure to natural environments, with a particular focus on blue spaces. It critically reviews current knowledge to identify existing gaps related to everyday exposure to natural environments and social interaction.

2.1 Mental Health and Well-Being: Conceptual Foundations

The World Health Organization (WHO) defines mental health not only as being completely free of psychosocial and/or mental disabilities and disease, but as state of mental, social, and physical well-being, in which individuals can effectively cope with life's stresses, contribute to their community, learn and work productively (WHO, 2022b, 2025a).

Building on this, Keyes (2005) proposed a two-continua model in which mental illness and health can be seen as two interrelated but distinct domains. Where individuals can experience a positive mental well-being even in the presence of mental illness (flourishing) or exhibit low mental well-being without psychological issues and illnesses (languishing) (Iasiello et al., 2020; Keyes, 2005; Keyes et al., 2008; Westerhof & Keyes, 2010; WHO, 2025a).

Well-being research further distinguishes between hedonic well-being, concerning positive emotions, satisfaction, happiness and eudaimonic well-being, which concerns purpose, personal growth, meaning, positive social relations, and resilience (Fredrickson, 2013; Keyes, 2005; Schotanus-Dijkstra et al., 2016). Flourishing integrates both forms of well-being, encompassing emotional, psychological and social dimensions (Keyes, 2002; Lamers et al., 2011). This study adopts Keyes' multidimensional conceptualisation of mental health to examine how environmental exposure may influence well-being across these domains (Keyes, 2002, 2005).

While mental well-being provides a broad understanding of mental health, the present thesis also examines perceived restoration as a more immediate environment-specific outcome.

2.2 Perceived Restoration: Conceptual Foundations

In addition to mental well-being, this thesis examines perceived restoration as a main outcome. Restoration can be understood as a beneficial recovery process that occurs during or after exposure to environments with natural elements, where individuals may experience reduced stress, improved attention and renewed mental energy (Korpela et al., 2008). Both ART and SRT are relevant for understanding this process, although they emphasise slightly different mechanisms. ART focuses primarily on cognitive recovery from directed attention fatigue (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995). According to this perspective, urban environments often require sustained, effortful directed attention, while natural environments may support restoration by engaging attention in a

gentle, effortless way, without requiring sustained cognitive effort (Berman et al., 2008; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Ulrich et al., 1991). SRT, in contrast, focuses more on emotional and physical recovery from stress reactions. From this perspective, natural environments may support restoration by reducing stress, promoting calmness and improving affective states (Korpela et al., 2008; Ulrich et al., 1991). In this sense, the two theories can be seen as complementary perspectives on restoration, with ART emphasising cognitive recovery and SRT emphasising emotional and physiological recovery (Korpela et al., 2008).

In urban environments, constant exposure to traffic, noise, buildings and other sensory demands constant directed attention is needed, which contributes to mental exhaustion or fatigue. Natural environments, including blue or green spaces, may provide a form of recovery by allowing attention to shift toward less demanding and more effortless forms of focus. This may contribute to calmness, reduced stress and improved cognitive functioning (Huang et al., 2021; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Korpela et al., 2008; Ulrich et al., 1991). Perceived restoration therefore captures how individuals subjectively experience the restorative qualities of an environment, which in this thesis refers to blue spaces specifically (Korpela et al., 2008).

The restorative effect of natural spaces is well supported in the literature. A meta-analysis by Georgiou et al. (2021) found that increased contact with blue spaces and greater availability of blue spaces were significantly related to higher restoration levels. Similar findings have been reported for freshwater and other blue spaces, where frequent visits appear to promote psychological restoration (Gascon et al., 2015; Ghosh & Pal, 2024; Korpela et al., 2008; Roba et al., 2025; K. Wang et al., 2024; Zhang et al., 2025). Neuroscientific research also provides support for restorative effects, showing that exposure to natural environments is associated with brain activity related to emotional regulation, motivation and attentional recovery (Ancora et al., 2022; Berman et al., 2008; Gaekwad et al., 2022). Taken together, mental well-being and perceived restoration provide two related but distinct ways of understanding how environments may support human health. The next section places these outcomes within the broader context of urbanisation, where access to natural environments is increasingly shaped by urban development and planning.

2.3 Urbanisation, Natural Environments and Well-being

Urban areas refer to densely populated and built-up settlements, where infrastructure is generally highly developed, ranging from cities and towns to megacities inhabited by tens of millions of people. Urbanisation refers to the continuous growth of these urban areas, a process shaped by powerful actors influencing social and economic development, infrastructure and spatial planning (United Nations, 2025b). The priority to make sure that this urban development is sustainable,

inclusive, safe and resilient is the aim of Sustainable Development Goal 11 (SDG 11) from the 2030 Agenda for Sustainable Development (Biermann et al., 2017; United Nations, 2025b, 2025a).

Urbanisation often negatively affects natural environments through land use changes, including development in green and blue areas. This can contribute to biodiversity loss, reduced ecosystem quality and increased environmental pressures in and around cities, including air pollution (Ghosh & Pal, 2024; Kowarik et al., 2025). Areas often already under pressure due to climate change (Kowarik et al., 2025; Paleari, 2024). At the same time, urban growth and hard infrastructure without sufficient blue and green spaces may negatively affect human health by reducing everyday contact with nature and limiting access to restorative environments (R. Kaplan & Kaplan, 1989; Korpela et al., 2008; Ulrich et al., 1991). Over time, this may contribute to a disconnect from nature, where the health, social and ecological benefits of natural environments become less visible in everyday urban life, potentially weakening awareness of their value for well-being and sustainability (Britton et al., 2020; Shrestha et al., 2025).

2.4 Blue Space Research: Evidence and Limitations

While environmental health research has traditionally focussed on green spaces, blue spaces are increasingly recognised as a relevant and vital field of study in relation to mental well-being (Britton et al., 2020; Georgiou et al., 2021; K. Wang et al., 2024; White et al., 2021). Empirical evidence demonstrates that exposure to blue spaces, including rivers, lakes and coastal areas, is associated with lower levels of depression, psychological distress and anxiety (Britton et al., 2020; K. Wang et al., 2024; White et al., 2021; Zhang et al., 2025). This is further supported by neuroscientific data. A systematic review by Ancora et al. (2022) found that while urban environments generally elevate stress levels an provoke negative affect, blue spaces can mitigate these effects by having a positive and calming effect reflected in objective measures such as electroencephalogram (EEG) and heart rate variability (HRV) (Ancora et al., 2022; Zhang et al., 2025). Experimental studies using virtual reality and EEG have found similar restorative results (Zhang et al., 2025).

Literature identifies different pathways linking blue space to health: Physical activity, restoration, social interaction and environmental factors such as heat and flooding mitigation (Georgiou et al., 2021). Despite these benefits, there is an emphasis on the need for more research on freshwater blue spaces as most research focusses on coastal environments even though half of the global population lives near freshwater bodies (K. Wang et al., 2024). Context remains important however, particularly in Norway where around 80% of the people lives within 10 kilometres from the sea and coastal areas (Directorate of Fisheries, n.d.; Miljødirektoratet, n.d.-b). Norway provides a particularly relevant context for this study. After Canada, it has one of the world's longest coastlines, spanning approximately 24.000 kilometres, while inland freshwater bodies (e.g., lakes, rivers) cover

around 6% of Norway's surface (Faugli, 2005; Uglem et al., 2018). Methodologically, blue space and health research remains limited as much of the research relies on cross-sectional designs, which makes it difficult to study causal relationships and change over time, ideally future research would focus on longitudinal data to address this restriction (Ancora et al., 2022; Britton et al., 2020; Geneshka et al., 2021).

Furthermore, much of the literature focusses on large natural areas used for deliberate recreational activities and overlooks short-term daily, and often unintentional, interactions with nearby nature, which may be increasingly degraded or limited by urbanisation (Britton et al., 2020; R. Kaplan & Kaplan, 1989; Labib et al., 2020; K. Wang et al., 2022, 2024). The lack of standardised measurement approaches also limits comparability across studies (Gascon et al., 2015; Labib et al., 2020; K. Wang et al., 2024).

For this study, urban blue spaces refer to accessible water bodies within or near built urban environments, including rivers, lakes, canals, and coastal areas, as well as (recreationally) designed water features that support social or restorative activities. By excluding pools and focussing on these public water features, this thesis aims to examine how everyday interactions with blue spaces support mental well-being across urban, suburban and rural experiences. Although the focus is on urban blue spaces, participants from suburban and rural areas are also included to capture a wider range of daily experiences with water environments.

2.4.1 Blue Space Exposure: Individual and Contextual Factors

Blue spaces are theorized to support both mental well-being and perceived restoration through mechanisms described by ART and SRT, such as mental restoration, stress reduction and emotional recovery (Ancora et al., 2022; Georgiou et al., 2021; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Korpela et al., 2008; Ulrich et al., 1991).

Longitudinal data from a study in Australia found an association between lower rates of anxiety and depression among the population living near an area with more than 41% green-blue coverage (White et al., 2021). This was not found separately for blue, green and blue-green areas in general in this study, although among women there may be a reduction in depression symptoms associated with blue spaces. For men, this positive link was found in relation to green spaces and green-blue infrastructure (White et al., 2021).

Based on these previous findings, gender was included as a potential covariate in this study, as blue space and mental health associations may differ by gender (Roba et al., 2025; White et al., 2021). Additionally, age, education level and household composition were controlled for due to their confirmed influence on mental well-being in association with exposure to nature (Roba et al., 2025; Shrestha et al., 2025; K. Wang et al., 2024). Such as age, which might increase the awareness

to the effect of environment on health and additionally older adults often have a higher risk of disease and mental disorders, while socio-economic factors like education and employment can determine both the degree of daily stress and the available resources to cope with this (Georgiou et al., 2021; Roba et al., 2025; K. Wang et al., 2024). Furthermore, household composition and having a partner or not (civil status) has a significant influence on how individuals experience and use blue spaces, specifically in relation to perceived safety and time constraints (Gehl, 2011; Labib et al., 2020; Singh et al., 2025). And finally, environmental factors influencing accessibility, such as walking distance to the nearest blue space, perceived accessibility and living situation (suburban and rural areas, with urban areas as the reference) were measured (Georgiou et al., 2021; Pasanen et al., 2018; Roba et al., 2025; Singh et al., 2025; K. Wang et al., 2022, 2024). Based on prior research, a wide set of demographic, socioeconomic and environmental variables was considered as potential covariates.

2.5 Everyday Exposure and Short-Term Interaction

Much of the existing literature has focussed on deliberate visits to larger natural environments, for recreational use or therapeutic interventions (Britton et al., 2020; Labib et al., 2020; K. Wang et al., 2024). Measurement approaches in these studies often focus on distance from home, with less attention given to the frequency and duration of the visits, which may be more relevant regarding understanding everyday, non-deliberate contact with blue spaces (Labib et al., 2020).

In contrast, significantly less attention has been given to incidental exposure, the often non-deliberate, routine, short-term visits with blue spaces that happen during daily life, such as passing a lake or canal on the way to work (Janeka et al., 2025; K. Wang et al., 2024). Yet these everyday interactions may be particularly relevant in urban contexts, where repeated brief encounters with nearby blue spaces can have a cumulative effect and positively influence long-term mental well-being and restorative experiences (Labib et al., 2020).

Existing urban blue spaces, whether newly developed or older, are often uniquely integrated into the built environment making them important sites for daily interaction instead of only occasional recreation (K. Wang et al., 2024). Historical examples include the Amstel River and canals in Amsterdam and the Breivatnet in Stavanger. Other examples can be found in cities such as Antwerp and Rotterdam, where water bodies enhance areas surrounding historical rivers and are increasingly integrated into multipurpose parks that combine daily use, recreation, transport and climate adaptation through NBS (Pourmohammad-Zia & van Koningsveld, 2024; *Ringpark Het Schijn*, n.d.; *Rotterdam Watercity 2035*, n.d.).

Understanding these ordinary forms of exposure is therefore essential for capturing how blue spaces function as health promoting and preventive environments in daily life. Furthermore, these short interactions are in line with Gehl's view on urban planning, which focusses on the life between buildings. In this perspective, repeated daily visits and passive, brief and effortless social encounters are fundamental to urban social-ecological resilience (Gehl, 2011).

2.6 Social Interaction in Natural Environments

Building on the importance of everyday and often incidental encounters with blue spaces, relatively little is known about the mechanisms underlying the relationship between blue space exposure and mental well-being. In particular, the social dimension of these routine encounters remains underexplored. A meta-analysis by Georgiou et al. (2021) showed that living near or having access to large amounts of water environments was associated with increased physical activity and a positive relationship with restoration; this relation was especially significant when there was a greater presence of water in the area and more frequent contact with blue spaces.

Additionally, it appeared that the role of social health, such as opportunities for social interaction and the experience of social connectedness, has received limited empirical attention and is often not clearly investigated (Gascon et al., 2015; Georgiou et al., 2021; K. Wang et al., 2024). This gap is notable, as definitions of health and mental well-being consistently identify social health or social well-being as a core dimension. Feeling socially connected and capable of engaging in meaningful social interaction is considered fundamental to overall well-being (Ghosh & Pal, 2024; Keyes, 2002; C. Wang et al., 2023; K. Wang et al., 2022).

Recent reviews suggest that social interaction may function as a mediating mechanism in the association between exposure to blue spaces and mental well-being. Engagement with others in natural environments may directly promote mental well-being while also enhancing restorative experiences and strengthening social resources. Blue spaces as places for social interaction might function as a buffer against feelings of depression, anxiety and stress (Gehl, 2011; Ghosh & Pal, 2024). Blue spaces might even be more effective than green spaces for enhancing mental well-being by promoting amongst other positive social relationships, it has been found that people living within closer proximity to water environments have higher perceived social support (Janeka et al., 2025).

However, current findings on the mediating effects of social interaction remain contradictory and inconclusive, calling for further empirical investigation (Georgiou et al., 2021; Shrestha et al., 2025; K. Wang et al., 2024). While some research shows that closer proximity to blue spaces increase social well-being aspects as community cohesion, a meta-analysis found no statistically significant association between distance to blue space and general social interaction (Georgiou et al., 2021). Additionally, the social context can play a negative role when there is overcrowding, and high

population density in urban areas, which can diminish the restorative benefits of blue spaces and negatively affect one's mental well-being (Ancora et al., 2022).

This highlights the potential of blue spaces not only as restorative environments but also as social settings where formal or informal activities could generate synergistic benefits, including increased mental well-being, perceived restoration, social belonging and perceived safety (Georgiou et al., 2021; Shrestha et al., 2025).

Overall, these findings suggest that social interaction may help explain how blue space exposure translates into improved mental well-being, supporting its conceptualisation as a mediating mechanism in the present study. This mediating role is examined by assessing self-reported blue space exposure, social interaction during exposure, together with mental well-being and perceived restoration outcomes. This thesis examines three distinct levels of social interaction, namely passive contact (the most common form, involving simply seeing and hearing other people), and active contact (planned meetings and activities) or incidental contact (unplanned exchanges like a smile, a nod or a brief chat), based on Gehl's (2011). This framework is increasingly supported in nature and well-being research as a way to encompass all levels of interaction (Gaekwad et al., 2022; Georgiou et al., 2021; Shrestha et al., 2025; K. Wang et al., 2024).

2.7 Nature-Based Solutions and the Climate Health Nexus

In recent years, there has been increasing attention to NBS, as integrated approaches to address environmental and societal challenges in urban contexts. NBS are defined as multifunctional actions that are rooted in nature, mimicking natural processes and strengthening these to address issues such as climate change, biodiversity loss and human well-being (Alves et al., 2024; Paleari, 2024; Pearlmutter et al., 2020). Examples of blue space NBS include rain gardens, retention ponds, living shorelines or constructed wetlands, which can support stormwater management, biodiversity, climate adaptation and everyday human experience (Chowdhury et al., 2025; European Commission, 2025). The cover image of this thesis provides a visual example of such a blue-green solution, Madlabekken Rensepark in Stavanger, where water management, wetland processes and everyday access for walking, running and daily use are combined.

Within urban environments, blue and green infrastructures are fundamental components of NBS, functioning as interconnected systems that provide multiple ecosystem services (Hohmann et al., 2025). These include climate regulation, such as a cooling effect and water management, ecological benefits, and positive health and social outcomes. This multifunctionality positions NBS as a central element in the transition toward more sustainable and resilient cities (Chatzimentor et al., 2020; Labib et al., 2020).

Although green and blue infrastructures are often considered as integrated systems, this thesis places particular emphasis on blue spaces, as a distinct, yet interrelated part of urban NBS. However, despite the multifunctional potential of blue-green infrastructure, research and practice often remain fragmented across disciplinary and institutional boundaries. Urban planning has traditionally been organised in sectoral silos, separating environmental, social and infrastructural considerations, although this silo behaviour is increasingly being challenged by nexus-based approaches (Hohmann et al., 2025; Paleari, 2024). Such fragmentation can limit the effective implementation of integrated blue-green infrastructure solutions (Hohmann et al., 2025).

