GREEN AND HEALTHY NORDIC CITIES

HOW TO PLAN, DESIGN, AND MANAGE HEALTH-PROMOTING, URBAN GREEN SPACE

Green and healthy Nordic cities: How to plan, design, and manage health-promoting urban green space

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EXECUTIVE SUMMARY

This handbook is the culmination of the NORDGREEN project, which develops and implements smart planning and management solutions for well-designed, high-quality green spaces that promote health and well-being. Researchers and practitioners worked alongside one another in six Nordic cities: Aarhus (Denmark), Espoo and Ii (Finland), Stavanger (Norway), and Täby and Vilhelmina (Sweden). Together, the researchers and practitioners applied methods including GIS data analysis, statistical analysis, PPGIS surveys and analysis, policy document analysis, interviews, and evidence-based design models.

The handbook uses an innovative framework based on the multi-disciplinary approach of the project, using epidemiological studies, environmental psychology, policy and management, and citizen participation. These fields of study and their respective methodologies are divided into the four so-called NORD components—NUMBERING, OBSERVING, REGULATING, and DESIGNING—which, accompanied by a BACKGROUND section reviewing the evidence linking green space and human health, form the bulk of the handbook. Some key take-away messages from these chapters include:

- There is a fairly broad consensus that access to, and use of, natural and green areas have a positive influence on people's health and well-being.
- Both perceived and objective indicators for access to green space and for health are needed for making a more comprehensive evaluation for how people's health is influenced by green space.
- Citizens' experiential, local knowledge is a vital component of urban planning, and PPGIS can offer practitioners the opportunity to gather map-based experiential knowledge to provide insights for planning, designing, and managing green spaces.
- Alignment, both vertically across the political, tactical, and operational levels, as well as horizontally across departments, is critical for municipal organisations to foster health-promoting green spaces.
- Evidence-based design models can provide important categories and qualities for diagnosing the gaps in existing green spaces and designing green spaces with different scales and scopes that respond to the various health and well-being needs of different people.

Based on the research and lessons learned from the six case study cities, the handbook provides practitioners with a TOOLBOX of adaptable

methods, models, and guidelines for delivering health-promoting green spaces to consider in their own contexts. By reading this handbook, planners and policymakers can expect to gain (1) a background on the evidence linking green spaces and health, practical tools for planning, designing, and managing green spaces, (2) tips from researchers regarding the challenges of using various methods, models, and guidelines for delivering health-promoting green space, and (3) inspiration on some success stories emerging from the Nordic Region in this area of study. The handbook covers a wide range of health and urban green space topics. Landscape architects will find evidence-based design models for enhancing existing green space design processes. Planners will find methods and guidelines for identifying, collecting, and analysing both qualitative and quantitative green space and health data from statistical databases, national citizen surveys, and map-based participatory surveys. And all practitioners will find guidelines for achieving programmatic alignment in their work for delivering health-promoting green space.

Our hope in providing such a handbook to practitioners is that they would be both inspired and challenged to plan, design, and manage urban environments that promote the health and well-being of the people who call their cities home!

PART 1

INTRODUCTION

INTRODUCING A HANDBOOK FOR DELIVERING HEALTH-PROMOTING GREEN SPACE

LUCIANE AGUIAR BORGES & LISA ROHRER

ABSTRACT

This chapter discusses the relevance of providing local authorities with practical tools and guidelines to develop and manage urban public spaces—particularly green spaces—that promote human health and well-being. It introduces the NORDGREEN project, six case studies in Nordic cities, and the NORD framework—an innovative research framework that includes epidemiology, co-creation, governance, and environmental psychology. The combination of these different fields results in a set of tools and methods that can be employed in different planning stages and scales and can assist practitioners to plan, design, and manage health-promoting green spaces.

WHAT IS THIS HANDBOOK ABOUT?

Much of life in the Nordic countries is coloured in shades of green. Even in dense urban areas where population increase might otherwise threaten the availability of green space, public accessibility to parks, forests, and other natural resources remains high. While rural areas can often claim high green area coverage, Nordic cities challenge the notion that modern urban life must take the shape of a concrete jungle. Instead, many municipalities throughout Sweden, Norway, Finland, and Denmark show how cities can provide exposure to, accessibility to, and engagement with green outdoor environments. By doing so, planners, designers, and managers provide their residents with public spaces that can reduce stress, offer social benefits, and enable physical activity, all of which promote well-being in their populations.

This handbook aims to increase awareness and deliver knowledge to planners and policymakers on how to plan, design, and govern urban green space to promote human health and well-being. It builds on the scientific evidence showing the potential of green space to positively influence people´s health and well-being. The handbook presents tools and methods for developing and maintaining health-promoting green space in the context of Nordic cities.

Cities in the Nordic countries are often mentioned as global leaders in creating conditions for equality, well-being, and quality of life in international networks and rankings of "healthy cities" or "age-friendly cities" (WHO, n.d.-a; WHO, n.d.-b). In fact, the Nordic urban landscape is dominated by small and medium-sized cities with a relatively sparse built environment, and parks and green areas are generally publicly accessible (Randrup & Persson, 2009). Although some Nordic capital cities have a history of integrated urban planning (e.g., Copenhagen's Finger Plan), several Nordic cities are experiencing high levels of social and spatial segregation, and there are socioeconomic and health-related divides that correlate with differences in accessibility to urban amenities (Andersson, 2010; Næss et al., 2007; Tunström & Wang, 2019). Additionally, densification, especially in former industrial areas, has led to new but generally smaller green spaces that provide specific functions and limit the use to particular social groups (Randrup et al., 2020). These trends bring additional challenges to delivering restorative environments to urban populations.

Given this background, this handbook encourages civil servants to work towards ensuring that amenities such as high-quality public green spaces are available and accessible to all. These environments have the potential to positively influence people's health and well-being while tackling some socio-economic disparities.

WHY DO WE NEED A HANDBOOK ON HEALTH-PROMOTING PLANNING, DESIGN, AND GOVERNANCE OF URBAN GREEN SPACE?

Urbanisation is a critical challenge for public health

On a global scale, the World Health Organisation outlines that urbanisation is one of the critical challenges for public health in the 21st century (WHO, 2016). This is often discussed negatively, with reference to infectious outbreaks, stress-inducing lifestyles, and environmental threats. In fact, stress-related non-communicable diseases are associated with urban lifestyles and have been the cause of approximately 70% of global deaths (WHO, 2019). Furthermore, non-communicable diseases are an economic burden to governments and societies as they are the main cause of disabilities displacing a significant number of people from labour markets, increasing the demand for health services, and heightening public costs while narrowing the possibility to make use of public resources to address other urgent challenges. These burdens are prevalent in urban areas and are unequally distributed, with vulnerable populations suffering the most (Marmot & Bell, 2019). However, while urbanisation is often discussed as a threat to health, other studies clarify that, when well-managed, urbanisation is beneficial for achieving higher health outcomes (Tripathi & Maiti, 2022).

Already in 2005, mental health disorders affected approximately 27% of the EU adult population (Wittchen & Jacobi, 2005). Yet, in recent years, COVID-19 has escalated mental health disorders and emphasised all the more to policymakers the strong link between the environment and health (WHO, 2020). In particular, the role of green areas to mitigate the social isolation and mental health outcomes of lockdown policies have been extensively acknowledged in academic research (Barton et al., 2020; Davies & Sanesi, 2022; Haase, 2021; Maury-Mora et al., 2022; Ugolini et al., 2020).

From a political perspective, building healthy and liveable cities features as one out of six prescriptions outlined on the WHO Manifesto for a healthy recovery from COVID-19 (WHO, 2020). This document provides policymakers with action items to ameliorate access to

high quality public and green open spaces for people regardless of their age and abilities (WHO, 2018) and advises integrating health into urban planning policies (WHO, 2016; 2018). Furthermore, the manifesto recommends the adoption of a people-centred framework called "right to health" which combines the right for people to access, use, and transform urban environments to build social cohesion and health equity.

Responding to these various health needs and recommendations requires new approaches from planners, designers, and managers to improve liveability for urban residents.

Green public spaces are resources for improving health and well-being

In recent years, researchers and practitioners have begun to reconsider once more man's relationship with nature by exploring how nature can provide solutions to major global challenges, including physical and mental health, social inequality, and environmental crises. While the natural environment was once a barrier to overcome in developing human settlements, today urban planners have sought ways to integrate nature and reestablish our relationship with green (and blue) spaces, even within our dense city environments. The Nordic countries have a somewhat unique relationship with nature—in these northern climates, people have long understood the vital importance of living alongside the natural world and finding its value in everyday life.

Research has associated access to natural environments with physical activity, which is also important for mental and cognitive health (e.g., van den Berg et al., 2015; van den Bosch & Ode Sang, 2017) alongside other co-benefits such as climate change mitigation/adaptation and biodiversity. Furthermore, cities that promote walkability and green space accessibility have achieved significant public health cost savings compared to car-oriented cities (Baobeid et al., 2021). Natural environments may thus play a significant role in opportunities for short and long restorative moments, and they can be a resource for improving well-being, mental health, and physical health, and for preventing illness.

Urban planning, design, and governance can do more for public health

Cities are complex centres in which many problems are exacerbated due to the concentration of people, yet they are also places that have the potential to address some of our most severe challenges, including concerns about health and well-being. Enhancing public health through urban planning is not novel; it has been a strategy to counteract harmful urban conditions and pests and infections caused by them. Nevertheless, especially after COVID-19, it has become even more important to embrace public health as a primary objective in urban planning and design.

This, however, is a complex and multifaceted task as there is no "one size fits all" approach considering the distinctive characteristics of cities and the habits and preferences of their people. It is important to emphasise that more green space does not necessarily equal good health. The qualities of green space and how people perceive them all play a role. Moreover, health and well-being are complex, and a range of different factors influence health and well-being both positively and negatively. Understanding the health impacts of planning, design, and governance related to built and natural environments requires an understanding of various relationships that operate through multiple pathways. For example, individuals and social groups have different health needs and perceptions of the environment, while urban environments have particular characteristics that can be addressed differently through planning, design, and management methods.

In the Nordic countries, urban areas are home to around 71% of the total population (Statista, 2023), which, in the last decades, has become much more diverse with regards to age distribution and background (Norlén et al, 2022). Planning systems also play a role in addressing both green space and health-related factors in urban areas. Despite the challenge of responding to a heterogeneous and growing Nordic urban population, the spatial planning systems of the Nordic countries grant significant power to the local government level, which means that Nordic municipalities are accountable for delivering several services. Therefore, they have great legislative, administrative, and political power to create healthier cities.

As urban spatial qualities (e.g., density and connectivity) have a significant impact on our quality of life, including our physical and mental health, making cities accountable for public health requires coordination of different policy sectors. This includes land use transportation, green infrastructure, and the design, maintenance, and use of buildings, public spaces, and transport networks (WHO, 2022).