In this context, understanding how everyday interactions with urban blue spaces contribute to mental and social well-being can provide valuable insights into the human dimension of NBS. Such knowledge may support more holistic urban planning approaches that integrate health, social and environmental objectives (Paleari, 2024). In addition to examining psychological outcomes, the thesis places urban blue spaces within the wider context of NBS and sustainable urban development in Norway, where questions of accessibility, implementation and interdisciplinary collaboration are increasingly relevant.

2.8 Urban Blue Spaces, Planning and the Norwegian Policy Context

Within the Norwegian context, NBS are increasingly important in spatial and land-use planning as well as climate adaptation. Spatial and land-use planning in Norway is shaped by national, regional and municipal frameworks, where municipalities play a central role in land-use decisions, while private developers are often important actors in the implementation of urban projects. Although national policy encourages the use of NBS and blue-green solutions, implementation can be limited by fragmented responsibilities, unclear definitions, financial uncertainty and sectoral planning structures (Hohmann et al., 2025; Marino et al., 2025).

This is particularly relevant for urban blue spaces, which can provide climate adaptation functions such as stormwater management and cooling, while also supporting everyday use, restoration and social interaction (Remme et al., 2024; Alves et al., 2024). However, when the human and social benefits of blue spaces are not clearly recognised in planning and development processes, their value may be reduced to technical or aesthetic functions, which can limit their broader contribution to sustainable urban development (Marino et al., 2025; Naserisafavi et al., 2022). Understanding the psychological and social benefits of everyday blue space exposure may therefore contribute to a broader valuation of NBS in urban development. This thesis responds to this need by linking individual experiences of restoration, well-being and social interaction to wider questions of sustainable urban transformation.

2.9 Summary and Research Gap

Current research provides increasing evidence that exposure to blue spaces can support mental well-being and has a restorative effect via potentially social pathways (Ancora et al., 2022; Britton et al., 2020; Georgiou et al., 2021; K. Wang et al., 2024). In particular, studies increasingly demonstrate positive associations between exposure to blue spaces and reduced psychological distress, increased positive emotions and enhanced perceived restoration in both natural and urban settings (White et al., 2021; Zhang et al., 2025). Recent systematic review results further support the protective role of blue spaces for mental health outcomes, while emphasising the need for more standardised measurement approaches and longitudinal designs (Geneshka et al., 2021; K. Wang et al., 2024).

However, important gaps remain. Much of the existing literature have focused on coastal environments, larger environmental settings, or deliberate recreational visits, while less is known about short-term, routine and incidental exposure to blue spaces in everyday urban life (Britton et al., 2020; Labib et al., 2020; K. Wang et al., 2024). These recurrent brief encounters may have cumulative effects on mental well-being and restorative experiences, yet research on this is scarce (Chelli et al., 2025; Labib et al., 2020; Shrestha et al., 2025).

In addition, although social interaction is increasingly discussed as a relevant pathway, current findings regarding its mediating role remain mixed and inconclusive (Gascon et al., 2015; Georgiou et al., 2021; Shrestha et al., 2025). This is specifically evident given that everyday urban blue spaces often function as social settings where passive, incidental and active encounters may occur simultaneously (Gehl, 2011). Furthermore, relatively limited research has examined these associations in a Norwegian context, where water environments are well integrated in everyday landscapes and urban landscapes (Faugli, 2005; Gehl, 2011; Ministry of Climate and Environment, 2024; Schartau et al., n.d.; Uglem et al., 2018). Finally, although urban blue spaces are increasingly relevant withing NBS and sustainability planning, their psychological and social benefits are not always clearly integrated into urban development and real estate decision making (Remme et al., 2024; Naserisafavi et al., 2022). This thesis addresses these gaps and examines whether exposure to urban blue spaces is associated with mental well-being and perceived restoration, whether social interactions function as mediating mechanisms, and how these findings may inform wider questions of sustainable urban transformation.

Chapter 3

Theoretical Framework

These gaps identified in the previous chapter provide the basis for the theoretical framework presented here in chapter 3, which examines the psychological and social mechanisms through which urban blue spaces may support well-being. This framework connects the cognitive and affective benefits of individual nature exposure with the wide-ranging requirements for societal sustainability transformations.

3.1 Psychological Theories

A theoretical explanation for the beneficial effects of blue spaces on one's mental well-being is provided by the biophilia hypothesis, which proposes that people from an evolutionary perspective people feel connected to nature, this can be experienced both consciously and unconsciously (Geneshka et al., 2021; Georgiou et al., 2021; Kellert & Wilson, 1993; K. Wang et al., 2022, 2024; Wilson, 1984). This evolutionarily predisposition may help explain the psychologically restorative and emotionally calming effects of blue spaces (Gaekwad et al., 2022; R. Kaplan & Kaplan, 1989; Kellert & Wilson, 1993; Ulrich et al., 1991).

Building on the conceptual discussion of restoration in chapter 2, ART and SRT are used here to explain how natural environments may support restoration and mental well-being (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Ulrich et al., 1991). ART focusses primarily on the cognitive recovery from directed attention fatigue, while SRT emphasises emotional and physiological recovery from stress responses (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Ulrich et al., 1991). In urban environments, characterised by high levels of sensory stimulation and cognitive demands, such as traffic noise, crowds and dense built structures, require constant, focussed attention and may contribute to mental fatigue. Whereas natural environments may promote restoration in a gentle way, effortless by not forcing the brains focus and giving it time to rest and recover. This improves cognitive function and can potentially increase one's positive emotions (Berman et al., 2008; Gaekwad et al., 2022; R. Kaplan & Kaplan, 1989).

The resulting increase of positive emotions in turn, may further enhance mental well-being, consistent with Fredrickson's broaden-and-build theory, which states that positive emotions broaden an individual's cognitive and behavioural tendencies, thereby cultivating, amongst other things, resilience, optimism and building lasting psychological and social resources (Fredrickson, 2001; Isgett & Fredrickson, 2015; Kellert & Wilson, 1993). Enhanced well-being may also promote pro-environmental behaviours, suggesting a feedback cycle between emotional well-being and sustainable action (Fredrickson, 2013; Geary et al., 2023; White et al., 2020; WHO, 2022b, 2023).

Daily short-term exposure to urban nature, here blue spaces, lends itself particularly well to be studied using ART. This provides a fundamental theoretical basis for investigating perceived restoration and mental well-being without relying on complex psychological measures. Together ART and the biophilia hypothesis provide a strong theoretical foundation for understanding why exposure to blue spaces, is an essential biopsychological resource in urban context, with implications for mental well-being, social health and sustainability (Gaekwad et al., 2022; R. Kaplan & Kaplan, 1989; Kellert & Wilson, 1993; Wilson, 1984).

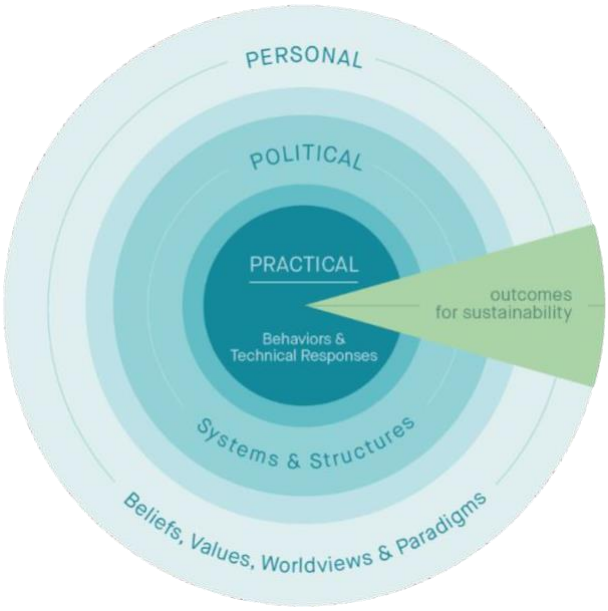
3.2 Three Spheres of Transformation Framework

While this thesis primarily focusses on individual-level psychological outcomes, this study applies the three spheres of transformation framework to understand these within the larger context of sustainability challenges (Leichenko & O'Brien, 2024; O'Brien, 2018; O'Brien & Sygna, 2013). The framework provides a way to interpret how personal experiences of urban environments may connect to wider social and institutional transformations.

The framework comprises three integrated spheres, the personal sphere encompassing values, beliefs, emotions and worldviews; the political sphere, referring to individual and collective behaviours and social practices, and the practical sphere which include systems, policies and institutional structures, as illustrated in Figure 2 (Leichenko & O'Brien, 2024; Mayer et al., 2009; O'Brien, 2018; O'Brien & Sygna, 2013; Steg, 2012). Change processes within these spheres are understood as mutually reinforcing rather than linear.

Figure 2

The three spheres of transformation



Note. From ¨O'Brien, K., & Sygna, L. (2013). Responding to climate change: the three spheres of transformation. *Proceedings of transformation in a changing climate*, *16*, 23.¨

This thesis focuses primarily on the personal sphere, exploring how everyday exposure urban blue space exposure relates to mental well-being and perceived restoration (Leichenko & O'Brien, 2024; Mayer & Frantz, 2004; Watson et al., 1988). However, findings are interpreted within the overarching transformation framework, acknowledging that individual psychological experiences may shape social practices, perceptions of place and support for urban sustainability initiatives (Avelino et al., 2016; Bennett, 2018; Biermann et al., 2017; Meadowcroft, 2011; Steg, 2012; van der Stel et al., 2024). In this sense, the three spheres framework provides an interpretive perspective for understanding how individual psychological outcomes relate to urban sustainability, planning and governance (O'Brien, 2018; O'Brien & Sygna, 2013).

Biophilia provides the evolutionary logic explaining the importance for why natural environments may support human well-being, while ART and the broaden-and-build theory explain the psychological mechanism through which such environments foster restoration, positive affect and the development of personal and social resources (Fredrickson, 2001; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Kellert & Wilson, 1993). The three spheres framework connects these insights by situating individual-level benefits within a wider societal and sustainability context (O'Brien, 2018; O'Brien & Sygna, 2013).

3.3 Nature-Based Solutions and Urban Sustainability

While chapter 2 reviewed NBS as multifunctional urban strategies, the present chapter uses NBS as an interpretive perspective to place individual well-being outcomes within systemic sustainability transformations. Within the three spheres of transformation framework, blue spaces and blue-green infrastructure can be understood as practical expressions of urban sustainability ambitions, where ecological performance, climate adaptations and everyday human experience intersect (Chatzimentor et al., 2020; O'Brien, 2018; Pearlmutter et al., 2020).

In this context positive everyday experiences with urban blue spaces may reach beyond individual restoration alone. Repeated exposure may strengthen attachment to a place and social interaction, promoting a stronger sense of responsibility toward the local environment (Gaekwad et al., 2022; Naserisafavi et al., 2022). By functioning as urban water commons, these spaces leverage community cohesion and increase public acceptance of resilient blue-green urban design (Perrotti et al., 2020). The psychological and social benefits examined in this thesis may therefore function as important leverage points within the personal sphere (emotions and worldviews), ultimately supporting more holistic sustainability transitions through the political and practical spheres of urban planning and design (O'Brien, 2018; Shrestha et al., 2025).

3.4 An Integrated Model of Incidental Blue Space Exposure, Social Interaction and Well-Being

Based on the theoretical perspectives outlined above, this thesis proposes an integrated conceptual model in which incidental everyday exposure to urban blue spaces is associated with improved mental well-being and increased perceived restoration. ART provides the primary explanation mechanism for the restorative and cognitive benefits of such exposure (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995), while the biophilia hypothesis offers an evolutionary explanation for the positive emotional responses associated with natural water environments (Kellert, 1984; Kellert & Wilson, 1993).

In addition to these direct associations, the model proposes that social interaction during blue spaces exposure functions as a mediating social pathway, building on Gehl's (2011) work, where passive, incidental and active social contact in and near blue spaces may strengthen psychological benefits by promoting positive affect and social connectedness (Gaekwad et al., 2022; Gehl, 2011). This social interaction is conceptualised as a mediating mechanism that may help explain how blue space exposure translates into improved mental well-being and hereby addresses the inconsistent and inconclusive evidence currently found in the literature (Georgiou et al., 2021; K. Wang et al., 2024).

From a comprehensive perspective the model places these individual-level mechanisms within the sustainability and urban transformation perspective of the three spheres framework and

NBS. Positive everyday experiences with blue spaces serve as a leverage point in the personal sphere, contributing to individual flourishing, stronger place attachment and the social acceptance of resilient blue-green urban design (Chatzimentor et al., 2020; O'Brien, 2018; Perrotti et al., 2020)

Chapter 4

Research Methodology

This thesis is positioned within a post-positivist research paradigm (Creswell & Creswell, 2018). It assumes that relationships between blue space exposure, restoration, mental well-being and social interaction can be studied empirically through measurable variables, while also acknowledging that these relationships are complex, context-dependent and partly shaped by subjective experience. The quantitative cross-sectional survey design therefore makes it possible to investigate statistical associations, but not to draw causal conclusions. This position aligns with the aim of the thesis, which is to provide theoretically grounded knowledge regarding the relationship between everyday exposure to accessible urban blue spaces and well-being and sustainable urban development.

4.1 Research Design

This study uses a quantitative, cross-sectional survey design. Data were collected through an anonymous online questionnaire administered in Nettskjema. The survey was conducted at a single point in time using self-report methods of assessing exposure to blue spaces, social interaction during blue space exposure, perceived restoration and mental well-being. Data collection took place between February 20 and March 31, 2026.

A quantitative cross-sectional survey design was chosen because the aim was to examine associations between everyday blue space exposure, social interaction, perceived restoration and mental well-being in a broader adult example. While physiological methods such as EEG or HRV could provide more direct measures of cognitive restoration and stress recovery, these approaches were beyond the practical scope of the present thesis. The survey design was therefore considered appropriate for capturing self-reported everyday experiences with blue spaces, while physiological methods are suggested as a direction for future research.

To investigate the proposed mechanisms underlying the relationship between blue space exposure and perceived restoration and mental well-being, a mediation model was tested, with social interaction during blue space exposure as the statistical mediator. Given the cross-sectional design, mediation analysis was used to explore indirect associations rather than assuming causal relationships.

The primary focus of this study is on daily exposure to blue space in urban settings. Respondents are not restricted to living in urban areas, allowing for inclusion of experiences across different degrees of urbanisation. Participants therefore reported whether they lived in an urban, suburban or rural area. This demographic variable was used to describe the sample, and to explore potential contextual differences in access to and interaction with blue spaces.

4.2 Research Population

The target population consisted of adults 18 years and older residing in Norway, with good comprehension of the Norwegian or English language to complete the survey, which was available in both languages. A G*Power analysis was conducted to determine the sample size required for the correlation and regression analysis (hypothesis one and two), showing that the minimum respondents needed was $N > 107$ when power = .95 and $p = .05$ (Faul et al., 2009; Field, 2024; Tabachnick et al., 2019).

In addition, a Monte Carlo power analysis was conducted to determine the sample size required for detecting the indirect effect in the mediation model. Assuming small to moderate standardised effects for paths a (blue space → social interaction) and b (social interaction → mental well-being/restoration) ($\beta = 0.2$), simulations indicated that a sample of approximately $N = 275$ is required to achieve 80% power to detect the indirect effect at $\alpha = .05$ (Schoemann et al., n.d., 2017).

The final achieved sample consisted of $N = 142$ respondents. A detailed description of the sample characteristics is presented in chapter 6.

4.3 Procedure

Participants were recruited via personal and university networks, social media and community outreach. Invitation leaflets were placed at various places, with information about the study and QR codes. Participants received a link to the digital survey with the invitation to participate or they could scan a QR code to participate. Beforehand they were presented the letter of consent. When consent was given the survey started. The survey lasted approximately 6 to 8 minutes. In addition, the respondents were invited to disseminate the survey within their networks, using the snowball effect to gain a bigger reach.

4.4 Measuring Instruments

Established psychological questionnaires were used for measuring mental well-being and perceived restoration and additionally social interaction and blue space exposure were measured by statements based on the literature as no standardised instruments were available. The survey included questions concerning demographic background characteristics (age, gender, civil status, the area where one lives (urban, suburban, rural), educational attainment, employment status, household composition). Structural factors as distance and perceived accessibility, urbanity, and demographic variables were included as control variables. The survey was available in both English and Norwegian.

The current thesis used the following questionnaires:

4.4.1 Blue Space Exposure

Blue space exposure was assessed using self-developed Blue Space Exposure items informed by previous literature and Sustainable Development Goal 11, target 7 (access to safe, inclusive, accessible, *green* and public spaces...) (Georgiou et al., 2021; Korpela et al., 2008, 2014; Kosovac & Pejic, 2023; Labib et al., 2020; Rijkswaterstaat, n.d.; Shrestha et al., 2025; WHO, 2022a). Participants were instructed: "*The following questions concern your use of blue spaces such as, rivers lakes, canals, coastlines or other water environments in your everyday life.*"

Frequency and duration (exposure behaviour). Frequency of visits was assessed with the item: "*How often do you visit blue spaces?*" Responses are given on a 5-point scale, from 0 (never) to 4 (daily). Typical duration of visits was measured with: "*On a typical visit how long do you usually stay in a blue space*". Responses were recorded on an 8-point scale ranging from 0 (I never visit) to 7 (more than 60 minutes) with intermediate categories representing increasing time intervals (<10 minutes, 10-20. Minutes, 20-30 minutes, 30-40 minutes, 40-50 minutes, 50-60 minutes). Participants are also asked: "In the past four weeks, how often have you visited a blue space". Responses were given on a 5-point scale, from 0 (never) to 4 (daily).

Blue space exposure was operationalized as a two-item behavioural index consisting of frequency of visit and general duration of visits. These items were averaged to represent overall exposure. Because these items capture complementary aspects of exposure rather than interchangeable indicators of a psychological scale, Cronbach's alpha was not considered the primary indicator of reliability, instead the index was kept on conceptual grounds, as frequency and duration together represent overall exposure (Labib et al., 2020; K. Wang et al., 2024).

Distance and accessibility. Distance to the nearest blue space was assessed with: "*Approximately how far is the nearest blue space from your home in walking distance?*" Response categories ranged from 1 (<300meter) to 4 (>1km). Perceived accessibility was measured with: "*How easy is it for you to access a blue space?*" Responses were given on a 5-point scale ranging from 0 (very difficult) to 4 (very easy).

Distance to the nearest blue space and perceived accessibility were included as potential covariates and to further explore contextual differences in daily exposure to blue spaces.

4.4.2 Social Interaction

Perceived social interaction during blue space visits were assessed using a brief social interaction scale developed for this study based on previous literature (Ancora et al., 2022; Gehl, 2011; Georgiou et al., 2021; Shrestha et al., 2025).

The scale consists of six items reflecting passive, incidental and active forms of interpersonal interaction.

Participants were instructed: "*Thinking about what typically happens during a visit to a blue space you use, please indicate how much you agree with the following statements*."
Responses are provided on a 7-point Likert scale from 0 (strongly disagree) to 6 (strongly agree), with higher scores indicating greater agreement. Passive interaction was assessed with the item: "*While in this blue space, I enjoy simply seeing and hearing other people.*"
Incidental interaction was assessed with the items: "*I often engage in any brief, unplanned interactions (e.g., a smile, greeting, nod) with people I don't know*" and "*blue spaces make it easier to start conversations with others*." Active interaction was assessed with the items: "*I often spend time here specifically to meet with others or participate in a group activity (e.g., walking with a friend, community group)*" and "*I visit blue spaces together with friends, family or others.*"
Shared activity encouragement was measured with the item: "*Blue spaces encourage shared activities (e.g., walking, swimming, sitting).*"

Item scores were averaged to create a total social interaction score, with higher values indicating greater perceived social interaction during blue space visits. Internal consistency was assessed using Cronbach's alpha. The Norwegian version of the MHC-SF was used in the present study. The self-developed items for blue space exposure and social interaction were translated using the back-translation method. As the Norwegian and English versions used the same coding structure in Nettskjema, responses were combined for analysis. Internal consistency was assessed for the combined dataset before data analysis.

4.4.3 Mental Well-Being

Mental well-being was assessed using the Mental Health Continuum-Short Form (MHC-SF). The MHC-SF consists of 14 items and measures positive mental health defined as emotional (3 items), psychological (6 items) and social (5 items) well-being (Keyes et al., 2008; Lamers et al., 2011). Participant respond to all items based on the prompt: "*In the past month how often did you feel…*" Responses are given on a 6-point Likert scale ranging from 0 (never) to 5 (every day), with intermediate options: 1 (*once or twice a month*), 2 (*about once a week*), 3 (*two or three times a week*), and 4 (*almost every day*).
The emotional well-being items are: "*Happy*", "*interested in life*" and "*satisfied*") and example items for psychological well-being are: "*That you liked most parts of your personality*", "*good at managing the responsibilities of your daily life*". Concluding, example items for social well-being are: "*That you had something important to contribute to society*", "*that people are basically good*" and "*that the way our society works makes sense to you*".

The MHC-SF has demonstrated a high internal consistency in previous research (α = .92), and per subscale: Emotional (α = .88), psychological (α = .85) and social (α = .77) (Franken et al.,

2018; Keyes et al., 2008; Lamers et al., 2011). Internal consistency was also assessed in the present sample.

In addition to continuous scores, participants were categorised as flourishing, moderately mentally healthy or languishing, according to Keyes' criteria (Keyes, 2002; Keyes et al., 2008). Individuals classified as flourishing must reply "every day" or "almost every" on at least one emotional well-being item and at minimum seven items of social and/or psychological well-being. Languishing is defined by reporting "never" or "once or twice" a month on at least one emotional well-being item and at least six psychological and/or social well-being items (Keyes, 2006; Keyes et al., 2008; Schotanus-Dijkstra et al., 2016). The MHC-SF has been translated in Norwegian by Langeland et al. (2013), which was used for this study, this version demonstrated a similar high internal consistency as the original in English (α = .92), and per subscale: Emotional (α = .88), psychological (α = .88) and social (α = .83) (Langeland et al., 2013).

Item scores were averaged to compute a total well-being score, with higher scores indicating greater positive mental well-being.

4.4.4 Perceived Restoration

Perceived restoration was assessed using the Restoration Outcome Scale (ROS; Korpela et al., 2014, 2008). The scale consists of six items and assesses the extent to which an environment promotes psychological restoration.

In the present study, the scale was adapted to refer specifically to participants experiences in blue spaces. Participants are instructed: "*Please think about your experiences in blue spaces that you visit. Indicate to what extend spending time in these places typically makes you feel the following.*" Responses are given on a 7-point Likert scale from 0 (*not at all*) to 6 (*totally*). Three items reflect relaxation and calmness: "*I feel calmer after being here*", "*after visiting this place, I feel restored and relaxed*" and "*I get enthusiasm and energy for my everyday routines from here*". One item captures attention restoration: "*My concentration and alertness increase here*". And two items reflect clearing once thoughts: "*I can forget everyday worries here*" and "*visiting here is a way of clearing and clarifying my thoughts*".

Item scores were averaged to create a total ROS score, with higher values indicating greater perceived restoration. Previous research has demonstrated high internal consistency (α =.92) (Korpela et al., 2008). Internal consistency was also assessed for the present sample. For the Norwegian survey, the ROS was translated using the back-translation method. Because the Norwegian and English survey used the same coding structure, responses were combined for analysis, and internal consistency of the ROS assessed for the combined dataset before data analysis.

A complete overview of demographic questions, blue space exposure items, social interaction items, MHC-SF and ROS items is provided in Appendix B.

4.5 Reliability, Validity and Research Credibility

The reliability and validity of the study were addressed in several ways. First, established and previously validated instruments were used to measure well-being and perceived restoration. Mental well-being was assessed using the MHC-SF, which is available for research use and has demonstrated strong internal consistency in previous research, including the Norwegian version (Keyes, 2006; Keyes et al., 2008; Lamers et al., 2011; Langeland et al., 2013). Perceived restoration was assessed using the ROS, which was used with reference to the original source as requested by the scale author and has demonstrated high internal consistency in previous studies (Korpela et al., 2008). Internal consistency was assessed in the present sample using Cronbach's alpha for all multi-item scales.

Second, the measures for blue space exposure and social interaction were developed, based on the literature, specifically for this study, as no fitting standardised instrument was available that fully captured daily, brief and incidental blue space exposure together with social interaction during blue space use (Gehl, 2011; Georgiou et al., 2021; Korpela et al., 2008, 2014; Kosovac & Pejic, 2023; Labib et al., 2020; Rijkswaterstaat, n.d.; Shrestha et al., 2025; WHO, 2022a). This decision is supported by current systematic reviews highlighting that there is a lack of universal or standardised measures for blue space exposure in the literature (Georgiou et al., 2021; K. Wang et al., 2024). In addition, although social interaction is frequently discussed as a possible pathway linking blue spaces to well-being, it is often measured inconsistently or indirectly (Britton et al., 2020; Georgiou et al., 2021; K. Wang et al., 2024). To strengthen content validity, these items were based on previous literature and reflected the theoretical focus of the study, including frequency and duration of exposure, perceived accessibility, and passive, active and incidental forms of social interaction (Gehl, 2011; K. Wang et al., 2024). However, as these measures were self-developed, they should be interpreted with some caution and would benefit from further validation in future research.

Third, the survey was made available in both Norwegian and English to increase accessibility for participants in Norway. For translated items, a back-translation procedure was used. Nevertheless, all measures relied on self-report, meaning that responses may be influenced by recall bias, subjective interpretation and social desirability. Finally, this study uses a cross-sectional design. The findings should therefore be interpreted as associations between self-reported blue space exposure, social interaction, perceived restoration and mental well-being, rather than objective measures of environmental exposure or causal effects.

4.6 Privacy and Ethics

Participants provided informed consent before taking part in the study. Formal ethical approval was not required; however, the project was submitted to SIKT to ensure compliance with data protection requirements, and permission to conduct the study was granted (SIKT, 2025). Participants were informed that participation in the study was voluntary, without expected risk and that the results would only be reported anonymously. They were also informed that they had the right to withdraw at any time before, during and after the survey. Personal data were treated with the utmost care and confidentiality, in accordance with the General Data Protection Regulation (Regulation (EU) 2016/679). Demographic data were collected to examine covariates that may influence the outcomes. The survey was anonymous.

Chapter 5

Data Analysis

The statistical analyses were done using IBM SPSS Statistics (Version 31). A significance level of $p < .05$ was used for al statistical tests and a confidence interval of 95%. A confidence interval indicates the range of plausible values within for the true effect or relationship in the wider population, based on the data collected in the sample (Field, 2024). As described in chapter 4, the final sample consisted of $N = 142$, which was lower than the Monte Carlo power analysis indicated ($N = 275$) for the detection of the indirect effect. Therefore, mediation findings, were interpreted with caution and an exploratory approach was taken.

5.1 Descriptive Analyses

A frequency analysis was performed to explore the demographics and the main variables in terms of the means, standard deviation, and normal distributions. Missing values and outliers were checked for analysis. No cases were removed unless responses indicated technical errors or invalid completion. The final handling of missing data is reported in chapter 6, paragraph 6.2.

Although several covariates were identified based on prior literature, only key demographic and environmental variables (age, gender, education and perceived accessibility) were included in the final analyses to limit model complexity and minimize the risk of overfitting.

5.2 Reliability Analyses

Internal consistency of all multi-item scales was assessed using Cronbach's alpha and for blue space exposure the inter-item correlation will be assessed using Pearsons's correlation.

5.3 Correlation

To explore the associations between variables, Pearson's correlations were computed between the main variables, blue space exposure, social interaction, mental-well-being and restoration.

5.4 Linear Regression Models

For the first hypothesis: "Greater exposure to blue spaces is positively associated with mental well-being" a linear regression model was used with blue space exposure ("Blue_exposure") as independent variable and mental well-being ("@MHCSF") as dependent variable. A linear regression model was also used for the second hypothesis: "Greater exposure to blue spaces is positively associated with perceived restoration". The independent variable here was blue space exposure ("Blue_exposure"), the dependent variable was restoration ("@ROS"). The models were adjusted for the covariates gender (Gender_Single), age, education (Education_Single) and perceived blue space access (Blue_Access.1).

5.5 Mediation Analysis

Traditionally, the approach by Baron and Kenny (1986) required significant total effect as a condition for establishing mediation. However, contemporary bootstrapping approaches do not need this condition, as indirect effects may be present even when the total effect is non-significant (Field, 2024; Hayes, 2022; Hayes & Little, 2013). Therefore, the proposed mediation models were tested using bootstrapped confidence intervals with an indirect effect considered significant when the 95% confidence interval did not include zero (Field, 2024; Hayes, 2022). The regression-based mediation analyses were conducted using PROCESS macro, version 4.2, for IBM SPSS version 31.0 (Model 4; Hayes, 2022). Two separate mediation analyses were conducted for hypothesis three: "Social interaction during blue space exposure statistically mediates the relationship between blue space exposure and mental well-being." and hypothesis four: "Social interaction during blue space exposure statistically mediates the relationship between blue space exposure and perceived restoration."

In both models, blue space exposure was entered as the independent variable (X) and social interaction as the mediator (M). In the first model, mental well-being functioned as the dependent variable (Y) and in the second model, perceived restoration was entered as the dependent variable (Y). Indirect effects were tested using bias-corrected bootstrapping with 5000 resamples. An indirect effect was considered statistically significant if the 95% confidence interval did not include zero.

The models were adjusted for the covariates gender (Gender_Single), age, education (Education_Single) and perceived blue space access (Blue_Access.1).

Chapter 6

Results

This chapter presents the results of the statistical analyses. Beginning with the sample characteristics and descriptive analyses, followed by reliability analyses, correlations, regression models and mediation analyses. The findings are organised according to the research questions and hypotheses presented in chapter 1.

6.1 Sample Characteristics

The final sample consisted of N = 142 respondents residing in Norway. Participants ranged in age from 18 to 80, with the average age around 42. The largest group of respondents lived in urban areas (70.4%), a smaller group lived in suburban areas and even less lived rural (resp. 20.4% and 9.2%). The majority of the respondents were women (61.3%) and 36.6 % were men, 2 were non-binary/non-conforming (1.4%) and 0.7% preferred not to disclose their gender. Most respondents were married or in a partnership (71.1%) and the second largest group was single (21.1%), with most households consisting of 2, 3 or 4 people (resp. 32.6%, 16.9% and 22.5%). A large group conducted higher education (68.3%), a PhD/ Doctorate degree (11.3%) or secondary level education (11.3%). Most of the respondents were employed (66.9%), students (19%) or self-employed (7%).

6.2 Descriptive Analyses

Descriptive analyses were conducted to examine the distribution of the variables. Frequencies, means and standard deviations were computed for all variables. The distribution of continuous variables was examined using a Kolmogorov-Smirnov and Shapiro-Wilk test, histograms (see Appendix A), Q-Q plots and skewness statistics. Minor deviations from normality were observed. Missing values and outliers in the data were checked, no errors seem to have been made, therefore none of the outliers have been removed. Missing data were limited to age (8.5%) and civil status variables (1.4%). These cases were kept in the dataset because the respondents provided valid responses on the main study variables. However, analyses including age as covariate were conducted using listwise deletion, meaning that cases with missing values were excluded from the respective analyses. Consequently, adjusted regression and mediation analyses were based on a slightly smaller sample (N = 130) than analyses that did not include age.

Results of the Kolmogorov-Smirnov analysis on the data revealed that the data were not normally distributed, for restoration D (142) = .103, p < .001. Social interaction did not significantly deviate from normality (D (142) = .074, p = .053), also mental well-being met the assumption of normality (D (142) = .063, p= .200). Shapiro-Wilk tests further showed that restoration (W (142) = .938, p = < .001) and social interaction (W (142) = .970, p = .003) significantly deviate from normality, whereas mental well-being did not (W (142) = .982, p = .056). Visual inspection showed that the

distribution of the main variables was close to normal distribution (see Appendix A for histograms with normal curve per variable). Therefore, no transform was performed due to the risk of violation of the reliability of the data (Field, 2024). Table 1 shows that the measurement scales used have good internal consistency, apart from blue space exposure, as this consisted of two items only.

Table 1

Descriptives

	N	Range	Mean	Skewness	Kurtosis	*SD*	Cronbach's α
Blue_Exposure	142	-	2.21	-.459	.130	.878	.36
@MHC (mental well-being)	142	1-5	3.23	-.444	.088	.845	.93
@ROS (restoration)	142	0-6	4.03	-.851	.481	1.40	.94
@Social (social interaction)	142	0-6	3.71	-.654	1.09	1.06	.77

Note. Cronbach's alpha is reported for multi-item scales. Blue space exposure was treated as a two-item behavioural indicator, index consisting of visit frequency and typical duration. The two items showed a small but significant inter-item correlation, $r = .221$, $p = .008$, therefore the alpha value should be interpreted with caution.

6.3 Correlation

Bivariate correlations were computed as an exploratory step to examine associations between blue space exposure, mental well-being, perceived restoration and social interaction, (N = 142), results are presented in Table 2. Both Pearson and Spearman correlation were used since the data deviated slightly from normality. Blue space exposure was positively associated with perceived restoration, as indicated by a significant Pearson correlation, $r(140) = .36$, $p < .001$. A similar positive association was found between social interaction and perceived restoration, $r(140) = .36$, $p < .001$. In contrast blue space exposure was not significantly associated with mental well-being, $r(140) = .08$, $p < .159$. Spearman rank-order correlation showed similar results, indicating that blue space exposure was significantly associated with restoration $\rho(140) = .329$, $p < .001$), and similarly for social interaction and perceived restoration, $\rho(140) = .263$, $p < .001$). Spearman correlation indicated a significant association for social interaction and mental well-being $\rho(140) = .229$, $p < .001$), There was no significant correlation between blue space exposure and mental well-being, $\rho(140) = .064$, $p = .225$).