Focusing on public green areas which are part of the

everyday life of urban dwellers, this handbook argues that these spaces can become supportive environments.

Box 1. About NORDGREEN.

NORDGREEN develops and implements smart planning and management solutions for well-designed, high-quality green spaces that promote health and well-being. This approach to urban planning and green space design includes comprehensive analyses of green space accessibility, inclusive and participatory decision-making, and evidence-based monitoring of well-being impacts for different groups of green space users.

NORDGREEN is a consortium of four research institutions (Nordregio, Aalto University, Swedish University of Agricultural Science—SLU, and the Norwegian University of Life Science—NMBU) that work together with six cities and towns from four Nordic countries – Espoo (FI), Täby (SE), Stavanger (NO), Aarhus (DK), Vilhelmina (SE), and Ii (FI). The research-practice interaction includes participatory co-production with cities and citizens to explore pathways to transform existing and plan new public green spaces responsive to human health and well-being.

In line with the consortium group, academia and practitioners are the target audiences of NORDGREEN. This resonates with the NORDGREEN dissemination strategy that includes contributions to academic research with the publication of several scientific articles,[1] presentations at conferences, and inputs for the education of PhD, master's, and bachelor's students.[2] For practitioners, the implementation of the NORDGREEN City Talks webinar series,[3] participation in several discussion forums in the Nordic Region and Europe,[4] and the publication of this handbook are some of the main contributions of the project.

If well planned, designed, and managed, green areas hold the potential to deliver physical and mental wellness to a wide range of social groups as they enable people to release stress or act as therapeutic sites for mental and physical health recovery. They can also combat risks of lifestyle diseases such as obesity and can act as test beds for new ideas and innovations in health. From a user's perspective, these benefits can become part of inhabitants' everyday experiences in urban environments, even if they do not seek out the stress-releasing or wellness outcomes directly. To this end, the handbook provides tools and guidelines to politicians, professionals, and city makers to facilitate their work of promoting wellness for people of different ages, incomes, and cultures. The handbook therefore assists practitioners with understanding the linkages between *people* (with regards to their health and well-being) and *spaces* (specifically urban green spaces) and how these linkages can be mediated through *governance*.

These questions and local actions at the interface of green space and health are the key focus of the project Smart Planning for Healthy and Green Nordic Cities (NORDGREEN) financed by NordForsk under the programme Sustainable Urban Development and Smart Cities (see Box 1). NORDGREEN was implemented from 2020–2023. This handbook is one of the project outcomes that supports professionals dealing with urban environments and public health, with knowledge and insight to improve people's health and well-being through planning, design, and management of public green spaces.

WHAT'S IN THE HANDBOOK FOR PLANNERS AND POLICYMAKERS?

The target audience of this handbook is practitioners and policymakers responsible for planning or influencing health-promoting, public urban spaces. By reading the chapters contained in the handbook, we expect readers to walk away with:

- A richer understanding of the evidence for how green spaces can improve health.
- Clear facts for building a case to support and protect urban green spaces.

[1] As of December 2023, ten scientific articles have been published; see https://nordregioprojects.org/nordgreen-publications/

[2] Four master's theses and two bachelor's theses have been produced in conjunction with the NORDGREEN project

[3] NORDGREEN City Talks can be viewed at https://nordregio.org/events/city-talks-1-2-3-espoo-taby-stavanger-and-vilhelmina-share-experiences-on-green-urban-planning/

[4] E.g., European Green Week (2020) and European Week of Cities and Regions (2023)

- Practical and adaptable tools and guidelines for how to analyse, co-create, manage, and design green spaces.
- Useful frameworks for assessing the efficacy of existing ways of working with urban green space planning and management.
- Inspiration from research and practice in several Nordic cities.

In addition, the handbook provides an array of tools and methods that can assist planners to:

- Identify linkages between green space accessibility and health indicators. The handbook provides innovative methods for integrating public health knowledge with green space availability.
- Carry out planning processes with active and impactful public participation. The handbook shares experiences and delivers methodologies that integrate the information from citizen engagement into the planning process in meaningful ways.
- Develop new governance approaches for health and green infrastructure planning. The handbook uses a framework that helps municipalities to identify and address concerns with government silos and lack of collaboration across governance levels.
- Employ evidence-based design tools for the planning and design of urban green areas that acknowledge health and well-being, with its point of departure in existing landscape qualities. The handbook provides practical methods for assessing existing design that provides or lacks important health-promoting qualities and displays examples of how planners have applied these methods to develop green spaces that accommodate different user groups and health needs.

Contribution to policymaking

The methods, tools, and guidelines provided in the handbook aim to assist local governments in addressing key challenges raised by international strategies and agendas:

- The 17 Sustainable Development Goals (SDGs) marked out in **Agenda 2030**[5] provide a common vision for global action towards social, environmental, and economic prosperity. The research and tools developed in NORDGREEN and described in this handbook directly address Goal 3 (Ensure healthy lives and promote well-being for all at all ages), Goal 10 (Reduce inequality within and among countries), Goal 11 (Make cities and human settlements inclusive, safe, resilient, and sustainable), Goal 13 (Take urgent action to combat climate change and its impacts), and Goal 16 (Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels).
- The **EU Global Health Strategy**[6] to improve global health security and deliver better health to all. This strategy seeks to reclaim the lost position on health targets in the 2030 SDGs. The document lays out three key interrelated priorities including the delivery of better health and well-being for people of all ages. In line with this priority, this handbook exploits the potential of planning, management, and design of urban spaces to promote health and prevent illness at population level, contributing to reduced health inequalities by giving opportunities for equal and secure health for all.
- The **EU Biodiversity Strategy for 2030**[7] recognises the value of green urban spaces for the health and quality of life of citizens. The strategy recommends cities of at least 20,000 inhabitants to "..develop ambitious Urban Greening Plans" including "measures to create biodiverse and accessible urban forests, parks and gardens; urban farms; green roofs and walls; treelined streets; urban meadows; and urban hedges" (European Commission, 2020, 19). To support this action, the European Commission is currently developing guidelines for cities to elaborate their Urban Greening Plans.[8] Responding to this need, the partnership between NORDGREEN researchers and civil servants from different Nordic municipalities enables the development of tools and guidelines that can assist planners, managers, and designers to perform their work aligned with the protection, preservation, and restoration of nature bolstering biodiversity in urban areas while enhancing health.

[5] https://sdgs.un.org/2030agenda
[6] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7153
[7] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
[8] https://circabc.europa.eu/ui/group/3f466d71-92a7-49eb-9c63-6cb0fadf29dc/library/6d3d8199-38cf-443b-b4ec-3326263db9e3/details?download=true

- The **EU forest strategy**[9] for 2030 is one of the flagship initiatives of the European Green Deal. The strategy sets a vision and concrete actions to protect, restore, and enlarge European forests to fight climate change, reverse biodiversity loss, and ensure resilient and multifunctional forest ecosystems. In this strategy, urban and peri-urban areas (including, e.g., urban parks, trees on public and private property, greening buildings and infrastructure, and urban gardens) are mentioned as having the potential for extending forest and tree coverages. The document also recognises the physical and mental health benefits people can have from their exposure to green and afforested areas. The role of public green areas in complying with the main objectives of this strategy is extensively discussed in the guidelines on biodiversity-friendly afforestation and reforestation (European Commission, 2023). Through the use of public participatory methods, the handbook presents findings that reinforce the societal and environmental value of preserving nature in cities.

- The **New European Bauhaus** (NEB)[10] initiative translates the European Green Deal into actual changes in local communities that improve people's daily life, through buildings and public spaces but also in fashion or furniture. The NEB aims to enhance new lifestyles that strive for sustainability through good design that requires less carbon and is inclusive and affordable for all, while respecting the diversity of and beyond Europe. This handbook contributes to this initiative as it strengthens concrete cooperation between municipalities on green urban development and planning, delivering knowledge not only about the importance of green infrastructure for cities but also providing evidence-based models for quality and health promoting urban design.

- The **2030 Nordic Vision**[11] sets an agenda of the Nordic Region becoming "the most sustainable and integrated region in the world." This involves three intertwined strategic areas: competitive green growth, social sustainability, and environmentally friendly pursuits towards carbon neutrality and a bio-based economy. This handbook particularly responds to the social and environmental perspectives of the Nordic Vision as it delivers guidelines for including the public into the planning and design of health-promoting green areas.

HOW IS THE HANDBOOK STRUCTURED?

The NORD Framework

This handbook builds upon four components—NUMBERING (N), OBSERVING (O), REGULATING (R), and DESIGNING (D)—which make up the NORD framework (Figure 1). The framework reflects an innovative research approach that examines the health-green space nexus with assistance from epidemiology, co-creation, planning and governance, and environmental psychology as a knowledge base for strategies and policies on green space planning, management, and design. Each of the four components describe a lens through which green space and health have been analysed within the NORDGREEN project.

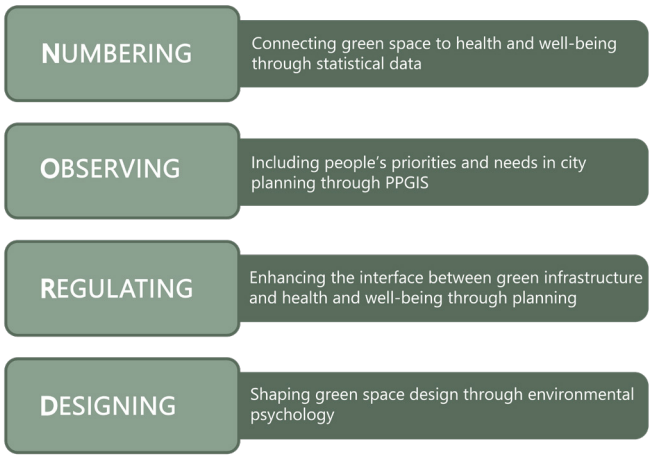


Figure 1. The NORD framework.

NUMBERING benefits from epidemiological research to bridge health and well-being data with indicators of green space access. Research according to this theme develops data and indicators for monitoring health in relation to green space characteristics (e.g., size, vegetation cover, and distance). This allows researchers and planners to estimate the relationship between green space accessibility and health and quality of life for residents in urban areas. Combining both green space and health data provides evidence to the planning, design, and management of green spaces that are responsive to human health and well-being. Furthermore, this knowledge makes it possible to identify risky areas from the perspective of health, inform planning and design interventions to improve green space quality, and establish innovative monitoring systems

[9] https://environment.ec.europa.eu/strategy/forest-strategy_en
[10] https://europa.eu/new-european-bauhaus/about/about-initiative_en
[11] https://www.norden.org/en/declaration/our-vision-2030

that allow authorities to estimate the performance of urban green spaces and public spaces in promoting health and well-being.

OBSERVING builds on co-creation to understand and integrate people's needs and their use of urban spaces into the planning process by implementing Public Participatory Geographical Information Systems (PPGIS) surveys. This public engagement method supports local planning processes as it provides evidence of the linkages between green space and critical aspects of well-being that are not included in epidemiological research (NUMBERING) or environmental psychology (DESIGNING). PPGIS surveys offer an interface where the respondents can visualise geographic areas for planning and design interventions and provide geo-located feedback. This allows practitioners to gain direct input on a map and work with different layers of information so they can identify which public spaces people use in their everyday lives and determine differences in accessibility and well-being outcomes among various user groups in a given area.

REGULATING approaches green space from an organisational perspective and studies practice to understand how different planning and management approaches influence health-promoting green space. The municipalities' organisational contexts are studied through document analysis, interviews, and workshops in the cities. Therefore, this NORD thematic area approaches planning practice by considering policies, decision-making structures, and stakeholder narratives.

DESIGNING combines environmental psychology with landscape architecture and planning to provide evidence-based design processes for the development of health-promoting outdoor environments for all people. This approach considers how people experience a green space based on its landscape qualities, and the ways in which these qualities can either stimulate them (i.e., encourage them towards physical activity or social interaction) or enable stress recovery for different social groups. While there is some recognition that nature is beneficial for human health and well-being, it is important to understand these different environmental qualities to guide health-promoting design, planning,

Table 1. NORD framework main characteristics.

	FIELD OF KNOWLEDGE	METHODS	NORD TOOLS AND GUIDELINES (SEE TOOLBOX CHAPTER)
NUMBERING	Epidemiology	GIS data analysis; statistical analysis	Methods for identifying/collecting/analysing objective/perceived indicators for access to green space, health, and both together
OBSERVING	Citizen participation	PPGIS surveys and analysis	Guidelines for designing a PPGIS survey; methods for PPGIS survey analysis; guidelines for integrating the results of PPGIS surveys into planning practice
REGULATING	Policy and management	Document analysis; interviews	Guidelines for producing a cross-disciplinary plan
DESIGNING	Environmental psychology; landscape architecture and planning	Evidence-based design models	Models for identifying environmental qualities, identifying interfaces of people and nature, and designing restorative environments

and management of green spaces. The approach ensures that evidence-based research is integrated into the design process itself so as to make a greater impact for health and well-being.

KEY TERMS USED IN THE HANDBOOK

The handbook is divided into chapters according to the four components of the NORD framework. Throughout the handbook, we often refer to *urban green spaces*. We use the term in a general sense with some caveats across the chapters. In a broad sense, urban green spaces are areas within a city's administrative territory in which natural elements (e.g., vegetation, water) are the primary expression of the environment. These spaces could be naturally vegetated or strategically planned. Since this handbook predominantly speaks to green spaces over which civil servants have influence or responsibility, we mainly focus on public and/or semi-public areas, such as parks, cemeteries, and forests. However, some chapters (for example, DESIGNING) also have potential applicability for private sector development. When conducting specific data analysis (such as in NUMBERING), the authors present more detailed terminology of green space (e.g., *vegetation cover* or *green area*) accompanied by definitions to clarify which elements of the landscape are captured in the data and subsequent analysis. Meanwhile, in OBSERVING, the authors more commonly discuss *public urban space*, which extends beyond green space alone to include all forms of space within the city to which people have public access. In REGULATING, the authors mention the term *green infrastructure* to refer to the networks of nature-based urban green spaces and elements comprised of vegetation. The handbook also refers specifically to *health-promoting green spaces,* by which we mean green spaces which have the potential to support human health and/or well-being due to their specific qualities.

The terms *human health* and *well-being* refer to the multiple dimensions—including physical, mental, emotional, social, and spiritual dimensions—that make up an individual's or group's condition and capacity to conduct activities without risk of disease, illness, or stress.

The terms *planning*, *design*, and *management* of public green space are broadly conceived throughout the different chapters to describe the multi-dimensionality of working with public green space. Together, these terms highlight three interlinked processes and responsibilities. The BACKGROUND chapter focuses on research evidence about the health benefits that people can experience through exposure to nature. In this chapter, the roles of planning, management, and design are discussed as ways to expose inhabitants to the benefits of nature. NUMBERING and OBSERVING use a broad notion of planning as a practice conducted by civil servants who analyse the combination of green space and health indicators and employ participatory methods. In REGULATING, the authors take up planning and management in more detail, describing the internal governance structures of planning across departments, the complexities across different levels of operation within local planning, and touching on the broader levels of local, regional, and national responsibilities. DESIGNING paints a more robust picture of the concept of urban design. The design of green spaces can imply either small interventions in the natural environment (e.g., paths through a forest) or the arrangement of new green elements (e.g., trees, landscaping) in a planned environment, such as a park. The chapter also refers to *evidence-based design* to describe the process of designing green space informed by evidence-based research and stepwise methods, including the characteristics of the existing landscape and environmental psychology.

WHICH CITIES DOES THE HANDBOOK FEATURE?

NORDGREEN researchers worked together with six local governments from four Nordic countries (see Figure 2)—Espoo (FI), Täby (SE), Stavanger (NO), Aarhus (DK), Ii (FI), and Vilhelmina (SE)—to explore pathways to make their public green spaces responsive to human health and well-being. These cases were carefully selected to represent different types of local authorities (capital regions, secondary cities, and rural communities) to increase the possibility of scaling up and replicating the knowledge-based planning and management tools to other cities in the Nordic Region and beyond.

The municipalities cover a range of urban typologies, making it possible to study comparable as well as contrasting urban regions and green space characteristics. Espoo (FI) and Täby (SE) are part of metropolitan regions; Aarhus (DK) and Stavanger (NO) are medium-sized, so-called secondary cities; and Vilhelmina (SE) and Ii (FI) are small towns in sparsely populated rural areas. The municipalities are spread across the Nordic Region and function both as single cases and

as starting points for comparisons and cross-sectoral Nordic learning. The research process, from development of the research plan to the final outputs, was based on close collaboration and dialogue between the municipal staff and the researchers who worked together on municipal policies and projects to create high quality, multifunctional, public green space for the well-being of their residents and socioeconomically vulnerable groups.

Figure 2. Location of NORDGREEN municipalities.

CAPITAL CITIES

ESPOO

Espoo (Finland) is the second largest municipality in Finland with 292,796 inhabitants (Aamodt et al., 2023). The municipality is part of Greater Helsinki in the region of Uusimaa and is known for its rich natural areas, shoreline, and archipelago in the Gulf of Finland. Administratively, the City of Espoo is divided into seven districts. Amongst them is Tapiola, in which the garden city model, developed in the 1950s and 1960s, became well-known amongst planners from all over the world (Hautamäki, 2021). In recent years, the city developed its Integrated Action Plan for health-responsive blue-green infrastructure (2022-2030) as a key mechanism for integrating urban development work with health-related concerns. Learn more about Espoo in this handbook in the OBSERVING chapter.

Population	292,796
Total land area	528 km^2
Population density	578 per km^2
Percent of green area coverage	45.3%
Distance to green areas	68.2 m
Area of green space per inhabitant	1,725.5 m^2

TÄBY

Täby (Sweden) is located roughly 15 km north of Stockholm, with a population of 72,755 (Aamodt et al., 2023). The municipality is one of the most highly educated and wealthiest in Sweden.[12] The municipality expects to grow significantly, with a prognosis of 100,000 inhabitants in the year 2050 (Täby Municipality, 2019). Historically a rural settlement, the area developed according to principles of the garden city and acted as a popular municipality for holiday homes until the 1950s. After this period Täby's urban development was shaped by modernist housing and transport infrastructure, which, to some extent, has added physical barriers to and limited green space. In 2022, Täby developed a comprehensive green plan, which aims for half of Täby to be green and contribute to health promotion and biodiversity. Learn more about Täby in this handbook in the NUMBERING chapter.

Population	72,755
Total land area	71 km^2
Population density	1,058 per km^2
Percent of green area coverage	32.4%
Distance to green areas	89.8 m
Area of green space per inhabitant	1,146.3 m^2

[12] Täby has the third highest median income per capita, and it scores as the sixth highest with regards to the share of highly educated population (Aamodt et al., 2023).

SECONDARY CITIES

AARHUS

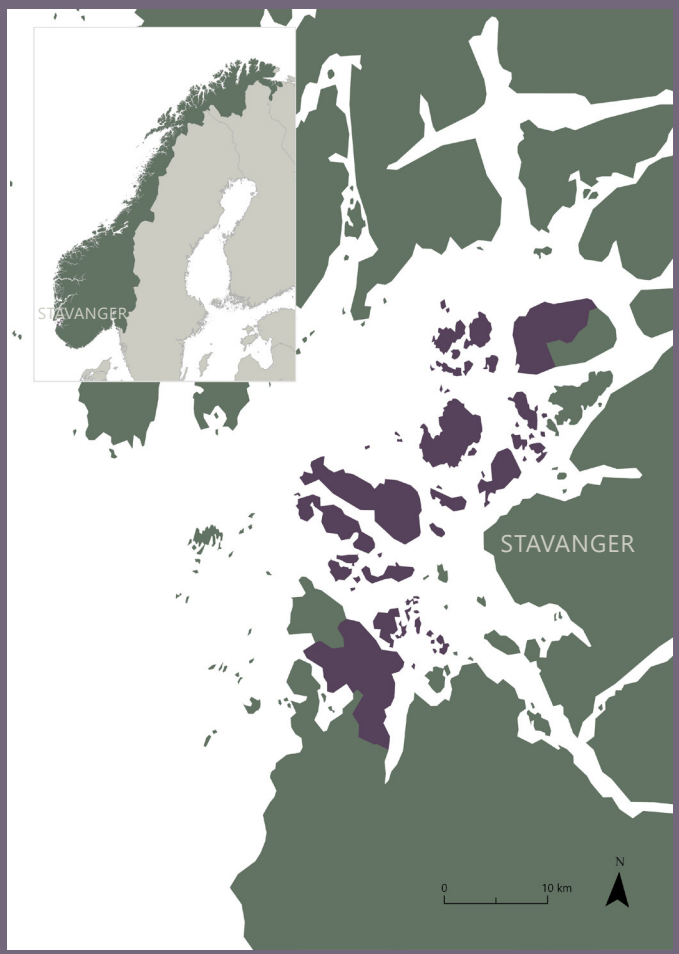
Aarhus (Denmark) is the second-largest municipality in Denmark with 352,348 inhabitants (Aamodt et al., 2023). Approximately 35% of the municipality is urbanised, with the remaining 65% dedicated to other land uses, including green open spaces (Hansen et al., 2015). The land cover of the municipality has changed with increases in urbanised areas, forests, and water and a decrease in agricultural land. Between 2009 and 2012, 320 hectares of land on the urban fringe was afforested as part of a strategy to safeguard groundwater that was under threat due to pesticides and pollutants associated with the previous agricultural land use (Hansen et al., 2015). In Aarhus, the Health Administration and the Technology and Environment Department have established a joint position to promote the integration of nature and health in daily work. Learn more about Aarhus in this handbook under REGULATING.