Table 2

Pearson correlations for the variables blue space exposure, mental well-being, perceived restoration and social interaction

Variable	1	2	3	4
1. Blue space exposure	_			
2. Mental well-being	.084	_		
3. Perceived restoration	.364***	.139*	_	
4. Social interaction	.248***	.165*	.357***	_

Note. N = 142.Correlations are Pearson Correlation coefficients. One-tailed tests were used. *$p < .05$, **$p < .01$, ***$p < .001$.

6.4 Linear Regression Models

The results of the multiple regression testing the first hypothesis showed no significant positive association between blue space exposure and well-being (β = .01, p = .897). Thus, blue space exposure was not associated with mental well-being, and the first hypothesis was not supported.

There was, however, a significant positive association between the outcome perceived accessibility to blue spaces and mental well-being (β = .29, p = .007), indicating that respondents who reported easier access to blue spaces tended to have higher mental well-being. No significant associations were found for the covariates age, gender and education.

The overall model was significant, $F(5, 124) = 2.93$, p = .015, explaining 10.6% of the variance in mental well-being (R^2 = .11).

In contrast to mental well-being, the results of the multiple regression testing for the second hypothesis showed a significant positive association between blue space exposure and perceived restoration (β = .40, $p < .001$). Thus, blue space exposure was positively associated with perceived restoration, and the second hypothesis was supported.

No significant associations were found between perceived restoration and the covariates (age, gender, education and perceived accessibility). Thus, while perceived accessibility was significantly associated with mental well-being in the first regression model, it was not significantly associated with perceived restoration in the adjusted restoration model. The overall model was statistically significant, $F(5, 124) = 5.53$, $p < .001$, explaining 18.2% of the variance in perceived restoration and (R^2 = .18).

6.5 Mediation Analysis

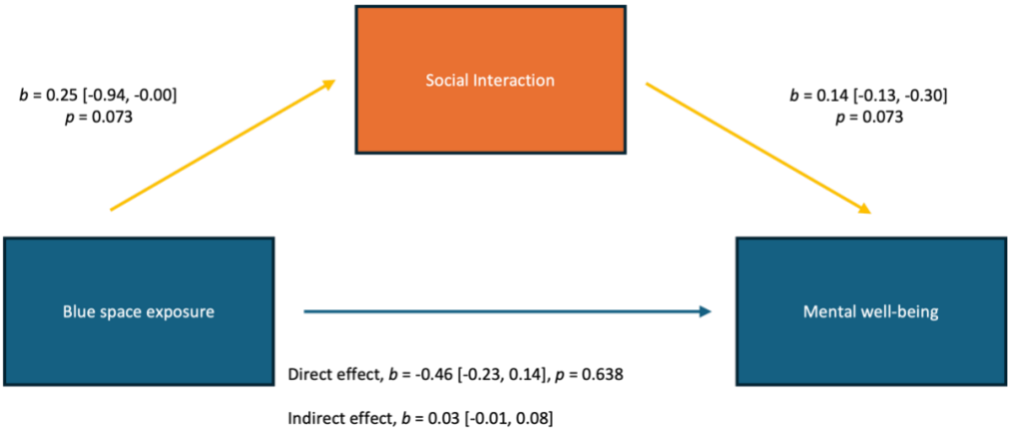
A regression-based mediation analysis was conducted using PROCESS macro version 4.2 for IBM SPSS 31.0 (Hayes, 2022) to examine whether social interaction mediated the relationship between blue space exposure and mental well-being (hypothesis three). The overall model was significant, R^2 = .14, p = .014. However, the indirect effect of blue space exposure on mental well-being through social interaction was non-significant, b = 0.03, 95% BCa CI [-0.01, 0.09], see Figure 3. This effect was small β = .04.

For the fourth hypothesis, examining whether social interaction mediated the relationship between blue space exposure and perceived restoration, the mediation analysis also showed a non-significant indirect effect, b = 0.09, 95% BCa CI [-0.01, 0.23], see Figure 4. This effect was small β = .06.

These findings indicate that social interaction did not significantly mediate either relationship, therefore both hypotheses, three and four, were not supported. However, blue space exposure did still have a significant direct association with perceived restoration, suggesting a direct rather than a socially mediated pathway.

Figure 3

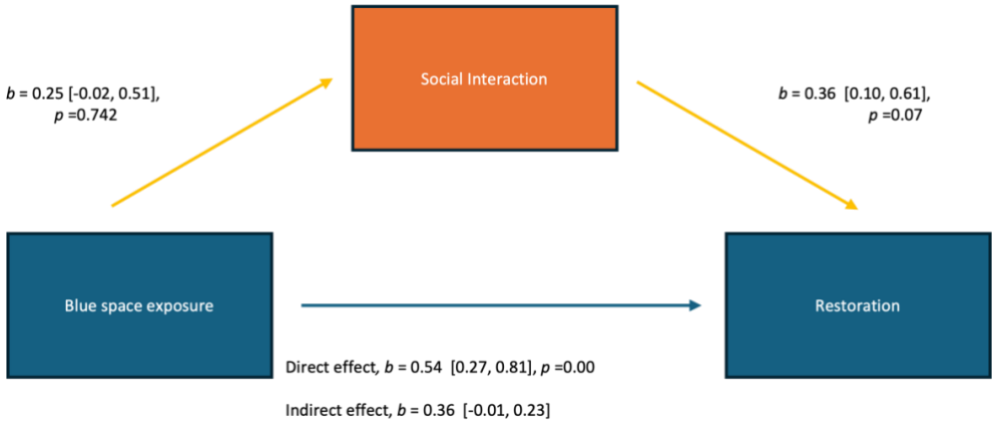
Model of blue space exposure as predictor for mental well-being, mediated by social interaction



Note. The confidence interval for the indirect effect is a BCa bootstrapped CI based on 5000 samples.

Figure 4

Model of blue space exposure as predictor for restoration, mediated by social interaction



Note. The confidence interval for the indirect effect is a BCa bootstrapped CI based on 5000 samples.

Chapter 7

Discussion: Interpreting the Findings

This chapter discusses and interprets the findings presented in chapter 6 in relation to the research questions, theoretical framework and wider sustainability context. Rather than repeating the statistical results, the chapter discusses what the pattern of findings suggests for understanding everyday urban blue spaces as restoration, social health and sustainability relevant environments.

The main objective of this study was to contribute to a more nuanced understanding of how urban blue environments might support restoration and mental well-being and whether social interaction mediated this relationship. The findings suggest that blue space exposure is more consistently associated to perceived restoration than with broader mental-well-being. In addition, perceived accessibility, rather than exposure itself, was associated with mental well-being, and the hypothesized mediating role of social interaction was not supported.

Taking everything into account, these results suggest that blue space benefits may operate through multiple pathways, with restoration appearing to be primarily driven by direct environmental mechanisms, whereas broader mental well-being may be more dependent on contextual factors such as accessibility and cumulative experiences over time.

7.1 Blue Space Exposure and Perceived Restoration

The positive association between blue space exposure and perceived restoration supports theoretical expectation originated from ART, SRT and the biophilia hypothesis. These frameworks suggest that natural environments promote recovery from mental fatigue through relatively direct psychological processes, in particular through effortless attention and emotional regulation (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Kellert & Wilson, 1993; Ulrich et al., 1991).

The present findings are consistent with previous research demonstrating that exposure to natural environments including blue spaces is associated with enhanced restoration and reduced stress (Ancora et al., 2022; Georgiou et al., 2021; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Korpela et al., 2014; Ulrich et al., 1991). However, the results of this study strengthen this literature by suggesting that such restorative benefits may even occur during brief everyday interactions, rather than only during intentional or longer visits. This aligns with emerging research emphasising the importance of incidental exposure in urban contexts (Labib et al., 2020; K. Wang et al., 2024).

One possible explanation is that blue spaces provide sensory conditions that support restoration more directly than other environments. Features such as water movement, soundscapes, and visual openness may facilitate effortless attention and reduce cognitive fatigue (Ancora et al., 2022; Zhang et al., 2025). Psychophysiological studies have shown that exposure to natural environments can activate neural processes associated with relaxation and reduced attentional

demand (Ancora et al., 2022; Zhang et al., 2025). The findings of this study support the idea that restoration may operate through direct environmental pathways, requiring limited cognitive effort or social engagement.

Importantly, the absence of a mediating effect of social interaction suggests that restoration may occur independently of social processes. While social interaction may occur together with blue space use, the findings in this study indicate that it is not necessary for restorative benefits to happen. This reinforces previous findings that restoration is one of the most consistent pathways linking natural environments to health outcomes (Georgiou et al., 2021; Korpela et al., 2008). From a sustainability perspective, restoration should not only be understood as an individual psychological outcome but also as a societal resource influencing resilience, civic participation and long-term adaptive capacity within urban populations.

While this supports a direct restorative pathway, the same pattern was not found for broader mental well-being, suggesting that restoration and well-being should not be treated as similar outcomes.

7.2 Blue Space Exposure and Mental Well-Being

In contrast to restoration, no significant association was found between blue space exposure and mental well-being. This finding suggests that the relationship between environmental exposure and well-being may differ depending on the type of outcome considered.

One interpretation for this, is that mental well-being reflects more stable and cumulative processes, whereas restoration captures immediate psychological responses to environmental exposure (Gascon et al., 2015; Geneshka et al., 2021). Although previous experimental studies have shown that brief exposure to natural environments can enhance mood and cognitive functioning, the cross-sectional findings of the present study suggest that such short-term effects may not necessarily translate into broader or long-term well-being outcomes (Berman et al., 2008; Gaekwad et al., 2022).

A key finding in this study was that perceived access to blue spaces was positively associated with mental well-being. This suggests that the availability of blue spaces, rather than exposure alone, may play a more important role in cultivating broader mental well-being. Accessible environments may function as a psychological resource, providing individuals with the opportunity to restore when needed. This interpretation is consistent with previous research linking access to natural environments with improved mental health (Labib et al., 2020; K. Wang et al., 2024).

From the perspective of the broaden-and-build theory, access to blue space may facilitate repeated opportunities for positive experiences, which over time contribute to the development of psychological resources such as resilience and optimism (Fredrickson, 2001). In this sense,

restoration and well-being may be indirectly related, where repeated restorative experiences accumulate to influence broader mental well-being over time.

It is important to note that perceived accessibility was included as a covariate in the restoration model as well but was not significantly associated with perceived restoration. This suggests that accessibility may be more relevant for broader mental well-being than for immediate restorative experiences in this sample. One possible interpretation is that restoration depends more directly on actual exposure and the quality of the blue space experience, which aligns with ART, whereas perceived access may represent a broader psychological resource linked to everyday well-being (Georgiou et al., 2021; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Korpela et al., 2008; Labib et al., 2020; K. Wang et al., 2024).

Another possible explanation relates to the measurement of mental well-being. The MHC-SF is comprised of psychological, emotional and social well-being, representing a broad and multidimensional construct (Keyes, 2002). Previous studies have often focused on narrower outcomes, such as stress, mood or symptoms of anxiety and depression, where stronger associations with blue space exposure have been found (Georgiou et al., 2021; K. Wang et al., 2024). This suggests that the absence of a direct association in this study may partly reflect differences in how mental well-being is operationalized.

In addition, there may be some conceptual overlap between the social well-being dimension of the MHC-SF and the social interaction scale used in this study. However, the MHC-SF assesses broader social well-being, whereas the social interaction scale measured interaction specifically during blue space exposure. Nevertheless, this overlap should be considered when interpreting the non-significant mediation findings.

Collectively these findings indicate that while blue space exposure may contribute to immediate restorative experiences, broader mental well-being may depend on a more complex variety of factors, including accessibility, environmental quality and cumulative experiences over time. This distinction between exposure, access and broader well-being also has implications for how social interaction is understood as a potential mechanism linking blue space exposure to health-related outcomes.

7.3 The Role of Social Interaction

Contrary to the hypothesized mediation model, social interaction did not mediate the relationship between blue space exposure and restoration or mental well-being. However, this finding should not be interpreted as evidence that social processes are irrelevant. Rather, it suggests that the role of social interaction may be more complex than a simple mediation model captures.

One possible explanation is that social interaction operates as a complementary or contextual pathway, rather than as a mediating mechanism. Blue spaces may at the same time support restoration through environmental processes and social well-being through opportunities for interaction, without one necessarily explaining the other. This interpretation aligns with previous research indicating that evidence for social interaction as a mediating mechanism remains mixed and inconclusive (Georgiou et al., 2021; Shrestha et al., 2025).

In addition, different forms of social interaction, such as passive, incidental and active interaction may have distinct effects on well-being. While passive interaction, such as seeing or hearing others may enhance feelings of safety and belonging, more active forms of interaction may contribute to social connectedness. These differences may not be adequately captured by a single overall score, which could explain the absence of a significant mediating effect in the present study.

Furthermore, social interaction may depend on contextual factors such as design, size and quality of blue spaces. Previous research suggests that certain blue environments may even reduce social interaction or cohesion depending on their characteristics (Georgiou et al., 2021). This highlights the importance of considering environmental context when examining social processes in natural settings. These findings therefore point toward a more complex model in which environmental, social and contextual pathways operate alongside one another.

7.4 Integrating Findings: Multiple Pathways to Well-Being

In sum the findings in this study suggest that the relationship between blue space exposure and well-being may be better understood as a multi-pathway process. Restoration appears to be linked primarily to direct environmental exposure, while broader mental well-being may depend more on accessibility and cumulative experiences over time. Social interaction, in contrast, did not function as a mediating mechanism, but may still operate as a contextual or parallel pathway.

This distinction highlights the importance of differentiating between short-term and long-term outcomes in environmental health research. While everyday incidental exposure to blue spaces may be sufficient to support restoration, additional factors may be required for sustained improvements in mental well-being, such as accessibility, environmental quality and repeated opportunities for positive experiences. This multi-pathway interpretation is important because it shifts the focus from the question of whether blue spaces are beneficial in general, to the question of how, for whom, and under what circumstances they may support and promote well-being.

7.4.1 Theoretical Integration: From Restoration to Sustainability Transformation

The theoretical frameworks used in this study help clarify the multi-pathway interpretations of the results and findings presented. ART, biophilia hypothesis, broaden-and-build theory and the three spheres framework each explain different levels of the relationship between blue space

exposure, restoration, mental well-being and sustainability transformation. Thus, the findings of this study suggest that the relationship between exposure to blue space and well-being cannot be explained by a single psychological mechanism alone. Instead, the results support a multi-level interpretation in which cognitive restoration, emotional processes, environmental accessibility and broader socio-ecological conditions interact.

The key finding in this study was the positive association between blue space and perceived restoration. This finding aligns particularly well with ART (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Korpela et al., 2008). Importantly, the findings suggests that these restorative effects may happen even during brief and everyday interactions with blue spaces, rather than only during intentional or longer visits. This supports emerging research highlighting the importance of incidental exposure in urban contexts, where repeated short encounters with natural environments may still provide meaningful restorative opportunities (Labib et al., 2020; K. Wang et al., 2024).

At the same time, the findings can also be interpreted through the biophilia hypothesis, which proposes that humans possess an innate emotional affiliation with natural systems (Kellert & Wilson, 1993; Wilson, 1984). The direct association between blue space exposure and restoration may therefore not only reflect cognitive restoration, but also an emotional and sensory response to water environments themselves. Features such as water movement, openness and natural soundscapes may contribute to feelings of calmness and reduced stress, supporting psychophysiological restoration processes identified in previous research (Ancora et al., 2022; Ulrich et al., 1991; Zhang et al., 2025). Together, ART, SRT and the biophilia hypothesis help explain why restoration appeared to function mainly through direct environmental exposure rather than through social interaction. ART highlights cognitive recovery, SRT highlights stress reduction and the biophilia hypothesis provides a broader explanation for why blue spaces may be experienced as calming and restorative (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Kellert & Wilson, 1993; Ulrich et al., 1991).

However, the findings concerning mental well-being suggest a more complex process. While exposure itself was not significantly associated with broader mental well-being, perceived accessibility to blue spaces was positively related to mental well-being. This distinction may indicate that restoration and mental well-being operate on different temporal and psychological levels. Restoration may reflect an immediate response to environmental exposure, whereas mental well-being may develop through repeated restorative experiences accumulated over time. From this perspective, the findings align with the broaden-and-build theory, which proposes that repeated positive emotional experiences gradually strengthen psychological and social resources such as resilience and optimism (Fredrickson, 2001). Accessible blue spaces may therefore function as long-

term supportive resources by increasing opportunities for restoration, even if the effects on broader well-being are not directly observable through short-term exposure alone.