Population	352,348
Total land area	468 km^2
Population density	774 per km^2
Percent of green area coverage	12%
Distance to green areas	109.5 m
Area of green space per inhabitant	479 m^2

STAVANGER

Stavanger (Norway) is the fourth-largest municipality in the country, with a population of 144,147 (Aamodt et al., 2023). The coastal city is portioned into nine districts across multiple islands, agricultural land, and both dense and sprawled landscapes on the mainland. Stavanger is capital of the Rogaland County, also known as the oil capital of Norway since the oil industry boomed in the area in the 1960s. Yet by securing a good and coherent green infrastructure, Stavanger has created a reputation for itself as a role model for green cities both in Norway and internationally (Sørensen, n.d.). The joint work of landscape architects, planners, and health strategist are reflected on the revitalisation of green spaces in the city. Learn more about Stavanger in this handbook in the DESIGNING chapter.

Population	144,147
Total land area	262 km^2
Population density	558 km^2
Percent of green area coverage	31.9%
Distance to green areas	134.7 m
Area of green space per inhabitant	10,202 m^2



RURAL COMMUNITIES

VILHELMINA

Vilhelmina (Sweden) is a municipality that spans a large area of 8,740 km^2 in northern Sweden, yet it holds a relatively small population of just 6,393 inhabitants (Statistics Sweden, 2022). While it is among the smallest with regards to population size, it is one of Sweden's largest municipalities in terms of land area.[13] In general, as many other rural, sparsely populated municipalities, Vilhelmina faces the challenge of limited resources in relation to the widespread area under their governmental jurisdiction. In addition, Vilhelmina must handle the national government's strong interest in the municipality's vast and mountainous nature (Zachrisson et al., 2021). The municipality's comprehensive plan sets ambitious goals regarding good health for all on equal terms. Learn more about Vilhelmina in this handbook in the REGULATING chapter.

Population	6,393
Total land area	8,740 km^2
Population density	0.7 m^2

[13] Vilhelmina is Sweden's 259th-smallest municipality (of 290) in terms of population, but ninth-largest municipality in terms of land area.

Ii

Ii (Finland) is a municipality with 9,853 inhabitants situated by the Bothnian Bay in Finland's Northern Ostrobothnia region (Statistics Finland, 2022). It covers an area of 2,872 km^2, nearly 45% of which is water. Regarding health promotion, the municipality endorses rich opportunities for outdoor sports like swimming, running, biking, and skiing. Learn more about Ii in this handbook in the OBSERVING chapter.

Population	9,853
Total land area	2,872 km^2
Population density	3.4 km^2

HOW TO READ THE HANDBOOK

The handbook is divided into three parts:

Part 1 contains this introductory chapter, followed by a background chapter which reviews the evidence for how nature—specifically green space—can contribute to human health and well-being. BACKGROUND gathers scientific evidence about the benefits of outdoor environments for human health which can be valuable for practitioners and policymakers to realise and sustain the value of green space.

Part 2 consists of four chapters that correspond to the NORD framework. This is the bulk of the handbook in which researchers share experiences of applying various methodologies, guidelines, and tools in the case cities. Each chapter provides unique examples and key messages for practitioners to consider for their own work and in their own local contexts.

- In NUMBERING, researchers use objective and perceived indicators of both health and access to green space. The chapter shows how these indicators can be used to complement one another in planning green space for people's health by using examples from Täby.
- In OBSERVING, researchers describe how practitioners can use PPGIS to analyse how citizens use and perceive different public urban spaces, including green spaces, and integrate citizen-based knowledge into planning processes for ongoing and future green space development. The chapter highlights examples from four Nordic cities, with in-depth examples from Espoo and Ii.
- In REGULATING, researchers discuss the approach of programmatic alignment as a structure for evaluating and improving ways of working across municipal departments and levels of decision-making. Based on the contexts of Aarhus, Vilhelmina, Espoo, and Täby, researchers highlight findings from interviews with green space planners and managers, identify common gaps and existing political structures in the Nordic countries, and challenge planners to work more collaboratively, especially at the interface of green space planning and health strategy.
- In DESIGNING, researchers and landscape architects describe how they used a combination of evidence-based design models to investigate and design green spaces from an environmental psychology perspective. The chapter highlights some experiences of this work taking place in Stavanger.

Part 3 consists of a final chapter—the TOOLBOX—in which we summarise practical tools and methods for practitioners to plan, manage, and design health-promoting green space. The TOOLBOX also synthesises the messages emerging from Part 2 to describe how different methods can complement one another and be used at different stages of the planning process. We give attention to the resources (e.g., financial, time, knowledge) required to apply different tools for implementation and highlight important considerations for implementing similar methods in other contexts.

Despite being part of the NORD framework, each chapter was designed as a stand-alone article. This allows the reader to select relevant content depending on their needs and interests. It is also important to recognise that the tools and methods discussed throughout the handbook can be applied in various ways depending on the local context. What works well in one city may not have the same results in another city, even within the same country. Practitioners should value the examples and ideas herein as inspiration and not as a recipe for success to be replicated directly in another place. Instead, practitioners can ponder over these messages, identify which elements apply to their own contexts, and consider how the tools and methods can be integrated into existing practices or appropriated to suit new ways of working with green space and health.

BACKGROUND

THE SCIENTIFIC EVIDENCE FOR NATURE'S POSITIVE INFLUENCE ON HUMAN HEALTH AND WELL-BEING

KJELL NILSSON & PATRIK GRAHN

ABSTRACT

Over the past 40 years, many research projects have concluded that natural environments have a positive impact on human health and well-being. Researchers have also proposed that this knowledge can be used in health promotion and care. However, scepticism remains among many health professionals about nature's healing ability. Furthermore, the importance of green areas for people's health and well-being is not always integrated properly in the planning and design of our cities. The purpose of this chapter is to provide practitioners with research-based documentation through a critical mapping of the evidence concerning how natural environments affect human health as well as an introduction to theories within the field. The content consists of a meta-review of systematic reviews of scientific articles based on studies of the impact of nature on health. The purpose has been to map out and categorize existing literature and critically evaluate its quality by determining the degree of evidence regarding a causal relationship between human exposure to nature and subsequent health and well-being. The results show that there are many health benefits of living near green areas, at least in an urban context, especially if they are large and offer various environmental qualities. Some of the evidence from these reviews can be directly utilised in urban planning and design, but more research is needed regarding how cities can apply and integrate these findings into policy and planning.

INTRODUCTION AND BACKGROUND

A common desire from practitioners involved in the planning, design, and management of the city's outdoor environment is the need for reliable documentation regarding the influence of greenery on human health and well-being. This is useful for practitioners seeking to motivate decision-makers to invest in the construction of new and management of existing green spaces. Therefore, this chapter provides readers with an account of how strong the evidence is that green has a positive effect on health and well-being. Let's start with a short history and a brief introduction to the theories that have formed the basis of our understanding of how nature affects human health and well-being.

When the first public parks were created in cities almost 200 years ago, their importance for public health was one of the central arguments. Today, when public parks and other green areas are under pressure, planners can utilise scientific, health-related arguments to determine a balance between densification and providing residents with ample access to green spaces.

Over the past 50 years, researchers have suggested that spending time in, and having easy access to, forests, parks, and gardens may promote human health and well-being. Many experimental studies have documented (short-term) mental well-being benefits and, to a lesser extent, physiological effects. Additional (cross-sectional and longitudinal) epidemiological studies have shown a positive association between access to and contact with nature and (long-term) health and well-being, both mental and physical, in real-life situations. Likewise, researchers as well as practitioners have sought to apply such knowledge in the planning, design, and management of urban green areas and in how to conduct nature-based interventions.

19th century green salubrious urban planning

During the latter half of the 19th century and the first few decades of the 20th century, concerns regarding public health were of great importance for urban design and spatial planning, not least the planning and design of public parks. Representatives from several different disciplines began building parks for people in industrial cities with the intention of improving the health of residents and using nature and gardens to treat diseases. Planning and health went hand in hand. In some cases, for example, in Iceland, the first national planning legislation was prepared by an architect and an engineer alongside medical doctor Gudmundur Hannesson (Bogadottir, 2021). These ideas came after the industrialisation of the 19th century, when the number of inhabitants in many cities increased sharply, which led to congestion and diseases. Among the proponents of improving health via nature were Frederick Law Olmsted—creator of many American city parks and national parks—as well as influential American physician John H. Rauch, creator of the kindergarten Friedrich Fröbel, and founder of physiotherapy Pehr Henrik Ling. The intention was to create "green salubrious cities" (Szczygiel & Hewitt, 2000).

In the following sub-sections, we will give a brief introduction to the dominating theories regarding man's experience of nature and its effects on human health and well-being. This information can provide some insights for green space planners, designers, and managers working to promote health in their contexts. One of the major challenges in research has been to explain the causality in the relationship between nature and man. The theories below are attempts to explain why greenery has a positive effect on people's health and well-being.

Evolutionary theories

Early attempts to explain more deeply how nature affects people mentally arose with the intention of finding out what preferences people have in relation to different types of landscapes. Most prominent among these are the biophilia hypothesis (Fromm 1964; Wilson, 1984), the savannah theory (Orians, 1980), and the prospect-refuge theory (Appleton, 1975). These evolutionary theories emerged at a time when the awareness of environmental destruction and the limits of growth led to increased care for nature. To some degree, these theories responded to the changing needs of the time towards valuing and protecting nature.

The leading idea behind the biophilia hypothesis is that, due to genetics, people prefer environments and processes that involve contact with plants, animals, and natural landscapes (Hartig et al., 2011). According to this theory, creatures that have an easier time adapting to different environmental conditions have an easier time surviving and thus a better ability to reproduce.

In the savannah theory, this thought is carried forward by pointing out the environments perceived as most suitable for prehistoric man to survive in. According to Orians (1980), the tropical savannah, especially where the landscape varies with refuges such as rocks and caves, was an ideal environment for our ancestors to live in. A prerequisite for surviving on a savannah full

of predators is that you can spot danger and hide before it is too late. This is the premise of the prospect-refuge theory which, according to Appleton (1975), means that humans prefer places where we can see without being seen.

Common to these theories is that they assume that our environmental preferences are based on avoiding the dangers and overcoming the challenges that our prehistoric ancestors faced in their environment. Although the same threats do not exist in today's urban environments, the theories assume that elements that were once important for the survival of our ancestors are still perceived positively by modern man.

Theories about mental restoration

The next step in the theoretical development regarding nature's influence on human health and well-being are theories of mental restoration such as Stress Reduction Theory (SRT) and Attention-Restoration Theory (ART). Both theories hold that urban and artificial environments increase the experience of stress, and they provide explanations for why nature has a restorative effect on people suffering from mental fatigue or high levels of stress. These theories for mental restoration arose in the 1980s, at a time of explosive growth in the prescription of anti-depressant medications and a growing interest in alternative treatments. Since the 1980s, these two theories have dominated the discourse around why visiting natural environments has a positive impact on people's mental well-being.

In his explanation of SRT, Roger Ulrich (1979, 1983) claims that, through evolution, humans have developed congenital abilities to quickly determine whether a situation is dangerous or not. High cliffs, darkness, snakes, and spiders, as well as certain noises (e.g., roaring animals) and smells (e.g., smoke from a fire) make us extra vigilant and raise levels of stress. These sensations are bio-phobic, while bright, open landscapes, especially if they are adjacent to water, are biophilic and rapidly decrease people's stress levels and vigilance (Ulrich, 1993). A review by Corazon et al. (2019) supports the theory, revealing that exposure to biophilic natural environments have a positive effect on various emotional parameters that can be related to stress relief. In summary, the authors argue that recent years' research has established a sound evidence base for achieving positive psychological and emotional effects through exposure to natural environments as described by SRT. However, results are less clear regarding physiological effects.

ART (Kaplan & Talbot, 1983; Kaplan & Kaplan, 1989) claims that we have two types of attention: directed and spontaneous. Directed attention is used for our executive ability—in other words, perceiving which actions to take, prioritising tasks, planning, and implementation. In addition, directed attention is used to block information (both external, such as noise, and internal, such as one's own thoughts) that interferes with executing a task. To regain attention after your executive abilities have been compromised, one needs to come to a place that is free of noise and disturbing impressions that compete for your directed attention. ART suggests that natural areas are helpful for this because they only require spontaneous attention—which is used to perceive elements around us, such as the glitter on a water surface or the drilling of a woodpecker. If one is not given the opportunity to recover his or her executive abilities, one may suffer from "directed attention fatigue" or exhaustion (Kaplan, 2001).

Ohly et al. (2016) conducted a meta-analysis that provided some support for ART: their analysis showed that, when using some research methods, exposure of natural environments has significant positive effects on directed attention capacity; however, other research methods yielded less beneficial results. According to these results, it is unclear which aspects of directed attention capacity can increase from exposure to natural environments. As a follow-up, Stevenson et al. (2018) conducted a systematic review of 42 studies. The results showed that exposure to natural environments improves working memory, cognitive flexibility, and, to a less reliable degree, attention control.

Contemporary theories

Forest bathing (*shinrin-yoku*) is a widely practised activity in Japan and South Korea (Garcia & Miralles, 2020). Researchers show that spending time in a forest has a positive effect on health, not only because the peaceful forest environment affects us mentally, but also because trees secrete substances that affect us physiologically. A chief theory among this research is the so-called phytoncide theory (Li, 2012), which claims that trees release phytoncides which trigger the human body to produce natural killer cells and intracellular anti-cancer proteins in the lymphatic system, thus strengthening our immune systems.

Other theoretical attempts have adopted an ecosystem services approach and described pathways towards a better understanding of the relationship between access to and spending time in natural environments,

and human health and well-being (Hartig et al., 2014; Shanahan et al., 2015; Markevych et al., 2017). Markevych et al. (2017) emphasize three functions of green space with regards to health: green space reduces harm (such as air pollution, noise, and heat), restores capacities such as stress recovery, and builds capacities such as encouraging physical activity and facilitating social cohesion.

Table 1. Basic modern theories on nature's influence on human health and well-being.

TYPE OF THEORY	THEORY	KEY REFERENCES	MAIN MESSAGE	RELEVANCE FOR HEALTH-PROMOTING PLANNING AND DESIGN
Evolutionary theories	Biophilia	Fromm, 1964; Wilson, 1984	People have a preference for environments that involve contact with other biological life.	Mostly used for assessment of landscape attractiveness and biophilic design.
	Prospect-Refuge Theory	Appleton, 1975	People prefer places where they can see without being seen.	Can be applied in urban design by arranging places that offer both viewpoints and hideaways.
	Savannah Theory	Orians, 1980	The tropical savannah provides the ideal combination of natural elements needed for basic human survival.	See Prospect-Refuge Theory
Mental restoration theories	Stress Reduction Theory (SRT)	Ulrich, 1979, 1983	Natural environments have a positive effect on parameters related to stress relief.	Mostly practised in therapeutic treatment of stress-related illness, but also relevant regarding the need for peaceful natural spots in public areas.
	Attention Restoration Theory (ART)	Kaplan & Kaplan, 1989; Kaplan, 2001	To regain attention from a stressful daily life, one needs a place that is free of noise and disturbing impressions.	See Stress Reduction Theory
Contemporary theories	Phytoncide Theory	Li, 2012	Trees release phytoncides which trigger the body to produce natural killer cells and anti-cancer proteins.	People living in cities should have access to urban forests.
	Pathways	Markevych et al., 2017; Bratman et al., 2019	The effects of nature on human health and well-being depend on the elements of nature, the exposure to this nature, and the experiences resulting from this.	Green spaces in cities should be large enough and well-distributed so that inhabitants get sufficient exposure to meet their needs for contact with nature for their health and well-being, regardless of where they live or their socio-economic background.
	Calm and Connection Theory	Grahn et al., 2021; Stoltz & Grahn, 2021	The effects of nature are due to the activation of the body's oxytocinergic system.	Planning and design of green areas should take place so that people can visit both stimulating and restorative green areas within a reasonable distance.

Building on Markevych et al. (2017), Bratman et al. (2019) introduced a new conceptual model that distinguishes four aspects to consider when studying pathways by which nature may affect human health and well-being: (i) the *elements* of nature, including quantity, composition, and location; (ii) the amount of (actual) *exposure* to this nature, intentionally as well as incidentally (i.e., how much nature you have access to as well as the frequency and duration of nature contact); (iii) the *experience* resulting from exposure and engagement (i.e., the sensory qualities of the exposure); and finally (iv) the *effects* of nature (i.e. the potential mental health impacts that follow from a nature experience).

Researchers at the Swedish University of Agricultural Sciences propose a theory—the Calm and Connection Theory—which explains stress reduction and recovery of attention capacity, but also physiological health effects and so-called "instorative" effects, such as increased coping skills (Grahn et al., 2021). The theory is that basic neurological systems (oxytocinergic systems) are activated in natural areas that are perceived as attractive and safe. Nature provides a possible role for the human oxytocinergic system to act as a physiological mediator of several health-promoting effects. When the hormone oxytocin is released, a chain reaction occurs where the parasympathetic system is activated along with several other health-promoting reactions. Overall, levels of fear and stress decrease while levels of trust and well-being increase. Furthermore, it results in stress-reducing and healing effects (e.g., anti-inflammation). (For more on how the Calm and Connection Theory can be applied in a green space design process, see DESIGNING chapter.)

Table 1 gives an overview of the development of theories regarding nature and its influence on human health and well-being.

WHAT IS THE SCIENTIFIC EVIDENCE REGARDING THE EFFECTS OF NATURE ON HUMAN HEALTH AND WELL-BEING?

One of the first attempts to make a systematic overview of the scientific knowledge regarding the relation between nature and health was the COST Action E39 "Forests, Trees, and Human Health and Wellbeing" (Nilsson et al., 2011). Since the action terminated in 2009, research on the relationship between nature and health has exploded, and many review articles have been published. However, only a few attempts have been made to gain a complete overview of the last decade's research within the field.

A key problem is that the causal relationships and pathways between health and nature exposure are not well understood, and the long-term effects are less well-studied or recognised in policies. The following overview shows the state of knowledge regarding which evidence is strong to moderate between access or exposure to nature and subsequent health effects. To make this overview, we conducted a literature search (finalised in January 2020) using the databases Scopus, Google Scholar, and Web of Science, and we also made a search on the American Horticultural Therapy Association website. We limited the search to peer-reviewed articles published between 2007 and 2019 and by study type to include only systematic reviews and meta-analyses supplemented by randomized controlled trials and controlled intervention studies (e.g., natural experiments and quasi-experimental studies).

GRADE (Grading of Recommendations, Assessment, Development, and Evaluations)[1] is a commonly used assessment tool within the clinical health sciences to evaluate the quality of evidence in systematic reviews (see Box 1). The framework is important for planners and decision-makers since it helps them to make decisions based on the strength of the evidence. This chapter is therefore important for ensuring evidence-based planning made according to the strongest scientific evidence that exists at the moment.

While some evidence-based recommendations regarding nature and human health exist, practitioners need to know which evidence is of the highest quality (i.e., the most reliable) in order to make the best decisions about planning, managing, and designing urban green space. In the following sub-sections, we describe the scientific support, based on the GRADE system, for the various ways in which outdoor living and access to green spaces positively affect human health and well-being.

We have identified six health factors where the evidence for the association with access to or spending time in nature is at least of moderate quality. In two of these—*life expectancy* and *mental health*—the relationship is direct (i.e., it is the stay or access itself that is the reason for the positive effects), and the evidence

[1] https://www.gradeworkinggroup.org

Box 1. The GRADE framework (Guyatt et al., 2008).

According to the GRADE framework:

- *High quality evidence* means that "further research is very unlikely to change the confidence in the estimate of effect."
- *Moderate quality evidence* means that "further research is likely to have an important impact on the confidence in the estimate of effect and may change the estimate."
- *Low quality evidence* means that "further research is very likely to have an important impact on the confidence in the estimate of effect and is likely to change the estimate."
- *Very low quality evidence* means that "any estimate of effect is very uncertain."

is judged to be of moderate to high quality. For the next two—*physical activity* and *sun exposure*—the evidence is of high quality regarding their positive effects on health, while the evidence that access to nature leads to increased physical activity and sun exposure is judged to be of moderate quality. In the final two—*air quality* and *immune system*—the relationship is again direct but the evidence for positive effects on human health is of low to medium quality.

Life expectancy

Efforts to promote human health are generally measured by evaluating premature death. Several comprehensive reviews show that there is a clear link between living near natural areas or parks and reduced risk of dying prematurely (Gascon et al., 2015; 2016; Egorov et al., 2016; van den Bosch & Ode Sang, 2017; Braubach et al., 2017; Twohig-Bennett & Jones, 2018; Barboza et al., 2021). Van den Berg and colleagues (2015) assess that the evidence for this is moderate to high. According to van den Bosch and Ode Sang (2017), there is moderate evidence for significant positive associations between the quantity of green space in a city and perceived general health. They also show a clear connection between living further from green areas and perceived ill-health. For example, research shows that the closer people live to green areas, the more they visit the green areas, and the frequent visitors are less often affected by high levels of stress (Grahn & Stigsdotter, 2003). Another comprehensive study shows a similar pattern: the closer people live to green areas, the more often they visit them, which in turn leads to fewer cases of cardiovascular disease (Tamosiunas et al., 2014). Gascon and colleagues (2016) assessed that the association between good access to natural areas and parks and a reduced risk of suffering from cardiovascular diseases is so strong that they consider the evidence moderate to high on the GRADE scale.