The absence of a significant mediating role of social interaction further supports the interpretation that restoration may mainly occur through direct environmental pathways. Nevertheless, this does not necessarily mean that social processes are less important. Instead, they may operate more as a parallel or contextual mechanisms influenced by characteristics such as accessibility, design and environmental quality. The interpretation aligns with previous literature suggesting that the relationship between blue spaces and social well-being remains context dependent and insufficiently understood (Georgiou et al., 2021; Shrestha et al., 2025).

From the perspective of the three spheres of transformations framework, these individual psychological processes may also hold broader societal relevance (O'Brien, 2018). Repeated restorative experiences in everyday environments may influence how individuals perceive urban nature, shaping values, emotional attachment and support for sustainable urban development. In this sense, blue spaces may function not only as environmental resources, but also as socio-ecological infrastructure that connects human well-being with wider ecological health and sustainability transitions. This interpretation is specifically relevant within the context of nature-based solutions, where blue and blue-green infrastructures are increasingly recognised as multifunctional systems that simultaneously address climate adaptation, biodiversity and public health (Alves et al., 2024; Chatzimentor et al., 2020).

Jointly, the findings of this study support an interdisciplinary understanding of urban blue spaces as environments operating across multiple levels simultaneously. Supporting this, Table 3 presents an interpretation of the findings across psychological and sustainability dimensions. While restoration appears to happen primarily through direct environmental exposure, broader well-being outcomes may depend on cumulative experiences, accessibility and wider social and structural conditions. Integrating psychological and sustainability perspectives therefore provides a more comprehensive understanding of how blue spaces may contribute to resilient and healthy urban futures.

Having interpreted the findings at a psychological level, the next section considers what these findings imply in the Norwegian urban planning context. This is particularly relevant because the study suggests that accessibility and restorative quality, rather than exposure alone, may be important for well-being. The three spheres framework is therefore used to connect individual-level findings to broader planning, governance and NBS implementation (O'Brien, 2018).

Table 3

Interpreting the findings across psychological and sustainability dimensions

Empirical findings	Psychological interpretation	Sustainability and planning implication
Blue space exposure was not significantly associated with mental well-being	Broader mental well-being may depend on cumulative, long-term and contextual processes	Planning should not assume that exposure alone is sufficient, accessibility, quality and repeated opportunities for restoration are important
Blue space exposure was positively associated with perceived restoration	Supports ART and the biophilia hypothesis, restoration may occur through direct environmental and sensory pathways	Blue spaces can be understood as restorative infrastructure and should be integrated into everyday urban environments
Perceived accessibility was positively associated with mental well-being, but not with perceived restoration	Access may function as a psychological resource by providing the opportunity to restore when needed, for perceived restoration this might depend more on the actual exposure	Equitable access to blue spaces should be considered a public health and environmental justice issue
Social interaction did not function as a mediator	Social interaction may operate as a contextual or parallel pathway rather than a simple mediator	Blue spaces should support social use, but planning should not rely on social interaction as the only pathway to well-being
Findings suggest multiple pathways between blue spaces and mental well-being	Psychological, environmental and contextual processes may interact across different timescales	Blue spaces can be positioned as multifunctional NBS linking restoration, health, climate adaptation and urban resilience

Note. The Table presents an interpretive synthesis of the present findings and their relevance for sustainability-oriented planning.

7.5 Norway in the Socio-Ecological and Planning Context

Having established the relevance of NBS and the Norwegian planning structures in chapter 2 of this thesis, this part returns to that context in light of the study's empirical findings. The observed association to blue spaces and recovery, together with the relevance of perceived accessibility for mental-well-being, suggests that urban blue spaces should be viewed not only as technical or aesthetic planning elements, but also as health promoting socio-ecological infrastructure. The data used in this study were collected from Norwegian residents. Norway is particularly relevant due to its distinctive characteristics, its important role in the global green transition discourse and unique cultural relation with nature, seasonal variations as well as the country's abundant coastal, fjord and inland freshwater bodies (Ditlev-Simonsen, 2022; Janeka et al., 2025; Labib et al., 2020). The majority of the country's population resides in densely populated areas, and around 80% lives close to the coast (Directorate of Fisheries, n.d.; Miljødirektoratet, n.d.-b).

Norway generally has a high quality of living index, but with challenges concerning mental well-being and the recognition that the focus needs to shift from a curative to a more preventive approach to increase and strengthen general mental health and resilience over time (Helse- og omsorgsdepartementet, 2023; Tesli, 2023; WHO, 2022b). Although the use of NBS and blue-green solutions is increasingly encouraged, implementation remains limited in practice (Hohmann et al., 2025; Marino et al., 2025). To understand why these solutions are not more widely integrated into urban development, the following section examines the governance structures and planning barriers that help explain this gap between policy ambition and practical implementation.

7.5.1 Regulatory Frameworks and Planning Barriers for Nature-Based Solutions in Norway

Spatial planning in Norway is governed by a hierarchical structure with The Planning and Building Act (PBA) of 2008 serving as the legal fundament for sustainable land use and climate adaptation (Marino et al., 2025; Plan- og bygningsloven, 2008). National direction is provided every four years through the National Expectations for Regional and Municipal Planning 2023-2027, which currently prioritizes NBS for water management (Marino et al., 2025; Ministry of Local Government, 2023). A primary regulatory instrument is the State Planning Guidelines for climate and energy, which instruct that municipalities consider nature-based alternatives or otherwise they need to formally justify why they did not implement these (Lovdata, 2024). To support these guidelines, the Norwegian Environmental Agency, recently implemented an online manual to clarify these guidelines (Miljødirektoratet, 2026). However, there is a significant gap between national policy and local implementation, and although municipal master plans concerning urban planning and land use are legally binding, around seven out of ten zoning plan proposals come from private developers, who might prioritize short-term interests over broader climate ambitions (Marino et al., 2025).

Although tools like the Blue-Green Factor (BGF), which sets minimum requirements for blue-green qualities, amongst other stormwater, surface water and vegetation management in development projects, have been widely adopted, the implementation of NBS remains small-scale and fragmented (Marino et al., 2025). Marino et al. (2025) identify several critical regulatory and implementation barriers. First, the absence of a formal legal definition for NBS in Norwegian law leads to ambiguity and misinterpretation among stakeholders. Second, there are technical and financial uncertainties, specifically regarding the performance of NBS in colder climates and the distribution of the costs. Developers tend to prioritize immediate, private returns over long-term, public benefits (Marino et al., 2025). Finally, traditional departmental and budgetary silos create organisational fragmentation, such as legal restrictions that, for example, hinder the use of water charges for the maintenance of blue-green feature, thereby further delaying the transition from more conventional infrastructure (Hohmann et al., 2025; Marino et al., 2025; The Ministry of Local Government and Modernisation, 2019).

7.6 Sustainability Implications Through the Three Spheres of Transformation Framework

From the perspective of the three spheres of transformation framework, the findings of this study point beyond individual psychological processes to broader structural and political conditions (Gaekwad et al., 2022; Geels, 2019; O'Brien, 2018). Historically, transition literature focus on the practical sphere, emphasising technical innovations and behavioural responses, without including the social complexity needed for deep structural shifts, but it is essential to include personal and political dimensions of climate change (Geels, 2019; O'Brien, 2018).

Therefore, a new perspective is needed, one that acknowledges how the personal level, encompassing beliefs, values and worldviews, influence the perception of problems and possible solutions, such as in this case NBS and urban blue spaces (Geels, 2019; O'Brien, 2018). Values are what individuals find important, while beliefs shape the sense of what is possible and which actions are fitting and important here (O'Brien, 2018). Together, these contribute to how we shape reality individually, but also shared (e.g., worldviews) (O'Brien, 2018). This process is essentially political, as it validates social norms and what forms of governance are considered legitimate and feasible (O'Brien, 2018).

7.6.1 Personal Sphere: Values, Beliefs and Emotions

This study's findings on psychological restoration offer a critical, yet currently underutilized, vantage point for sustainable development. In the context of an increasing global mental health crisis, urban residents face high risks, due to the constant "directed attention" demand of their built environments (Ancora et al., 2022; Berman et al., 2008; Shrestha et al., 2025). Urban blue spaces through their restorative qualities facilitate cognitive recovery by providing "soft fascination"

allowing for attentional mechanisms to recover and restore (Berman et al., 2008; S. Kaplan, 1995; K. Wang et al., 2024).

As established in ART, directed attention, is a sensitive but essential resource in one's cognitive ability and human effectiveness (S. Kaplan, 1995). When this resource is fatigued this leaves less energy to think about and be more engaged in complex societal transformations considering for example climate change (S. Kaplan, 1995).

The association between blue space exposure and restoration observed in this study strengthens the important role of nature as a trigger for meaning making and transformative learning in the personal sphere (O'Brien, 2012, 2018). Repeated restorative experiences might give individuals more insight in their life's priorities (meaning making) (Korpela et al., 2008). One possible interpretation is that by cultivating an innate emotional connection with natural systems, these restorative experiences may ultimately promote sustainable pro-environmental behaviour and strengthen environmental stewardship (Gaekwad et al., 2022; Janeka et al., 2025; Shrestha et al., 2025).

From the perspective of the personal sphere reduced daily contact with nature may also have consequences that extend beyond immediate well-being (O'Brien, 2018). If children and young people grow up in urban environments where blue and green spaces are scarce, degraded or difficult to access, the benefits of nature may become less visible in daily life (Britton et al., 2020; Korpela et al., 2008; Shrestha et al., 2025). Over time this psychological distancing may influence how urban nature is valued, what is considered as a normal urban environment, and whether blue and green spaces are viewed as essential infrastructure or as optional amenities (O'Brien, 2018; O'Brien & Sygna, 2013; Shrestha et al., 2025). In this sense daily exposure to urban blue spaces may be relevant not only to restoration and well-being but also for shaping environmental awareness, pro-environmental behaviour, place attachment and support for sustainable urban development (Chowdhury et al., 2025; Naserisafavi et al., 2022).

7.6.2 Political Sphere: Environmental Justice and Access Inequalities

Although perceived accessibility was included as a covariate rather than a primary predictor, its significant association with mental well-being is theoretically interesting and suggests that accessibility may justify more explicit attention in future blue space research. The finding that perceived access seemed to be a more significant predictor than exposure for mental well-being is relevant for the political sphere, specifically regarding the systems and structures that govern urban space (O'Brien, 2018). The result raises critical questions of distributional justice and equal access. If mental well-being depends on the context or knowledge that a restorative resource is accessible, then the equitable distribution of these spaces becomes a fundamental public health necessity (Chelli et al., 2025; Janeka et al., 2025; K. Wang et al., 2024).

Low income and marginalized communities often live in densely built areas with limited or poor-quality blue-green infrastructure, a difference often rooted in historical environmental injustices (Janeka et al., 2025; Shrestha et al., 2025). This creates an extra disadvantage as these groups are often more vulnerable to the adverse effects of climate change, such as the urban heat island effect, while at the same time lacking the restorative resources needed to buffer these stressors (Janeka et al., 2025; Schüle et al., 2019; Shrestha et al., 2025). Consequently, preventive public health policies must shift from only promoting the importance of nature contact to making sure that blue-green infrastructure, as a public good, is equally distributed across all demographic groups (Britton et al., 2020; Janeka et al., 2025; The Ministry of Local Government and Modernisation, 2019). Another benefit here could be that if one views urban blue spaces as commons, this could even strengthen the feeling of a shared responsibility for these resources and with this further increase environmental stewardship and possibly strengthening social cohesion (Perrotti et al., 2020). In Norway, this perspective is especially relevant because access to nature is culturally and legally shaped by *allemansretten*, the right of public access, which is traditionally associated with access to uncultivated natural areas rather than dense urban environments (Miljødirektoratet, n.d.-a). However, how this shared access tradition is experienced in practice and how its values may be translated into urban life, remains less clear, particularly in dense urban areas where accessibility, design quality and ownership structures can vary (Marino et al., 2025; The Ministry of Local Government and Modernisation, 2019). Future research could therefore examine whether and how *allemansretten* influences social cohesion, stewardship and perceived accessibility in urban blue spaces.

Procedural justice, how decisions are made and who is involved is also relevant here, to ensure that the needs of all groups are recognised in the planning, also vulnerable groups, participatory co-design is therefore necessary (Alves et al., 2024; Janeka et al., 2025; Shrestha et al., 2025). In the long-term, such a structural shift towards more inclusive and health-oriented urban development could contribute significantly to lower public health costs by strengthening the resilience and well-being of the population (Britton et al., 2020; Shrestha et al., 2025).

However, significant regulatory and economic barriers persist. Although Norwegian regulations like the Climate Guidelines command that municipalities justify the selection of traditional infrastructure over NBS, this requirement is not yet consistently or rigorously executed due to a lack of clear implementation criteria and monitoring (Damman et al., 2025; Marino et al., 2025). A systematic review by Chelli et al., (2024) further identifies a core conflict between public and private interests namely, that the costs of NBS are often borne by developers, while social and environmental benefits are enjoyed by the neighbourhood or the entire city (upstream costs vs. downstream benefits) (Chelli et al., 2025). I

Furthermore, current Cost-Benefit Analysis (CBA) frequently focus on short-term financial returns for specific building solutions, failing to account for the long-term, multi-scale benefits of diverse types of NBS (Chelli et al., 2025). For a more complete political and economic picture, evaluation frameworks must move beyond limited financial metrics to include the social and environmental co-benefits that often show NBS to be more economically advantageous in the long-term (Chelli et al., 2025).

7.6.3 Practical Sphere: Systems, Infrastructure and Technical Solutions

The findings strengthen the argument for urban planning authorities and the real-estate actors to move beyond traditional hard infrastructure and increasingly consider multifunctional NBS. As argued in the introduction, urban development is increasingly expected to integrate more multifunctional nature-based systems, that can address climate adaptation, public health and social sustainability simultaneously (Hohmann et al., 2025). High quality blue spaces should be reconsidered as health and resilience promoting resources creating collective values that form attractive, resilient neighbourhoods while simultaneously addressing climate adaptation and public health (Alves et al., 2024; Hohmann et al., 2025).

However, significant technical and organisational obstacles remain. A main technical barrier is the lack of specialized knowledge and experience regarding NBS maintenance, including uncertainty about how some NBS solutions function in colder climates, which may impair features like rain gardens due to freezing temperatures (Damman et al., 2025; Marino et al., 2025). Organisationally, NBS implementation is often constrained by sectoral, departmental and budgetary silos (Hohmann et al., 2025; Marino et al., 2025).Because NBS combine water management, biodiversity, public space, health and climate adaptation functions, they may not fit within one department, budget category or professional responsibility, limiting cooperation between actors (Damman et al., 2025; Hohmann et al., 2025; Marino et al., 2025). Consequently, many developers may default to conventional building solutions that are perceived as less risky (Marino et al., 2025).

To successfully make NBS the norm, these sectoral silos must be dismantled (Damman et al., 2025). This means looking beyond the technical function of urban water systems as drainage or overflow infrastructure and instead designing them as multifunctional assets that support stormwater management, visual quality, accessibility and everyday use (The Ministry of Local Government and Modernisation, 2019). By integrating these well-being values, sensory and aesthetic qualities of water, into the technical infrastructure, the built urban environment may better support the cognitive recovery discussed in the personal sphere (The Ministry of Local Government and Modernisation, 2019). The real estate industry can play a proactive role by using infrastructure renewal to implement shared-value designs that promote long-term urban well-being, place quality and urban resilience (Chatzimentor et al., 2020; Hohmann et al., 2025).

7.6.4 Solutions and Strategies

The successful integration of urban blue spaces as NBS needs a fundamental transformation from the traditional hard or “grey” infrastructure toward multifunctional systems that simultaneously address climate adaptation, environmental quality and public health (Damman et al., 2025; Remme et al., 2024).