Could the connections be due to the fact that wealthy people, who otherwise live a healthy life, acquire housing with good access to natural areas? However, a review by Dadvand and Nieuwenhuijsen (2019) found that people specifically in the lowest socioeconomic groups benefitted from proximity to green areas, and a comprehensive epidemiological study by Mitchell and Popham (2008) produced compelling results in this regard. The study, which involved 40.8 million people in the UK, showed that those in the lowest socioeconomic category were especially supported by closeness to urban green environments.

In light of this research, planning cities so that all residents have access to green areas could result in a healthier population (i.e., a population with less instances of premature death). Studies show that urban residents in areas with lower socioeconomic status often have better access to green areas than residents in urban areas with higher socioeconomic status (Mears et al., 2019). However, the quality of these green areas is often deficient; for example, they may be fragmented and consist of narrow pedestrian/cycle lanes along mowed grass. Taking into account disturbances such as heavy traffic and noise, or factors such as size, maintenance of green areas, facilities, and amenities (e.g., seating, play equipment, ball courts, flower arrangements, cafeterias, etc), people living in neighbourhoods with higher socioeconomic conditions have much better access to high quality parks. This is true in large parts of the world such as in the United States (Dai, 2011; Odom, 2019), Portugal (Hoffiman et al., 2017), England (Mears et al., 2019), Sweden (Skärbäck et al., 2014), and Australia (Astell-Burt et al., 2014).

Although green areas in lower income neighbourhoods are often of low quality, these green areas are widely used, which favours the health of residents. How should these results be explained? Dadvand and Nieuwenhuijsen (2019) suggest that green areas are

the best leisure resource in these low-income neighbourhoods, which leads to their use, while people with better socioeconomic circumstances can, to a greater extent, travel to nature areas and/or to their own holiday homes on weekends and holidays.

Mental health

A number of systematic reviews show that the evidence is strong regarding the connection between frequent visits to nature and green areas and reduced risk of stress-related ill health. The more you visit and the longer you stay in green areas, the lower the risk of suffering from stress-related illnesses such as depression and burnout. This is because exposure to nature is linked to a reduction in stress levels and stress hormones (cortisol, adrenaline, and norepinephrine). There is also strong evidence that results can occur relatively quickly: feelings of anger and sadness decrease while feelings of joy and curiosity increase (Bowler et al., 2010; McMahan & Estes, 2015; Capaldi et al., 2015; Van den Berg et al., 2015; Egorov et al., 2016; Lee et al., 2017; van den Bosch & Ode Sang, 2017; Hansen et al., 2017; Oh et al., 2017; Payne & Delphinus, 2018; Vujcic et al., 2019).

In 2003, a study showed that a home's distance to available urban green spaces was related to the number of visits, the length of visits, and the residents' stress levels (Grahn & Stigsdotter, 2003). A Finnish study showed that residents were attracted to visit the city's green areas to a greater extent if their neighbourhood had a higher percentage of vegetation than if it was characterised by buildings and roads (Neuvonen et al., 2007). In addition, it turns out that residents' stress levels and their mental health are strongly related to how close or far their housing is to urban parks. Distances further than 300-400 m from parks are related to higher risk of mental illness (Sturm & Cohen, 2014). Van den Bosch and Ode Sang (2017) show that the number of coherent studies today is extensive, meaning that the evidence is strong regarding the connection between a longer distance to green areas, fewer visits in the green areas, and higher stress levels. In addition, the research shows a strong link between long distances (and thus fewer visits) to green areas and higher mortality in stress-related diseases such as cardiovascular disease, as well as higher risk of suffering from mental illness.

There is strong evidence of a positive relationship between the amount of green space that surrounds residential areas and residents' perceived mental health (van den Berg et al., 2015). Several reviews also declare there is strong evidence that visiting natural environments and urban green spaces improves emotional well-being (McMahan & Estes, 2015; Bowler et al., 2010; Capaldi et al., 2015; Egorov et al., 2016; van den Bosch & Ode Sang, 2017). Lee and colleagues (2017) maintain there is strong evidence for significant positive associations between active involvement with nature and lower risks of depression, while viewing or being present near nature may not be enough to have a significant impact on the level of depression. Lastly, there is a causal, significant link between long-term exposure to surrounding greenery and less risk of suffering from mental illness. However, the effect is limited (Gascon et al., 2015).

Physical activity

Research shows unquestionable links between increased physical activity (decreased sedentary time) and improved health. This includes a reduced risk of suffering from cardiovascular disease, stress-related mental illness, type 2 diabetes, and premature death (Lee et al., 2012; Hupin et al., 2015; Schuch et al., 2016; Ekelund et al., 2016; Twohig-Bennett & Jones, 2018). A connection between physical activity and reduced instances of cancer has also been established (Monninkhof et al., 2007; Wolin et al., 2009; Speck et al., 2010).

Green open spaces are particularly popular places for physical activity (Korpela & Ylen, 2007; Norman & Boman, 2010; Kline et al., 2011; Evenson et al., 2013; White et al., 2016), and research shows that proximity to green areas is crucial for people to practice physical activity outdoors (Konijnendijk et al., 2013; Akpinar, 2016; Wang et al., 2019). However, research shows that the green area needs to be close by and accessible but also large enough to enable physical activity among other qualities (Lovell et al., 2014; Akpinar, 2016; Wang et al., 2019).

Akpinar (2016) found that other crucial factors that encourage people to visit a green area for physical activity were that the green area was perceived to be clean and well-maintained, and that it had an open field that could be used for physical activity. Wang et al. (2019) came to the same conclusion: in addition to proximity and size, decisive factors included the presence of open fields or courts where people could practice a sport and feel safe and secure due to good green area maintenance. Wang et al. (2019) also found that people chose green areas for physical activity based on beauty (e.g., flowers) and access to amenities

such as toilets, cafeterias, kiosks, shelters, and seating.

Such characteristics are included in the eight Perceived Sensory Dimensions (PSDs; Grahn & Stigsdotter, 2010; Stoltz & Grahn, 2021) which are further described in the DESIGNING chapter. The researchers behind the PSDs suggest eight dimensions that influence people's perceptions and experiences of green areas: diverse, cohesive, social, cultural, open, serene, shelter, and nature. A major public health survey in Southern Sweden (Björk et al., 2008; de Jong et al., 2012) showed that if people live near green areas that offer many PSDs, their physical activity increases. In addition, the study by Björk and colleagues (2008) showed that the risk of obesity decreased when they lived near green areas with many PSDs, while the study by de Jong and colleagues (2012) showed that the inhabitants estimated their health to be good. The studies also showed a clear link between living near green areas with many qualities and a positive experience of the whole residential area.

Exposure to sun, UV-radiation, and daylight

Increasing the time people spend outdoors can be crucial for improving public health to such an extent that it increases people's lifespan. In fact, people have probably never been as much cave people as they are today. A Canadian study (Matz et al., 2014), which includes randomly selected people of all ages, proposes this. The results show that, on average, people spend 88.9% of their time in buildings and 5.3% of their time in vehicles every day. The results confirm studies conducted in other parts of the world (Klepeis et al., 2001; Schweizer et al., 2007), namely that, on average, people spend more than 90% of their time indoors. This has a negative impact on health in many ways. For starters, it means people may not be getting enough exposure to natural daylight (specifically, UV-B radiation that enables the production of vitamin D).

Natural daylight has a completely different frequency range than the lighting usually used indoors—a frequency range that can initiate and maintain many essential biological functions. A comprehensive review by Holick (2016) shows that natural daylight leads to better well-being, while natural daylight deficiency is strongly associated with depression. If people spend time outdoors during daylight, this will lead to a marked increase in expression and production of beta-endorphins, an endogenous opioid peptide that has been shown to improve not only well-being but also pain relief and relaxation.

It is proven that more sunlight on naked skin leads to higher levels of vitamin D in the body (Holick, 2004; Pan et al., 2017). An estimated 80–90% of vitamin D from the human body originates from skin synthesis, through sunlight activation, while the rest is supplied through supplements or food (Holick, 2004). Vitamin D affects many tissues and cells in the body, including macrophages, brain, breast, prostate, colon, and skin, to name a few, and promotes the control of many metabolic processes, including DNA repair, antioxidant activity, and regulation of cellular proliferation and differentiation. There is very strong evidence supporting that improvement of vitamin D status in early life may decrease the risk for many autoimmune diseases, such as multiple sclerosis, type 1 diabetes, and rheumatoid arthritis (Holick, 2016). With an increased amount of sunlight on the skin, the amount of vitamin D increases in the body. There is a strong link between a higher amount of vitamin D in the body and reduced incidences of influenza A infections, acute viral infections, and asthmatic attacks (Holick, 2016).

There is moderate to strong evidence that vitamin D deficiency is associated with hypertension, cardiovascular disease, and cardiovascular mortality. Findings from Eng and Mercer (1998) also show that seasons have a dramatic influence on cardiovascular mortality. The study showed that cardiovascular mortality is between 22% and 31% higher in Norwegian and Irish men and between 24% and 39% higher in Norwegian and Irish women in the winter compared to in the summer (Eng & Mercer, 1998). Several reviews show that there is moderate to strong evidence that exposure to urban green environments can reduce the risks of cardiovascular mortality (Gascon et al., 2016; Egorov et al., 2016; van den Bosch & Ode Sang 2017, Braubach et al., 2017); however, it is unclear whether this has to do with exposure to sunlight or if it is due to the stress-reducing effects of the green areas.

Air quality

The problem with air quality from a public health point of view is pollutants such as particulate matter (PM) and nitrogen oxides (NO_2 and NO) where long-term exposure to fine particulate air pollution has been associated with increased mortality, even with concentration rates well below European mean limits (Beelen et al., 2014). Furthermore, it has been related to low birth weight and preterm birth, which both have a substantial public health impact (Stieb et al., 2012).

An increasing number of studies are being conducted

to investigate whether urban green spaces can reduce climate impact and poor air quality (Baró et al., 2014; Janhäll, 2015; Zupancic et al., 2015; van den Bosch & Ode Sang, 2017; Aram et al., 2019; Li and Zhou, 2019; Masoudi & Tan, 2019). This research is emerging at a time when many major cities are thinking about future scenarios where they may experience more days of extremely hot and stagnant air, with harmful particles, ground-level ozone, etc. due to climate change. Such research typically focuses on finding evidence regarding the role of urban green parks in providing cooling effects and reducing air pollution. Owing to the Urban Heat Island (UHI) effect, an urban area can, on average, be 1.0–6.0 °C warmer than a nearby, non-urban area (Dimoudi et al., 2013). The urban morphology affects the formation of UHIs in several ways; for example, large cities generally have a stronger UHI effect than small cities. If the city is elongated and lies next to the sea or forests with large canopies, fewer UHIs are formed than if the city spreads radially (Li & Zhou, 2019; Masoudi & Tan, 2019). The question is whether urban green areas are significantly cooler, and whether they can reduce the strength of the UHI effect as well as improve air quality. Aram et al. (2019) and van den Bosch and Ode Sang (2017) conclude that there is moderate to strong evidence for reduced temperature and good cooling effects due to urban greening. An urban park is, on average, 1.0 ℃ cooler than the surrounding built areas (van den Bosch & Ode Sang 2017).