Transitioning to these systems is often hampered by existing planning structures, however, several strategies can be implemented to move beyond these barriers. These strategies may include:

1. **Seizing opportunities:** This is an important strategy for the integration of blue infrastructure, and may include aligning projects with planned infrastructure renewals, such as road maintenance or quay renewal (Hohmann et al., 2025; Remme et al., 2024). These opportunities make it possible to integrate nature-based elements at significantly lower additional costs, while simultaneously offering a ´niche` for urban innovation (Damman et al., 2025; Geels, 2011; Remme et al., 2024). In addition, by synchronizing long-term sustainability goals with short-term maintenance work, municipalities can reduce risk aversion among developers and governing bodies (Alves et al., 2024).
2. **Participatory co-design and stewardship:** This is needed to overcome the lack of significant mediation through social interaction found in this study; hence, planners should apply participatory co-design (Janeka et al., 2025; Shrestha et al., 2025). Viewing blue spaces as urban water commons promotes a psychological bond between residents and the environment, thereby strengthening increase community cohesion and environmental stewardship (de Groot & Thøgersen, 2018; Naserisafavi et al., 2022; Perrotti et al., 2020). While social interaction may not be a main driver for immediate restoration, local knowledge provides essential data and facilitates transformational learning making sure that infrastructure meets the actual needs of the community (Chatzimentor et al., 2020; Naserisafavi et al., 2022; O’Brien, 2012).
3. **Comprehensive social cost benefit analysis:** Important to justify public -private partnerships evaluation frameworks, which must reach beyond only the narrow financial measures to include social and environmental aspects (Chelli et al., 2025). By quantifying the economic value of mental health savings and climate adaptation benefits, such as reduced flood risk and heat stress reduction, planners can demonstrate that NBS are in the long-term often more economically advantageous (Chelli et al., 2025). This evidence is essential for distributing public funds to cover downstream public good benefits while private developers manage upstream costs (Chelli et al., 2025; Marino et al., 2025).
4. **Strategic coordination and conceptual clarity tools:** Tools such as the Infrastructure Transition Canvas (ITS) should be adopted to facilitate negotiation and map value streams

among various siloed stakeholders, including urban drainage, planning and green space departments (Hohmann et al., 2025). Furthermore, it is essential to address the ambiguity of NBS definitions to reduce uncertainty among actors (Marino et al., 2025; Remme et al., 2024). Effective NBS must address a combination of challenges by deliberately integrating ecological (living) elements, with social and economic components (Marino et al., 2025; Remme et al., 2024). This study thereby argues for the operationalisation of the framework promoted by Remme et al. (2024) for understanding the connection between NBS and ecosystems services. This framework offers policymakers and professionals a tool to address complex interconnected urban crises, such as the mental health crisis and climate adaptation (Damman et al., 2025; Remme et al., 2024).

Overall, this discussion has argued that everyday blue spaces should be understood as multifunctional socio-ecological environments. The findings suggest that blue space exposure is most directly related to perceived restoration, while broader mental well-being may depend more on accessibility, cumulative experiences and wider contextual conditions. Although social interaction did not mediate the tested relationships, it remains relevant as a possible contextual or parallel process. These findings support an interdisciplinary interpretation of urban blue spaces as restorative, socially relevant and sustainability-oriented infrastructure.

Chapter 8

Conclusion

This chapter brings the thesis to a conclusion by synthesising the main findings and reflecting on their contribution to blue space and sustainability research. It summarises the main answer to the research questions, outlines the empirical, theoretical and practical contributions, discusses limitations and future research, and ends with a final reflection of the role of urban blue spaces in sustainable urban development.

8.1 Main Conclusion

This thesis examined whether everyday blue space exposure is associated with mental well-being and perceived restoration, and whether social interaction mediates these relationships. Using a quantitative cross-sectional survey amongst the Norwegian adult population, the study investigated blue space exposure, social interaction, mental well-being and perceived restoration within a broader sustainability and urban development context.

The main conclusion is that everyday blue space exposure appears to be more directly related to perceived restoration than to broader mental well-being. Blue space exposure was positively associated with perceived restoration, supporting the idea that everyday contact with blue spaces may provide restorative benefits. However blue space exposure was not significantly associated with mental well-being. Instead, perceived accessibility was positively associates with mental well-being, suggesting that the opportunity to access blue spaces may be more relevant for overall mental well-being than exposure alone.

The hypothesised mediating role of social interaction was not supported. Social interaction did not mediate the relationship between blue space exposure and mental well-being and perceived restoration. However, the findings suggest that social interaction may operate as a contextual or alternative pathway, possibly shaped by accessibility, design, quality and social use of blue spaces.

Taken together this thesis argues that urban blue spaces should be understood through multiple but distinct pathways. Direct environmental exposure appears most relevant for restoration; perceived accessibility may be more relevant for broader mental well-being and social interaction may depend on wider spatial and social conditions. This multi-pathway interpretation is central to the thesis' contribution as it connects individual psychological outcomes to wider questions of sustainable urban planning, NBS and socio-ecological transformation.

8.2 Contributions

This thesis contributes to blue space and sustainability research by examining everyday exposure to urban blue spaces from an interdisciplinary perspective. Rather than treating mental well-being, restoration , social interaction and sustainable urban development as separate concerns,

the thesis brings these dimensions together to understand how urban blue spaces may function as both psychological and socio-ecological resources.

8.2.1 Empirical Contributions

Empirically, the study contributes by examining everyday and often incidental exposure to blue spaces, an aspect that has received less attention than deliberate recreational visits to larger blue or green areas (Labib et al., 2020; K. Wang et al., 2024). This is relevant because of much of the blue space literature has focused on coastal environments, recreational visits or broader measures of environmental availability, while less is known about how everyday interactions with urban water environments relate to well-being and restoration (K. Wang et al., 2024).

The findings add context-specific knowledge from Norway, where water environments are strongly integrated into both urban and cultural landscapes, yet remain comparatively understudied within international blue space research (Marino et al., 2025). By including mental well-being, perceived restoration, perceived accessibility and social interaction in the same study, the thesis also contributes to a more nuanced empirical understanding of different possible pathways through which blue space exposure may influence health-related outcomes (Georgiou et al., 2021). In particular, the distinction between exposure, restoration and accessibility is an important empirical contribution, as the findings suggest that these should not be treated as interchangeable dimensions (Labib et al., 2020).

8.2.2 Theoretical Contributions

Theoretically, the thesis contributes by integrating environmental psychology with sustainability transformation perspectives. The findings support the relevance of ART, SRT and the biophilia hypothesis for understanding why everyday blue space exposure may be associated with perceived restoration (Ancora et al., 2022; R. Kaplan & Kaplan, 1989; S. Kaplan, 1995; Kellert & Wilson, 1993; Ulrich et al., 1991; K. Wang et al., 2024). At the same time, the absence of a significant association between blue space exposure and broader mental well-being suggests that restoration and mental well-being may operate on different temporal and psychological levels (Ghosh & Pal, 2024; K. Wang et al., 2024).

The thesis also contributes by refining the proposed role of social interaction. Although social interaction was conceptualised as a mediating mechanism, the mediation hypotheses were not supported. This does not necessarily imply that social processes are irrelevant but suggests that social interaction may operate more as a contextual or parallel process than as a simple mediator (Georgiou et al., 2021). In this way, the findings contribute to current debates in the literature by suggesting that blue space benefits may be better understood through multiple and interacting pathways rather than a single explanatory system (Georgiou et al., 2021; K. Wang et al., 2024).

Furthermore, this study contributes conceptually by linking individual psychological outcomes to the three spheres of transformation framework (O'Brien, 2018). This integration shows how restoration and perceived accessibility can be understood not only as individual experiences, but also as part of wider questions of urban sustainability, environmental justice and socio-ecological transformation (O'Brien, 2018).

8.2.3 Policy and Practical Contributions

The thesis also offers policy and practical contributions relevant to urban planning, municipal governance and real estate development. The finding that perceived accessibility was associated with mental well-being suggests that access to blue spaces should be understood as more than a spatial of technical planning issue (Alcock et al., 2020; K. Wang et al., 2024). It may also represent a public health and social sustainability concern (The Ministry of Local Government and Modernisation, 2019). This is relevant for planners and developers because it highlights the need to consider not only the presence of blue spaces, but also their accessibility, quality and integration into everyday urban life (Alcock et al., 2020; Gaekwad et al., 2022).

In addition, the thesis supports a broader valuation of NBS. Urban blue spaces should not only be considered in terms of stormwater management, climate adaptation or aesthetic value, but also as health-supportive infrastructure with potential restorative and social benefits (Chelli et al., 2025; Damman et al., 2025). For urban development actors, including municipalities, planners and real estate developers, this implies that blue-green infrastructure can contribute to long-term societal value by linking climate resilience, public health, social sustainability and place attractiveness (Marino et al., 2025; Remme et al., 2024).

These contributions are particularly relevant in the Norwegian planning context, where national ambitions for NBS and blue-green infrastructure are increasingly present, but implementation remains limited by governance structures, sectoral silos and financial uncertainty (Marino et al., 2025). By connecting empirical findings on restoration and accessibility to these broader planning challenges, the thesis provides a basis for considering urban blue spaces as multifunctional socio-ecological infrastructure (Damman et al., 2025; Marino et al., 2025).

8.3 Limitations of the Study

This study acknowledges a number of limitations. First, the cross-sectional design of this study limits its ability to draw causal conclusions regarding the relationships between blue space exposure, restoration and mental well-being. While the mediation analyses explored indirect associations, the temporal direction of these relationships cannot be determined. It is possible, for example, that individuals with higher well-being are more likely to seek out or perceive blue spaces positively (Alcock et al., 2020).

Second, the relatively modest sample size reduced the statistical power of the mediation analyses, meaning that smaller indirect effects may not have been detected. The mediation findings should therefore be interpreted cautiously and, above all, as exploratory. This is particularly important because the non-significant mediation results do not necessarily demonstrate that social interaction is unimportant but rather that the proposed mediation model was not supported in this sample (Georgiou et al., 2021; K. Wang et al., 2024).

Third, although reliability and validity were considered through the use of established scales, internal consistency testing and theoretically informed item development, the study relied on self-report measures. This may introduce recall bias, subjective interpretation and common method variance, as all main variables were measured through the same survey method at one point in time. In particular, the self-developed measures for blue space exposure and social interaction, while theoretically informed, have not yet been extensively validated in previous research. Future studies should therefore continue to develop and test more standardised measures of everyday blue space exposure and social interaction in natural environments (Georgiou et al., 2021; Zhang et al., 2025).

Fourth, the sample consisted predominantly of highly educated respondents and women living in urban areas, which may limit the generalisability of the findings to the wider Norwegian population. Experiences of blue space may differ across demographic groups, socio-economic positions and geographical contexts (Britton et al., 2020; Shrestha et al., 2025). This is especially relevant given the thesis' emphasis on accessibility and environmental justice (Janeka et al., 2025).

Finally, although the thesis conceptually connects psychological restoration to broader sustainability transformations through the three spheres framework, these wider societal processes were not directly measured empirically. The study therefore provides a theoretical and interpretive integration rather than direct evidence of sustainability-related behavioural or societal change. The findings should therefore be read as a contribution to understanding possible links between individual restoration, accessibility and sustainable urban development, rather than as evidence that blue space exposure directly produces sustainability transformations (O'Brien, 2018).

8.4 Future Research

The findings and limitations of this study point to interesting possibilities that could be explored in future studies. Firstly, because the cross-sectional design of this study did not allow for conclusions about causality, future research could benefit from longitudinal and mixed-method approaches that further examine how repeated restorative experiences with blue spaces may influence social practices, environmental attitudes and long-term well-being outcomes over time (Geneshka et al., 2021; Georgiou et al., 2021). A promising measurement method for future research would be the experience sampling method (ESM), which allows participants to report emotions, restorative experiences, social interactions and blue space encounters in real time (Larson &

Csikszentmihalyi, 2014; Mehl & Conner, 2012). Also repeated measures can be taken over time using ESM, which could help examine whether everyday restorative experiences accumulate into broader mental well-being (Larson & Csikszentmihalyi, 2014; Mehl & Conner, 2012).

Secondly, because this study relied on self-reported exposure and perceived accessibility, future research could combine ESM with geographic information systems (GIS) or other spatial methods. GIS-based methods could provide more objective information about distance to a blue space, accessibility, visibility and environmental quality (Labib et al., 2020). Combining spatial data with real-time self-reports could reduce the risk of data distortion due to recall bias and provide a more detailed insight into perceived accessibility and actual brief and incidental exposure, such as passing a lake, river or coastal area during daily routines (Ancora et al., 2022; Labib et al., 2020; K. Wang et al., 2024). This would be particularly valuable given that perceived accessibility was associated with mental well-being in this present study.

Thirdly, future research should further validate and develop measures of everyday blue spaces exposure and social interaction. Exposure could be examined beyond frequency and duration by including visual exposure, sound, safety and type of blue space. Future studies could also combine self-reported restoration with psychophysiological measures, such as EEG or HRV, to examine cognitive restoration and stress recovery more directly (Ancora et al., 2022; Zhang et al., 2025). Social interaction should also be studied in more detail by distinguishing between passive, incidental and active forms of contact, and by testing if social interaction functions as a moderator, outcome, or parallel pathway rather than only as a mediator (Georgiou et al., 2021).

Fourthly, it would be interesting to further research blue space exposure in Norway, considering seasonal variation. Data collection of this study took place in February and March, which is late winter, early spring and experiences of blue spaces might be different in for example lighter summer and the darker winters. Seasonal differences may influence both exposure patterns and social interaction in outdoor environments (Gehl, 2011; Singh et al., 2025).

Fifthly, future research could examine whether perceived restoration functions as a pathway between blue space exposure and mental well-being over time. Although restoration was treated as an outcome in this study, the findings suggest that restorative experiences may represent a more direct response to blue space exposure, which could potentially contribute to broader well-being through repeated exposure and cumulative positive experiences.

Finally, future research should investigate how psychological and social benefits of blue spaces are understood and applied in urban planning and real estate development practice. Mixed-method studies with municipalities, planners, developers and residents could provide insight into how health related benefits are valued in decisions about NBS and blue-green infrastructure. This would help to translate evidence on restoration, accessibility and well-being into more practical

strategies for sustainable urban development and give more insight into how collaboration across sectors may help overcome the silos that currently limit the implementation of multifunctional NBS on a larger scale (Hohmann et al., 2025; Marino et al., 2025).

8.5 Final Reflection

Ultimately, this thesis argues that accessible urban blue spaces should not be understood only as aesthetic, recreational or technical elements of urban development. They may also function as restorative socio-ecological infrastructure, linking individual experiences of recovery and well-being to broader questions of climate adaptation, public health, environmental justice and sustainable urban transformation. For municipalities, planners and real estate developers this means that blue spaces should be valued not only for their environmental functions, but also to support everyday restoration, accessibility and long-term urban resilience.

References

Alcock, I., White, M. P., Pahl, S., Duarte-Davidson, R., & Fleming, L. E. (2020). Associations between pro-environmental behaviour and neighbourhood nature, nature visit frequency and nature appreciation: Evidence from a nationally representative survey in England. *Environment International*, *136*, 105441. https://doi.org/10.1016/j.envint.2019.105441

Alves, A., Van Opstal, C., Keijzer, N., Sutton, N., & Chen, W.-S. (2024). Planning the multifunctionality of nature-based solutions in urban spaces. *Cities*, *146*, 104751. https://doi.org/10.1016/j.cities.2023.104751

Ancora, L. A., Blanco-Mora, D. A., Alves, I., Bonifácio, A., Morgado, P., & Miranda, B. (2022). Cities and neuroscience research: A systematic literature review. *Frontiers in Psychiatry*, *13*. https://doi.org/10.3389/fpsyt.2022.983352

Avelino, F., Grin, J., Pel, B., & Jhagroe, S. (2016). The politics of sustainability transitions. *Journal of Environmental Policy & Planning*, *18*(5), 557–567. https://doi.org/10.1080/1523908X.2016.1216782

Bennett, N. J., & Satterfield, T. (2018). Environmental governance: A practical framework to guide design, evaluation, and analysis. *Conservation Letters*, *11*(6). https://doi.org/10.1111/conl.12600

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science*, *19*(12), 1207–1212. https://doi.org/10.1111/j.1467-9280.2008.02225.x

Biermann, F., Kanie, N., & Kim, R. E. (2017). Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability*, *26–27*, 26–31. https://doi.org/10.1016/j.cosust.2017.01.010

Britton, E., Kindermann, G., Domegan, C., & Carlin, C. (2020). Blue care: A systematic review of blue space interventions for health and wellbeing. *Health Promotion International*, *35*(1), 50–69. https://doi.org/10.1093/heapro/day103

Callaghan, A., McCombe, G., Harrold, A., McMeel, C., Mills, G., Moore-Cherry, N., & Cullen, W. (2021). The impact of green spaces on mental health in urban settings: A scoping review. *Journal of Mental Health*, *30*(2), 179–193. https://doi.org/10.1080/09638237.2020.1755027

Chatzimentor, A., Apostolopoulou, E., & Mazaris, A. D. (2020). A review of green infrastructure research in Europe: Challenges and opportunities. *Landscape and Urban Planning*, *198*, 103775. https://doi.org/10.1016/j.landurbplan.2020.103775

Chelli, A., Brander, L., & Geneletti, D. (2025). Cost-benefit analysis of urban nature-based solutions: A systematic review of approaches and scales with a focus on benefit valuation. *Ecosystem Services*, *71*, 101684. https://doi.org/10.1016/j.ecoser.2024.101684

Chowdhury, K., Basu, S., Pramanik, M., & Plieninger, T. (2025). Blue infrastructure as nature-based solutions for urban sustainability: Evaluating local perceptions from four Indian megacities. *Nature-Based Solutions*, *7*, 100211. https://doi.org/10.1016/j.nbsj.2025.100211

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. https://www.ucg.ac.me/skladiste/blog_609332/objava_105202/fajlovi/Creswell.pdf

Damman, S., Glotzbach, R., Gomes, C., Haugland, B. T., & Collette, R. (2025). Mainstreaming stormwater NBS: A study in transition governance. *Water Policy*, *27*(6), 639–656. https://doi.org/10.2166/wp.2025.238

de Groot, J. I. M., & Thøgersen, J. (2018). Values and pro-environmental behaviour. In *Environmental Psychology* (pp. 167–178). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119241072.ch17

Directorate of Fisheries. (n.d.). *Integrated coastal zone planning*. English. Retrieved April 3, 2026, from https://www.fiskeridir.no/english/coastal-management/integrated-coastal-zone-planning

Ditlev-Simonsen, C. D. (2022). *A Guide to sustainable corporate responsibility: From theory to action* (1st ed. 2022.). Springer International Publishing. https://doi.org/10.1007/978-3-030-88203-7

European Commission. (2025). *City blues: Adapting urban life with nature-based solutions*. https://environment.ec.europa.eu/news/nature-based-solutions-increase-nature-and-human-wellbeing-2025-05-21_en

Faugli, P. E. (2005). *The Norwegian water landscape- a historical view on watercourse management*. Norwegian Water Resources and Energy Directorate. https://publikasjoner.nve.no/diverse/2005/norwegianwaterlandscape2005.pdf

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Field, A. (2024). *Discovering statistics using IBM SPSS Statistics*. SAGE Publications.