Urban green areas (from single trees and green roofs to large natural areas) generally provide major climate benefits. The benefits are directly related to the size, quality, and density of the greenery (Zupancic et al., 2015; Aram et al., 2019; Li & Zhou, 2019; Masoudi & Tan, 2019;). The temperature differences of urban parks enable cooler and cleaner air to flow out towards the UHI. The reviews focused on different types and sizes of green spaces to assess how effective this air flow can be. A general finding is that urban parks, even small ones, can provide cleaner and cooler air to nearby areas to a significant degree. Aram et al. (2019) suggest that the climate effect will be good if the green areas are larger than 10 hectares. However, it is not just about the size. If the green areas only contain mowed grass, they will not have a significant impact on the climate. For smart planning, the green areas should have a certain density of vegetation in multiple layers—shrubs as well as a large tree canopy, where the permeability of wind in the vegetation should be about 50%. In addition to size and vegetation density, the green areas should be coherent—not diffused or sprawled—to maintain a good flow of air to surrounding built surfaces (Li & Zhou, 2019; Masoudi & Tan, 2019). Moderate to strong evidence shows that several nearby green areas with trees and shrubs that are not too densely planted provide better effects than large individual parks with open grassland (Baró et al., 2014; Janhäll, 2015; Zupancic et al., 2015; Aram et al., 2019; Li & Zhou, 2019; Masoudi & Tan, 2019). Thus, the size, density, and space configuration of an urban green area, together with the selection and design of plantings, can affect the temperature of the land surface in the city (Li & Zhou, 2019; Masoudi & Tan, 2019) and are crucial for improving the purity of city air. Trees have an exceptional ability to capture and filter multiple air pollutants, including ground level ozone, sulphur dioxide, nitrogen oxides, and particulate matter. Trees with big canopies along streets are also associated with significantly improved thermal comfort and relief from heat stress at the street level and neighbourhood scale, particularly during hot seasons and times of day (Baró et al., 2014; Janhäll, 2015; Zupancic et al., 2015; Aram et al., 2019).

The body's immune system

One of the foreground researchers of forest bathing, Dr Qing Li, claims that the air in the forest has a different quality than air in urban environments. Staying in forests appears to affect the immune system positively, as measured by the number of immunological markers in the blood. Old Japanese coniferous forests may be especially good to walk in because the air is saturated with phytoncides. These substances purify the air from microbes and benefit the body's immune system (Li, 2012; Li et al., 2016). The content of phytoncides in the air is also abundant in European coniferous forests, particularly where junipers are abundant. Four systematic reviews (Hansen et al. 2017; Oh et al. 2017; Payne & Delphinus, 2018; Andersen et al., 2021) state that many studies indicate that a walk in a coniferous forest can have effects on the immune system for up to 30 days. However, they point out that all these studies have been conducted with relatively few people. They call for studies with larger populations, preferably randomized controlled or longitudinal cohort studies, and they claim that the evidence is still low regarding the immunological effects.

A randomized controlled trial with an intervention group at Alnarp Rehabilitation Garden and a control group at Skåne University Hospital in Lund, Sweden, showed clear differences between rehabilitation in

nature versus in hospital settings. Patients treated in the rehabilitation garden significantly improved their immune systems compared to patients treated in the hospital (Bay-Richter et al., 2012). In this case, the improvement was not due to walking in old coniferous forests but in a garden environment. And unlike the studies mentioned above, it is unlikely the health improvements were due to breathing phytoncides. Braubach et al. (2017) describe studies and theories related to the possibility that a stay in nature can positively affect the immune system. For instance, they describe several studies suggesting that exposing young children to microorganisms in nature early in life may lead to fewer allergies, asthma, and autoimmune diseases, particularly when exposure to nature is in areas with high biodiversity. In Alnarp Rehabilitation Garden, it may be that the patients regained access to "old friends", i.e., microbes which are part of the human natural microbiome and protect us from many diseases. Stamper et al. (2016) have made an extensive systematic review of who these "old friends" are in nature and how they are lacking in our cities.

A review by Leung et al. (2019) shows that indoor microbiomes often contain dangerous pathogenic organisms. The microbiomes people encounter in built environments outdoors in cities can also be harmful to health (Stamper et al., 2016), while contact with topsoil, among other things, is important to counter allergies (Zhu et al., 2019). Topsoil contains extremely high biodiversity. In recent years, several initiatives have started in connection with the Microbiome Rewilding Hypothesis. This theory is about creating urban green spaces where people can encounter these "old friend" microbes to improve people's immune systems (Mills et al., 2017; Flies et al., 2018; Robinson et al., 2018). However, much research is still needed in this area before it is possible to comment on effects and mechanisms.

DISCUSSION AND CONCLUSIONS

In Table 2, we have summarised the most researched health effects of having access to and spending time in natural environments. Health effects are partly a matter of primary influence, such as when nature experiences affect people's mental health or when natural environments excrete substances that strengthen our immune system. In other cases, health effects are a matter of secondary impact such as access to natural areas stimulating more outdoor life and physical activity or that they contribute to cleaner air, which in turn has positive health effects. The table also shows the degree of evidence in relation to the terminology used in GRADE assessments with the support of selected review articles. Finally, we have tried to summarise the potential implications this evidence has for planning, design, and management of public green spaces.

Our meta-analysis shows that the evidence is of moderate to high quality regarding proximity to green areas and lower rates of premature death. An important reason for this is that proximity to green areas is of decisive importance for people spending time outdoors and being physically active. There is high quality of evidence that physical activity and exposure to sunlight reduce the risk of premature death. However, the evidence is still of moderate quality regarding the effects of green space providing cleaner air and strengthened immune systems. When it comes to the connection between proximity to green areas and mental health or stress-related diseases, the evidence is of moderate to high quality. In the NUMBERING chapter, methods for measuring the access to green areas is discussed further as well as the value of both perceived and objective indicators.

The most important evidence-based conclusions for planners and green space managers are that good access to and frequent stay in natural environments promotes people's health and well-being. Therefore, it is important that planners work to provide a just distribution of green areas that are of a sufficient size and quality. Municipalities are responsible for public green space, and the public health focus needs to permeate planning, governance, and management of green spaces, and to be anchored across sectors and collaborated across organisational levels to make sure that everyone is on board. In REGULATING, the authors show that the complex functionalities required by green spaces demands cross-sectoral collaboration and user participation to find ways of making sure that health promotion is synthesized with other demands such as biodiversity, stormwater management, etc.

When it comes to the specific design, the picture is considerably more complicated. Needs are diverse, and "one size fits all" does not apply to creating healthy public environments. For example, lawns are excellent for stimulating physical activity but less suitable if the intention is to create a comfortable local climate and clean air. In the same way, both areas that are physically challenging and stimulating and areas that are peaceful and stress-relieving are complementary to one another; both are needed, but not in the same spot. In DESIGNING, evidence-based models for health-promoting design of the outdoor environment

Table 2. Nature's influence on human health and its implications for green space planning and design.

HEALTH EFECT OF EXPOSURE TO NATURE	EVIDENCE/ ASSUMPTION	SELECTED REFERENCES	GRADE ASSESSMENT	LESSONS FOR PLANNING
Increasing life expectancy	Reduced risk of premature death if people live near natural areas or parks	Mitchell & Popham, 2008; Gascon et al. 2016; Van den Bosch & Ode Sang, 2017; Braubach et al. 2017; Twohig-Bennet & Jones, 2018	Moderate to high	Green spaces in cities should be large enough and evenly distributed so that inhabitants get sufficient exposure to meet their needs for contact with nature for their health and well-being regardless of where they live or their socio-economic background.
Decreasing risk of mental illness	The more one visits and the longer one stays in green areas, the lower the risk of suffering from stress-related illness such as depression and burnout.	Bowler et al., 2010; McMahan & Estes, 2015; Van den Berg et al., 2015; Egorov et al., 2016; Oh et al., 2017; Payne & Delphinus, 2018; Vujcic et al., 2019	Moderate to high	The evidence is strong regarding the connection between a longer distance to green areas, fewer visits to green areas, and higher stress levels; distances further than 300-400 m are related to higher risk of mental illness.
Increasing exposure to sun, UV-radiation, and daylight	Natural daylight leads to better health and well-being, e.g., by increased production of beta-endorphins and vitamin D, while natural daylight deficiency is strongly associated with depression.	Pereira-Santos et al., 2015; Holick, 2016; Pan et al., 2017	Moderate to high	Green spaces in cities should be large enough and evenly distributed so that the inhabitants get sufficient sun exposure and daylight.
Increasing physical activity	Physical activity leads to reduced risk of suffering from cardiovascular disease, stress-related mental illness, type 2 diabetes, and premature death; proximity to green areas is crucial for people to practice physical activity outdoors.	Lee et al., 2012; Hupin et al., 2015; Schuch et al., 2016; Ekelund et al., 2016; Akpinar, 2016; Wang et al., 2019	Moderate to high	Green areas need to be close to where people live and large enough to be active in different ways, as well as safe and secure, clean and well-maintained, and attractive.
Improving air quality	Urban green areas reduce the Urban Heat Island effect and have the ability to capture and filter multiple air pollutants.	Janhäll, 2015; Zupancic et al., 2015; Van den Bosch & Ode Sang, 2017; Aram et al., 2019; Li & Zhou, 2019; Matsoudi & Tan, 2019	Moderate	For cooling, green areas should be coherent and tree-covered; for cleaning the air, they can be more scattered but should have a certain density of multiple layers where the permeability should be about 50%.
Improving the body's immune system	Green areas produce phytoncides and microbes that improve people's immune systems.	Li et al., 2016; Hansen et al., 2017; Oh et al., 2017; Payne & Delphinus, 2018; Putra et al., 2018; Zhu et al., 2019	Low to moderate	Urban forests, preferably with coniferous trees, should be accessible to residents at a reasonable distance, and surfaces covered by topsoil should be frequently exposed in green areas.

are implemented to account for these variations of green space design.

Another important finding is that health promotion is only one of many ecosystem services that green spaces are expected to provide society. Other high-priority functions include promoting biodiversity, adapting to climate change by reducing the risk of flooding during heavy rainfall, and contributing to increased local self-sufficiency with fruits and vegetables. Often these functions can be reconciled with the ambition to promote people's health and well-being, but sometimes conflicts can arise, for example, when densification is desired to reduce climate impact at the expense of urban green areas. The conflict between the green vs. the dense city is discussed from a health perspective in OBSERVING with the Solomonic solution that cities need to be both dense and green.