Franken, K., Lamers, S. M. A., Ten Klooster, P. M., Bohlmeijer, E. T., & Westerhof, G. J. (2018). Validation of the Mental Health Continuum-Short Form and the dual continua model of well-being and psychopathology in an adult mental health setting. *Journal of Clinical Psychology*, *74*(12), 2187–2202. https://doi.org/10.1002/jclp.22659

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, *56*(3), 218–226. https://doi.org/10.1037/0003-066X.56.3.218

Fredrickson, B. L. (2013). Updated thinking on positivity ratios. *The American Psychologist*, *68*(9), 814–822. https://doi.org/10.1037/a0033584

Gaekwad, J. S., Sal Moslehian, A., Roös, P. B., & Walker, A. (2022). A meta-analysis of emotional evidence for the biophilia hypothesis and implications for biophilic design. *Frontiers in Psychology*, *13*, 750245. https://doi.org/10.3389/fpsyg.2022.750245

Gascon, M., Triguero-Mas, M., Martínez, D., Dadvand, P., Forns, J., Plasència, A., & Nieuwenhuijsen, M. J. (2015). Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review. *International Journal of Environmental Research and Public Health*, *12*(4), 4354–4379. https://doi.org/10.3390/ijerph120404354

Geary, R. S., Thompson, D. A., Garrett, J. K., Mizen, A., Rowney, F. M., Song, J., White, M. P., Lovell, R., Watkins, A., Lyons, R. A., Williams, S., Stratton, G., Akbari, A., Parker, S. C., Nieuwenhuijsen, M. J., White, J., Wheeler, B. W., Fry, R., Tsimpida, D., & Rodgers, S. E. (2023). Green and blue space and mental health. In *Green–blue space exposure changes and impact on individual-level well-being and mental health: A population-wide dynamic longitudinal panel study with linked survey data*. National Institute for Health and Care Research. https://www.ncbi.nlm.nih.gov/books/NBK597114/

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels, F. W. (2019). Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective. *Current Opinion in Environmental Sustainability*, *39*, 187–201. https://doi.org/10.1016/j.cosust.2019.06.009

Gehl, J. (2011). *Life between buildings: Using public space*. Island Press.

Geneshka, M., Coventry, P., Cruz, J., & Gilbody, S. (2021). Relationship between green and blue spaces with mental and physical health: A systematic review of longitudinal observational studies. *International Journal of Environmental Research and Public Health*, *18*(17), 9010. https://doi.org/10.3390/ijerph18179010

Georgiou, M., Morison, G., Smith, N., Tieges, Z., & Chastin, S. (2021). Mechanisms of impact of blue spaces on human health: A systematic literature review and meta-analysis. *International Journal of Environmental Research and Public Health*, *18*(5), 2486. https://doi.org/10.3390/ijerph18052486

Ghosh, S., & Pal, S. (2024). Anthropogenic impacts on urban blue space and its reciprocal effect on human and socio-ecological health. *Journal of Environmental Management*, *351*, 119727. https://doi.org/10.1016/j.jenvman.2023.119727

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach (3rd ed.)*. The Guilford Press.

Hayes, A. F., & Little, T. D. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Press.

Helse- og omsorgsdepartementet. (2023). *Escalation Plan for Mental Health (2023–2033)* (Meld. St. 23 (2022–2023)). Norwegian Ministry of Health and Care Services.

Hohmann, C., Bieker, S., & Truffer, B. (2025). Breaking out of the silo: Collaborative approaches to implementing blue-green infrastructure in urban areas. *Blue-Green Systems*, *7*(1), 95–109. https://doi.org/10.2166/bgs.2025.039

Huang, S., Qi, J., Li, W., Dong, J., & van den Bosch, C. K. (2021). The contribution to stress recovery and attention restoration potential of exposure to urban green spaces in low-density residential areas. *International Journal of Environmental Research and Public Health*, *18*(16), 8713. https://doi.org/10.3390/ijerph18168713

Iasiello, M., van Agteren, J., & Muir-Cochrane, E. (2020). Mental health and/or mental illness: A scoping review of the evidence and implications of the dual-continua model of mental health. *Evidence Base*, (1). https://doi.org/10.21307/eb-2020-001

Isgett, S. F., & Fredrickson, B. L. (2015). Broaden-and-build theory of positive emotions. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* (pp. 864–869). Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.26086-8

Janeka, P., Foellmer, J., Martinez, J. A., Schrammeijer, E. A., Hertig, E., Van Rompay, T. J. L., Cerrone, D., Sawungrana, A. R., & Anthonj, C. (2025). How green and blue spaces promote health among vulnerable urban populations facing climate hazards. A scoping review. *Wellbeing, Space and Society*, *9*, 100304. https://doi.org/10.1016/j.wss.2025.100304

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective* (pp. xii, 340). Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Kellert, S. R. (1984). Urban American perceptions of animals and the natural environment. *Urban Ecology, Special Issue Nature in the City*, *8*(3), 209–228. https://doi.org/10.1016/0304-4009(84)90036-6

Kellert, S. R., & Wilson, E. O. (Eds.). (1993). *The biophilia hypothesis*. Island Press.

Keyes, C. L. M. (2002). The mental health continuum: From languishing to flourishing in life. *Journal of Health and Social Behavior*, *43*(2), 207–222. https://doi.org/10.2307/3090197

Keyes, C. L. M. (2005). Mental illness and/or mental health? Investigating axioms of the complete state model of health. *Journal of Consulting and Clinical Psychology*, *73*(3), 539–548. https://doi.org/10.1037/0022-006X.73.3.539

Keyes, C. L. M. (2006). Mental health in adolescence: Is America's youth flourishing? *American Journal of Orthopsychiatry*, *76*(3), 395–402. https://doi.org/10.1037/0002-9432.76.3.395

Keyes, C. L. M., Wissing, M., Potgieter, J. P., Temane, M., Kruger, A., & van Rooy, S. (2008). Evaluation of the Mental Health Continuum-Short Form (MHC-SF) in Setswana-speaking South Africans. *Clinical Psychology & Psychotherapy*, *15*(3), 181–192. https://doi.org/10.1002/cpp.572

Korpela, K., Borodulin, K., Neuvonen, M., Paronen, O., & Tyrväinen, L. (2014). Analyzing the mediators between nature-based outdoor recreation and emotional well-being. *Journal of Environmental Psychology*, *37*, 1–7. https://doi.org/10.1016/j.jenvp.2013.11.003

Korpela, K., Ylén, M., Tyrväinen, L., & Silvennoinen, H. (2008). Determinants of restorative experiences in everyday favorite places. *Health & Place*, *14*(4), 636–652. https://doi.org/10.1016/j.healthplace.2007.10.008

Kosovac, A., & Pejic, D. (2023). 12 Cities and the SDGs: A spotlight on urban settlements. In L. Partzsch (Ed.), *The Environment in Global Sustainability Governance: Perceptions, Actors, Innovations* (pp. 269–294). Bristol University Press. https://www.degruyterbrill.com/document/doi/10.56687/9781529228021-025/html?srsltid=AfmBOooD-lUSOFS3Sqn4aGybj17PF78IYiq_T964CnrEHrCLmq_d8-hA

Kowarik, I., Fischer, L. K., Haase, D., Kabisch, N., Kleinschroth, F., Konijnendijk, C., Straka, T. M., & von Haaren, C. (2025). Promoting urban biodiversity for the benefit of people and nature. *Nature Reviews Biodiversity*, *1*(4), 214–232. https://doi.org/10.1038/s44358-025-00035-y

Labib, S. M., Lindley, S., & Huck, J. J. (2020). Spatial dimensions of the influence of urban green-blue spaces on human health: A systematic review. *Environmental Research*, *180*, 108869. https://doi.org/10.1016/j.envres.2019.108869

Lamers, S. M. A., Westerhof, G. J., Bohlmeijer, E. T., ten Klooster, P. M., & Keyes, C. L. M. (2011). Evaluating the psychometric properties of the Mental Health Continuum-Short Form (MHC-SF). *Journal of Clinical Psychology*, *67*(1), 99–110. https://doi.org/10.1002/jclp.20741

Langeland, E., Robinson, H. S., Moum, T., Larsen, M. H., & Wahl, A. K. (2013). Mental health among people with psoriasis undergoing patient education in climate therapy. *Scandinavian Journal of Psychology*, *54*(6), 508–514. https://doi.org/10.1111/sjop.12073

Larson, R., & Csikszentmihalyi, M. (2014). The experience sampling method. In M. Csikszentmihalyi (Ed.), *Flow and the foundations of positive psychology: The collected works of Mihaly Csikszentmihalyi* (pp. 21–34). Springer Netherlands. https://doi.org/10.1007/978-94-017-9088-8_2

Leichenko, R. M., & O'Brien, K. (2024). *Climate and society: Transforming the future* (2nd ed.). Polity Press.

Lovdata. (2024). *Statlige planretningslinjer for klima og energi*. https://lovdata.no/dokument/SF/forskrift/2024-12-20-3359

Marino, M. D., Furuseth, I. S., Enge, C., Solli, G. S., & Barkved, L. J. (2025). Nature-based solutions for climate change adaptation in urban areas: A Norwegian planning perspective. *Land Use Policy*, *157*, 107678. https://doi.org/10.1016/j.landusepol.2025.107678

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*(4), 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why Is nature beneficial? The role of connectedness to nature. *Environment and Behavior*, *41*(5), 607–643. https://doi.org/10.1177/0013916508319745

Meadowcroft, J. (2011). Engaging with the *politics* of sustainability transitions. *Environmental Innovation and Societal Transitions*, *1*(1), 70–75. https://doi.org/10.1016/j.eist.2011.02.003

Mehl, M. R., & Conner, T. S. (Eds.). (2012). *Handbook of research methods for studying daily life* (pp. xxvii, 676). The Guilford Press.

Miljødirektoratet. (n.d.-a). *Allemannsretten*. Retrieved May 19, 2026, from https://www.miljodirektoratet.no/ansvarsomrader/friluftsliv/friluftsliv-og-allemannsretten/allemannsretten/

Miljødirektoratet. (n.d.-b). *Friluftsliv i Norge*. Miljødirektoratet/Norwegian Environment Agency. Retrieved April 3, 2026, from https://www.miljodirektoratet.no/ansvarsomrader/friluftsliv/friluftsliv-og-allemannsretten/friluftsliv/

Miljødirektoratet. (2026). *Veileder: Statlige planretningslinjer (SPR) for klima og energi*. https://www.miljodirektoratet.no/ansvarsomrader/klima/for-myndigheter/kutte-utslipp-av-klimagasser/spr-klima-og-energi/

Ministry of Climate and Environment. (2024). *Meld. St. 35 (2023–2024)—Sustainable use and conservation of biodiversity* [White paper]. https://www.regjeringen.no/en/documents/meld.-st.-35-20232024/id3054780/

Ministry of Local Government. (2023). *National expectations regarding regional and municipal planning 2023–2027* (H-2543 E). https://www.regjeringen.no/contentassets/d71a3e61e774485fb4a98cab9255e53f/nasjonale_forventninger_en.pdf

Naserisafavi, N., Coyne, T., Melo Zurita, M. D. L., Zhang, K., & Prodanovic, V. (2022). Community values on governing urban water nature-based solutions in Sydney, Australia. *Journal of Environmental Management*, *322*, 116063. https://doi.org/10.1016/j.jenvman.2022.116063

Normann, H. E. (2015). The role of politics in sustainable transitions: The rise and decline of offshore wind in Norway. *Environmental Innovation and Societal Transitions*, *15*, 180–193. https://doi.org/10.1016/j.eist.2014.11.002

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography*, *36*(5), 667–676. https://doi.org/10.1177/0309132511425767

O'Brien, K. (2018). Is the 1.5°C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability*, *31*, 153–160. https://doi.org/10.1016/j.cosust.2018.04.010

O'Brien, K., & Sygna, L. (2013). Responding to climate change: The three spheres of transformation. *Proceedings of Transformation in a Changing Climate*, (pp. 16 – 23). University of Oslo. https://www.sv.uio.no/iss/english/research/projects/adaptation/publications/1-responding-to-climate-change---three-spheres-of-transformation_obrien-and-sygna_webversion_final.pdf

Paleari, S. (2024). The EU policy on climate change, biodiversity and circular economy: Moving towards a Nexus approach. *Environmental Science & Policy*, *151*, 103603. https://doi.org/10.1016/j.envsci.2023.103603

Pasanen, T. P., Ojala, A., Tyrväinen, L., & Korpela, K. M. (2018). Restoration, well-being, and everyday physical activity in indoor, built outdoor and natural outdoor settings. *Journal of Environmental Psychology*, *59*, 85–93. https://doi.org/10.1016/j.jenvp.2018.08.014

Pearlmutter, D., Theochari, D., Nehls, T., Pinho, P., Piro, P., Korolova, A., Papaefthimiou, S., Mateo, M. C. G., Calheiros, C., Zluwa, I., Pitha, U., Schosseler, P., Florentin, Y., Ouannou, S., Gal, E., Aicher, A., Arnold, K., Igondová, E., & Pucher, B. (2020). Enhancing the circular economy with nature-based solutions in the built urban environment: Green building materials, systems and sites. *Blue-Green Systems*, *2*(1), 46–72. https://doi.org/10.2166/bgs.2019.928

Perrotti, D., Hyde, K., & Peña, D. O. (2020). Can water systems foster commoning practices? Analysing leverages for self-organization in urban water commons as social-ecological systems. *Sustainability Science*, *15*(3), 781–795. https://doi.org/10.1007/s11625-020-00782-1

Plan- og bygningsloven. (2008). *Lov om planlegging og byggesaksbehandling* (LOV-2008-06-27-71). https://lovdata.no/dokument/NL/lov/2008-06-27-71

Pourmohammad-Zia, N., & van Koningsveld, M. (2024). Sustainable urban logistics: A case study of waterway integration in Amsterdam. *Sustainable Cities and Society*, *105*, 105334. https://doi.org/10.1016/j.scs.2024.105334

Rapp, B. L. (2024). *Stadig flere bor i tettsteder*. https://www.ssb.no/befolkning/folketall/statistikk/tettsteders-befolkning-og-areal/artikler/stadig-flere-bor-i-tettsteder

Remme, R. P., Meacham, M., Pellowe, K. E., Andersson, E., Guerry, A. D., Janke, B., Liu, L., Lonsdorf, E., Li, M., Mao, Y., Nootenboom, C., Wu, T., & van Oudenhoven, A. P. E. (2024). Aligning nature-based solutions with ecosystem services in the urban century. *Ecosystem Services*, *66*, 101610. https://doi.org/10.1016/j.ecoser.2024.101610

Rijkswaterstaat. (n.d.). *Handboek 3+30+300-regel*. Rijkswaterstaat. Kennisportaal Klimaatadaptatie. Retrieved January 21, 2026, from https://klimaatadaptatienederland.nl/hulpmiddelen/overzicht/handboek-3-30-300-regel/

Ringpark Het Schijn. (n.d.). DE URBANISTEN. Retrieved April 4, 2026, from https://www.urbanisten.nl/work/ringpark-het-schijn

Roba, H. S., Kolbe-Alexander, T., Baliunas, D., & Biddle, S. J. H. (2025). Associations between green space, and blue space and mental health outcomes in regional Australia: Cross-sectional and longitudinal analyses. *Journal of Affective Disorders*, *389*, 119685. https://doi.org/10.1016/j.jad.2025.119685

Rotterdam Watercity 2035. (n.d.). DE URBANISTEN. Retrieved April 4, 2026, from https://www.urbanisten.nl/work/rotterdam-watercity-2035

Schartau, A. K., Dolmen, D., Hesthagen, T., Mjelde, M., Walseng, B., Ødegaard, F., Økland, J., Økland, K. A., & Bongard, T. (Eds.). (n.d.). *Fresh water*. Retrieved April 5, 2026, from https://www.nina.no/archive/nina/pppbasepdf/Kapitler/2010/Schartau%20Fresh%20water%20K%C3%A5l%C3%A5s%20Environmental%20%20The%20Norwegian%20Biodiversity%20Information%20Centre%202010.pdf

Schoemann, A. M., Aaron, J. B., & Short, S. D. (n.d.). *Monte Carlo power analysis for indirect effects*. Retrieved January 20, 2026, from https://schoemanna.shinyapps.io/mc_power_med/

Schoemann, A. M., Boulton, A. J., & Short, S. D. (2017). Determining power and sample size for simple and complex mediation models. *Social Psychological and Personality Science*, *8*(4), 379–386. https://doi.org/10.1177/1948550617715068

Schotanus-Dijkstra, M., Pieterse, M. E., Drossaert, C. H. C., Westerhof, G. J., de Graaf, R., ten Have, M., Walburg, J. A., & Bohlmeijer, E. T. (2016). What factors are associated with flourishing? Results from a large representative national sample. *Journal of Happiness Studies*, *17*(4), 1351–1370. https://doi.org/10.1007/s10902-015-9647-3

Schüle, S. A., Hilz, L. K., Dreger, S., & Bolte, G. (2019). Social inequalities in environmental resources of green and blue spaces: A review of evidence in the WHO European region. *International Journal of Environmental Research and Public Health*, *16*(7), 1216. https://doi.org/10.3390/ijerph16071216

Shrestha, T., Voon Yi Chi, C., Cassarino, M., Foley, S., & Di Blasi, Z. (2025). Factors influencing the effectiveness of nature-based interventions (NBIs) aimed at improving mental health and wellbeing: An umbrella review. *Environment International*, *196*, 109217. https://doi.org/10.1016/j.envint.2024.109217

SIKT. (2025). *Sikt – Kunnskapssektorens tjenesteleverandør | Sikt*. https://sikt.no/

Singh, S., van de Wouw, M., Tomfohr-Madsen, L., Lebel, C., & Giesbrecht, G. F. (2025). The role of green and blue spaces in perinatal maternal mental health outcomes during the transition to parenthood. *Environment International*, *201*, 109572. https://doi.org/10.1016/j.envint.2025.109572

Steg, L. (2012). *Environmental psychology: An introduction*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/uisbib/detail.action?docID=7104525

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2019). *Using multivariate statistics* (Seventh edition). Pearson.

Tesli, M. S. (2023). *Psykiske plager og lidelser hos voksne*. Folkehelseinstituttet. https://www.fhi.no/he/fr/folkehelserapporten/psykisk-helse/psykiske-lidelser-voksne/

The Ministry of Local Government and Modernisation. (2019). *Network of public spaces: An idea handbook.* (H-2386). https://www.regjeringen.no/contentassets/c6fc38d76d374e77ae5b1d8dcdbbd92a/kmd_public-spaces_innmat_eng_org.pdf

Uglem, I., Dervo, B., Mjelde, M., Schartau, A. K., & Svenning, M. (2018). *Forest. Norwegian red list of ecosystems 2018. Norsk rødliste for naturtyper 2018.* Artsdatabanken. https://biodiversity.no/Pages/318300/Freshwater

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

United Nations. (2025a). *The-Sustainable-Development-Goals-Report-2025*. https://unstats.un.org/sdgs/report/2025/The-Sustainable-Development-Goals-Report-2025.pdf

United Nations. (2025b). *World urbanization prospects 2025: Summary of results* (UN DESA/POP/2025/TR/ NO. 12.). United Nations.

https://desapublications.un.org/publications/world-urbanization-prospects-2025-summary-results

van der Stel, J., Wortelboer, S., & Helmink, S. (Eds.). (2024). *Klimaatpsychologie*. BOOM. https://www.boom.nl/psychologie/100-15057_Klimaatpsychologie

Wang, C., Chen, S., Shao, R., & Yang, W. (2023). Redefining human health: Physical wellbeing, mental wellbeing, social wellbeing, and environmental wellbeing. *Chinese Medical Journal*, *136*(20), 2395–2396. https://doi.org/10.1097/CM9.0000000000002817

Wang, K., Sun, Z., Cai, M., Liu, L., Wu, H., & Peng, Z. (2022). Impacts of urban blue-green space on residents' health: A bibliometric review. *International Journal of Environmental Research and Public Health*, *19*(23), 16192. https://doi.org/10.3390/ijerph192316192

Wang, K., Zhang, X., & Zhou, Q. (2024). The influence of freshwater blue spaces on human health and well-being: A systematic review based on assessment method. *Environmental Research*, *263*, 120242. https://doi.org/10.1016/j.envres.2024.120242

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Westerhof, G. J., & Keyes, C. L. M. (2010). Mental illness and mental health: The two continua model across the lifespan. *Journal of Adult Development*, *17*(2), 110–119. https://doi.org/10.1007/s10804-009-9082-y

White, M. P., Elliott, L. R., Gascon, M., Roberts, B., & Fleming, L. E. (2020). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research*, *191*, 110169. https://doi.org/10.1016/j.envres.2020.110169

White, M. P., Elliott, L. R., Grellier, J., Economou, T., Bell, S., Bratman, G. N., Cirach, M., Gascon, M., Lima, M. L., Lõhmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schultz, P. W., van den Bosch, M., & Fleming, L. E. (2021). Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports*, *11*(1), 8903. https://doi.org/10.1038/s41598-021-87675-0

Wilson, E. O. (1984). *Biophilia* (1st ed.). Harvard University Press.

World Health Organization. (2022a). *Who benefits from nature in cities? Social inequalities in access to urban green and blue spaces across Europe* (Briefing no. 15/2021). https://doi.org/10.2800/041176

World Health Organization. (2022b). *World mental health report: Transforming mental health for all* (1st ed). World Health Organization.

World Health Organization. (2023). *Assessing the value of urban green and blue spaces for health and well-being* (WHO/EURO:2023-7508-47275-69347). https://www.who.int/europe/publications/i/item/WHO-EURO-2023-7508-47275-69347

World Health Organization. (2025a). *Mental health*. https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response

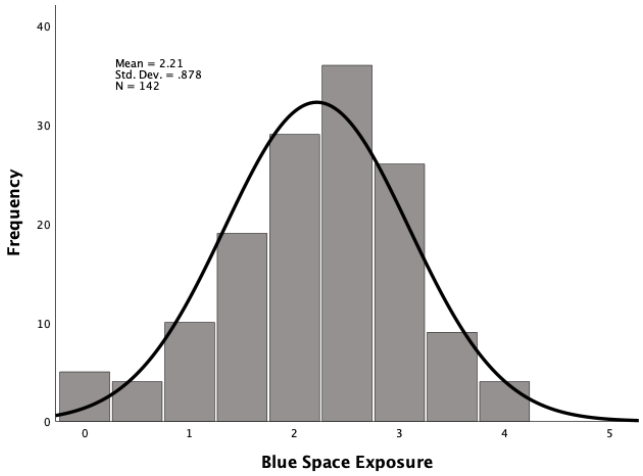
World Health Organization. (2025b). *Urban health*. https://www.who.int/news-room/fact-sheets/detail/urban-health

Zhang, Y., Zhu, X., & Li, Q. (2025). Model for impacts of urban water blue visual index and flow velocity on human brain state and its practical application. *Buildings*, *15*(3), 339. https://doi.org/10.3390/buildings15030339

Appendix A

Figure A4

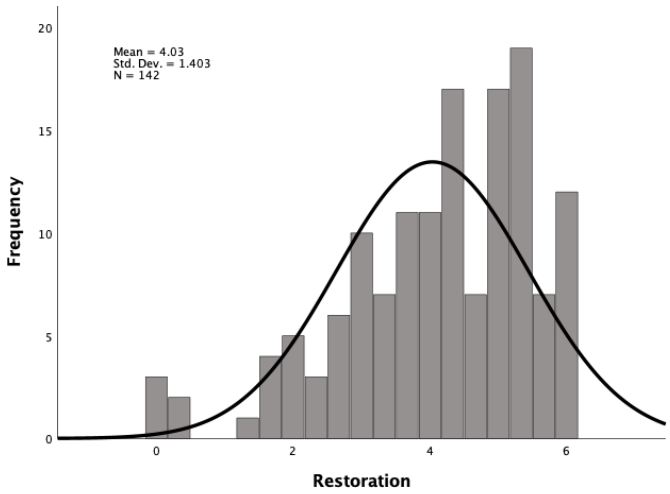
Histogram with normal curve for blue space exposure scores



Note. Blue space exposure was measured as a composite score based on frequency and duration of blue space visits, with higher scores indicating greater exposure. The black curve represents the normal curve.

Figure A5

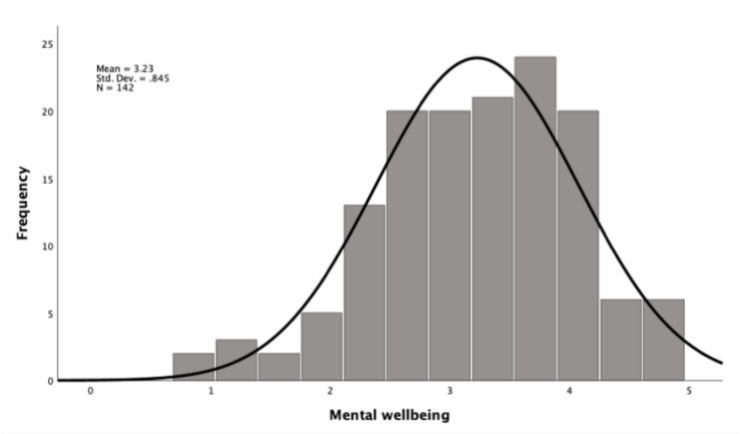
Histogram with normal curve for restoration scores



Note. Restoration was measured with a 7-point Likert scale, with higher scores indicating higher restoration. The black curve represents the normal curve.

Figure A6

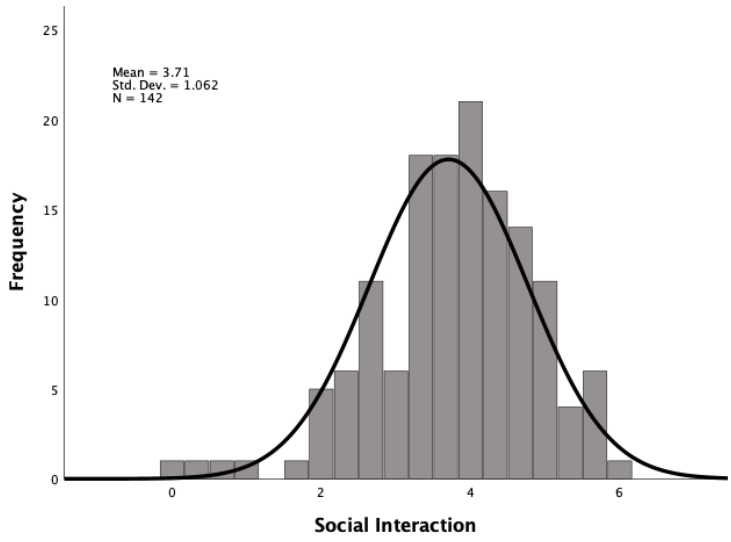
Histogram with normal curve for mental well-being scores



Note. Mental well-being was measured with a 6-point Likert scale, with higher scores indicating higher mental well-being. The black curve represents the normal curve.

Figure A7

Histogram with normal curve for social interaction scores



Note. Social interaction was measured as with a 7-point Likert scale, with higher scores indicating more social interaction. The black curve represents the normal curve.

Appendix B

Survey instruments used in this thesis:

This appendix presents the survey items used in the present study. The survey included demographic questions, the Mental Health Continuum-Short Form (MHC-SF), the Restoration Outcome Scale (ROS), a brief social interaction scale developed for this study and items measuring blue space exposure, distance and accessibility (Keyes, 2002; Korpela et al., 2008).

Note. The MHC-SF and ROS are included with reference to their original sources. The ROS was used with reference to the original source as requested by the scale author.

Demographic questions

Participants were asked to report the following demographic information:

- Gender: Man; Woman; Non-binary/non-conforming; Prefer not to say
- Age
- Civil status: Single; Married or in partnership; Widowed; Divorced; Separated; Prefer not to say
- Education: No formal schooling; Primary school; Secondary level; Tertiary vocation education; Higher education; PhD/Doctorate degree; Prefer not to say
- Employment status: Employed; Self-employed; Unemployed; Student; Retired; Unable to work; Prefer not to say
- Residential area: Urban (city or town); Sub-urban; Rural
- Household composition: How many people live in your household including yourself?

Mental Health Continuum – Short Form

The MHC-SF measures positive mental health across social, emotional and psychological well-being (Keyes, 2002; Lamers et al., 2011).

Participants were asked:

During the past month, how often did you feel …

Responses were given on a 6-point Likert scale, ranging from 0 (*Never*) to 5 (*Everyday*).

1. Happy
2. Interested in life

3. Satisfied with life
4. That you had something important to contribute to society
5. That you belonged to a community (like a social group, or your neighbourhood)
6. That our society is a good place, or is becoming a better place, for all people
7. That people are basically good
8. That the way our society works makes sense to you
9. That you liked most parts of your personality
10. Good at managing the responsibilities of your daily life
11. That you had warm and trusting relationships with others
12. That you had experiences that challenged you to grow and become a better person
13. Confident to think or express your own ideas and opinions
14. That your life has a sense of direction or meaning to it

Restoration Outcome Scale (ROS)

The ROS scale measures perceived restoration and is theoretically related to attention restoration theory, stress reduction theory and restorative environment research (Hartig et al., 1997; R. Kaplan & Kaplan, 1989; Korpela et al., 2008; Ulrich et al., 1991).

Participants were asked to think about their experiences I blue spaces that they visit and indicate to what extend spending time in these places typically makes them feel the following.

Responses were given on a 7-point Likert Scale (0 = not at all to 6 = totally).

1. I feel calmer after being here.
2. After visiting this place, I always feel restored and relaxed.
3. I get new enthusiasm and energy for my everyday routines from here.
4. My concentration and alertness increase here.
5. I can forget everyday worries here.
6. Visiting here is a way of clearing and clarifying my thoughts.

Brief Social Interaction Scale

Social interaction during blue space exposure was measured using items developed for this study, based on previous literature on social interaction, natural environments and blue space health pathways (Ancora et al., 2022; Gehl, 2011; Georgiou et al., 2021; Shrestha et al., 2025).

Participants were asked to think about what typically happens during a visit to a blue space they use.

Responses were given on a 7-point Likert scale from 0 (strongly disagree) to 6 (strongly agree).

1. I like to see and hear other people when I'm in this area.
2. I often engage in any brief, unplanned interactions (e.g., a smile, greeting, nod) with people I don't know.
3. I often spend time here specifically to meet with others or participate in a group activity (e.g., walking with a friend).
4. Blue spaces make it easier to start conversations with others.
5. I visit blue spaces together with friends, family or others.
6. Blue spaces encourage shared activities (e.g., walking, swimming, sitting).

Use of Blue Spaces

The following questions concerned participants' contact with blue spaces, such as rivers, lakes, canals, coastlines, or other water environments, in everyday life. Blue space exposure was measured using items developed for this study, based on previous literature and SDG 11 (Georgiou et al., 2021; Korpela et al., 2008, 2014; Kosovac & Pejic, 2023; Labib et al., 2020; Rijkswaterstaat, n.d.; Shrestha et al., 2025; WHO, 2022). The following questions concerned participants' contact with blue spaces, such as rivers, lakes, canals, coastlines, or other water environments, in everyday life.

Participants were asked to answer based on their typical experiences, regardless of their purpose for being there, such as walking, commuting, exercising, or other activities.

1. In the past four weeks, how often have you spent time in a blue space?
    - Never
    - Once or Twice
    - About once a week
    - Several times a week
    - Daily
2. When you spend time in a blue space, how long do you typically stay?
    - I never spend time here.
    - Less than 10 minutes

- 10-30 Minutes
- 31-60 minutes
- More than 60 minutes

3. Approximately how far is the nearest blue space from your home in walking distance?
    - Less than 300m
    - 300m–500m
    - 500m–1km
    - 1km–2km
    - More than 2km
4. How easy is it for you to access a blue space when you want to?
    - Very Difficult
    - Difficult
    - Neither Difficult nor Easy
    - Easy
    - Very Easy