Even among health promotion measures there are inherent conflicts. Earlier in the chapter, we presented the results of research that suggests spending time outside and exposure to sunlight is good for people's health, but we are fully aware that skin cancer is the form of cancer that has increased the most in the Nordics over the past half century, mainly due to excessive exposure to the sun (Boniol et al., 2012; Lashway et al., 2023). There are also other negative health aspects of staying in natural areas that we have not detailed, for example, allergic reactions, risk factors such as poisonous berries and mushrooms or falling trees, and tick-borne illnesses or other animal-borne pathogens (Tomalak et al., 2011; Rosenstock et al., 2023). However, reviews focusing on the negative effects are rare. Evidence about benefits of outdoor air quality is also not black and white; in some urban areas, pollution has a serious negative health effect on residents.

Although there is still much research to be done before it is possible to say with certainty which types of environments produce specific health effects, there is a fairly broad consensus that access to and use of natural and green areas has a positive influence on people's health and well-being. The purpose of this chapter has been to provide practitioners with the documentation of the evidence that current research contributes for this view. In the following chapters of the book, we will present tools for awareness if this can be applied in practical planning, design, and management of urban public places and to navigate some of the nuances.

PART 2

NUMBERING

WORKING WITH OBJECTIVE AND PERCEIVED INDICATORS OF HEALTH AND GREEN SPACE

HELENA NORDH, EMMA CHARLOTT A. NORDBØ, & GEIR AAMODT

ABSTRACT

Objective or "actual" access to green spaces near homes is not the same as perceived access to green space. Similarly, objective health, such as absence of disease, is not necessarily equivalent to how people perceive their health. Grounded in empirical work in the Nordic Region, and combined with existing research literature, this chapter unfolds and problematizes differences between perceived and objective indicators of access to green space and differences between perceived and objective indicators of people's health. Additionally, the chapter discusses how urban planners can use objective and perceived indicators of access to green spaces and people's health in their work with developing health-promoting and sustainable municipalities.

CHALLENGES WITH USING HEALTH STATISTICS IN PLANNING PRACTICE

To set the scene for this chapter about health and green space indicators, we will begin by sharing some reflections on the challenges of using health statistics in planning practice. As part of the NORDGREEN project, one of our colleagues interviewed municipal employees—planners, public health representatives, and green space managers—to investigate how municipalities use health statistics in planning practice. Four key challenges emerged from the interviews (see Box 1).

First, the municipal employees agreed that public health data derived from national authorities provide a good overview of the health status in the municipality, but such data do not say much about health at the local level where the planners operate. For health data to be useful for planners, they *need local data*, or data on a neighbourhood level. Some planners mentioned that they conduct their own surveys, such as PPGIS surveys (as described in the OBSERVING chapter). Some collect data through public participation, including local seminars and workshops. However, municipal employees had experienced a general survey-exhaustion among inhabitants making local data collection more demanding and challenging.

Second, planners *focus on use and activities* rather than health statistics. They rarely use health vocabulary and do not present health-related goals, for example, to reduce cardiovascular disease or body mass index (BMI), even if it is highly associated with low physical activity—a term perhaps more familiar to planners. Instead, their aim is to change the physical environment in ways that promote healthy lifestyles and enable people to develop healthy behaviours. However, there are exceptions. In Stavanger, for example, there has been a strategic choice to use health vocabulary in their integrated, area-based urban regeneration programmes. Such planning strategies differ from ordinary planning efforts in that they do not solely target the physical environment. Through area-based urban regeneration, the municipality contributes to physical, social, and environmental improvements over time in collaboration with residents and other local actors. These programmes provide grounds for collective municipal efforts during the planning period with the aim of ensuring better interaction across municipal services and bridging departments within the municipality.

Third, the planning departments within municipalities *lack competence* on how to analyse health data. In general, most of the planners and green space managers interviewed were unfamiliar with how the municipality uses health data in municipal planning, and health data were handled by others—a public health coordinator or someone at the analysis department, for example.

Finally, how well employees shared the information between different departments varied across municipalities, which corresponds to the fourth challenge, the classic *silo effect* by which one works solely within one's own department. On a related note, some respondents raised a challenge with lacking a dedicated person within the municipality who has an overarching perspective on health issues in relation to planning.

Box 1. Four key challenges municipal planners face when using health statistics in practice.

1. Lack of local-level data
2. Mismatch between health-related vocabulary and planning vocabulary
3. Lack of competence for analysing health data
4. Lack of cooperation across departments within the municipality (i.e., the classic silo effect)

This chapter will not provide solutions for all the challenges mentioned above; however, with tangible examples and illustrations, it aims to demonstrate how both green space and health indicators can be used in planning practice.

REVISITING RELATIONSHIPS BETWEEN GREEN SPACE AND HUMAN HEALTH

Vast evidence suggests that living in neighbourhoods with access to green space is beneficial for both physical and mental health (Browning et al., 2022; Labib et al., 2020; Markevych et al., 2017; Marselle et al., 2021; Remme et al., 2021; Wolf et al., 2020; Yang et al., 2021). Research has revealed that higher exposure to green space, as well as specific qualities of green spaces, are associated with several positive health outcomes, such as reduced risk of type 2 diabetes, all-cause mortality,

cardiovascular mortality (Astell-Burt et al., 2021; Barboza et al., 2021; Rojas-Rueda et al., 2019; Twohig-Bennett & Jones, 2018) and improved mental health (Min et al., 2017; Qiao et al., 2021). Specifically, Barboza et al. (2021) reported that meeting the WHO recommendation of access to green spaces within a 300-meter distance alone could prevent nearly 43,000 deaths in Europe in 2015, corresponding to 2.3% of the total mortality. There are three suggested pathways, representing different functions of green spaces, through which positive health effects can occur (Markevych et al., 2017; Marselle et al., 2021). These pathways have been elaborated in the BACKGROUND chapter and will only be rendered here briefly. First, the presence of green spaces can mitigate local environmental hazards by reducing exposure to, for example, air pollution, noise, and heat. Second, green spaces are important resources for psychological restoration and stress recovery. Third, accessible green spaces provide settings for physical and social activity (Markevych et al., 2017).

Since green spaces represent a resource for human health and well-being, municipal planners have an important role in ensuring that green infrastructure planning focuses on both ecological and social values. This will help municipalities to fulfil the UN sustainable development goals. Nordic municipalities have multiple tools and means of action that can be applied in such work, including utilisation of green space and health indicators. However, there are possibilities as well as potential challenges when developing and using green space and health indicators within planning practice. In the NORDGREEN project, we evaluated green space and human health in six municipalities throughout the Nordic Region—Aarhus, Espoo, Ii, Stavanger, Täby, and Vilhelmina—to explore how to use and combine such indicators in meaningful ways. In this chapter, we focus on examples from Täby, a municipality located about 12 km north of Stockholm (see INTRODUCTION).

DIFFERENCES BETWEEN PERCEIVED AND OBJECTIVE INDICATORS

As presented in the previous section, access to green space can impact people's health and well-being in various ways. To implement this knowledge in practice, planners need to acquire knowledge about the distribution of green space in the municipality and the health challenges among people living in these environments. This information can be used to target neighbourhoods or specific groups where a change in the physical environment is most urgently needed. But *how should the municipalities go about mapping and exploring access to green space and people's health?*

Measuring access to green space

A lot of map-based data already exists which can be downloaded and used to perform spatial analyses and develop objective indicators of access to green space using Geographic Information Systems (GIS). National authorities, such as Sweden's Lantmäteriet[1] and GeoNorge[2] in Norway, as well as worldwide open sources, such as Urban Atlas[3] and OpenStreetMap,[4] provide data on land use, land cover, and vegetation cover. These data depict the spatial distribution of green space and other types of land use in different ways. The typical green space land use classifications are forests, parks, and cemeteries. Common indicators to assess access to green space include distance from dwellings to different types of green spaces (e.g., parks, cemeteries, and forests) or proportion (%) of green space of the total land area within a specific geographical area (Lachowycz & Jones, 2013). These indicators can be derived for geographical areas at various spatial levels, such as post code areas, districts, or municipalities, but also within buffers around dwellings or neighbourhoods. Note that in this chapter, access to green space is not synonymous with accessibility, a term that encompasses aspects of universal design (Wong et al., 2023). Instead, access relates to proximity and amount of green space.

Using the above-mentioned datasets, we obtained national and local land cover, land use, and vegetation maps to compute the following green space access indicators: total area of green space, total area of different green space types, vegetation cover, green area, and mean distance to green space from all dwellings within each of the NORDGREEN municipalities. *Total area of green space* is a combined measure including all parks, forests, and cemeteries within a geographical area (Figure 1A), while the *total area of different green space types* gives a measure of the land area of parks, forests, and cemeteries separately (Figure 1B; the green space types are marked with different colours). These measures can further be used to compute the proportion (%) of the total land area devoted to green

[1] https://www.lantmateriet.se/
[2] https://www.geonorge.no/
[3] https://land.copernicus.eu/local/urban-atlas
[4] https://www.openstreetmap.org/

space, as well as the total area of green space and different green space types per inhabitant (in m^2; Aamodt et al., 2023). *Vegetation cover* (Figure 1C) was computed using a map based on satellite images downloaded from the Copernicus webpage,[5] a part of the EU space programme with open-access spatial data. We applied the Normalized Difference Vegetation Index (NDVI), a commonly used index which describes the vegetation density within 250 by 250 m pixels. In Figure 1C, dark green colour corresponds to high vegetation density, while light green colour corresponds to less vegetation density. Grey colour represents no or very limited vegetation, such as water bodies and asphalt.

Green area (Figure 1D) is an indicator describing the total land area devoted to the following combination of land uses: green urban areas, sport and leisure facilities, arable land, pastures, complex and mixed cultivation patterns, forests, herbaceous vegetation associations, and wetlands. We used Urban Atlas to compute green areas. Lastly, the *mean distance from dwellings to parks, forests, and cemeteries*, as well as the *mean distance to a green space of any type*, were computed to capture access to green space. The shortest straight-line distance between each dwelling and the different green space types were computed using national and local land-cover and land-use maps (Aamodt et al., 2023).

The objective green space access indicators show that Täby has 32.4% of total green space (forests, parks, and cemeteries), of which 2.3% are parks. On average, residents live 89.8 meters from the nearest green space of any type (for more details on these results, see Aamodt et al., 2023).

By using a variety of green space indicators, we have been able to explore if these objective indicators of access to green spaces correlate with a perceived indicator of access to green space. We will now illustrate how this was done using an example from Täby.

In Täby, we correlated objective indicators on access to green space with a perceived indicator of access to green space. The perceived indicator was obtained from the national citizen survey *Medborgarundersökningen* (Statistics Sweden, 2022) in which more than 1,000 inhabitants in Täby participated in 2019-2020. In the survey, inhabitants were asked to rate how they perceived their access to parks, green spaces, and

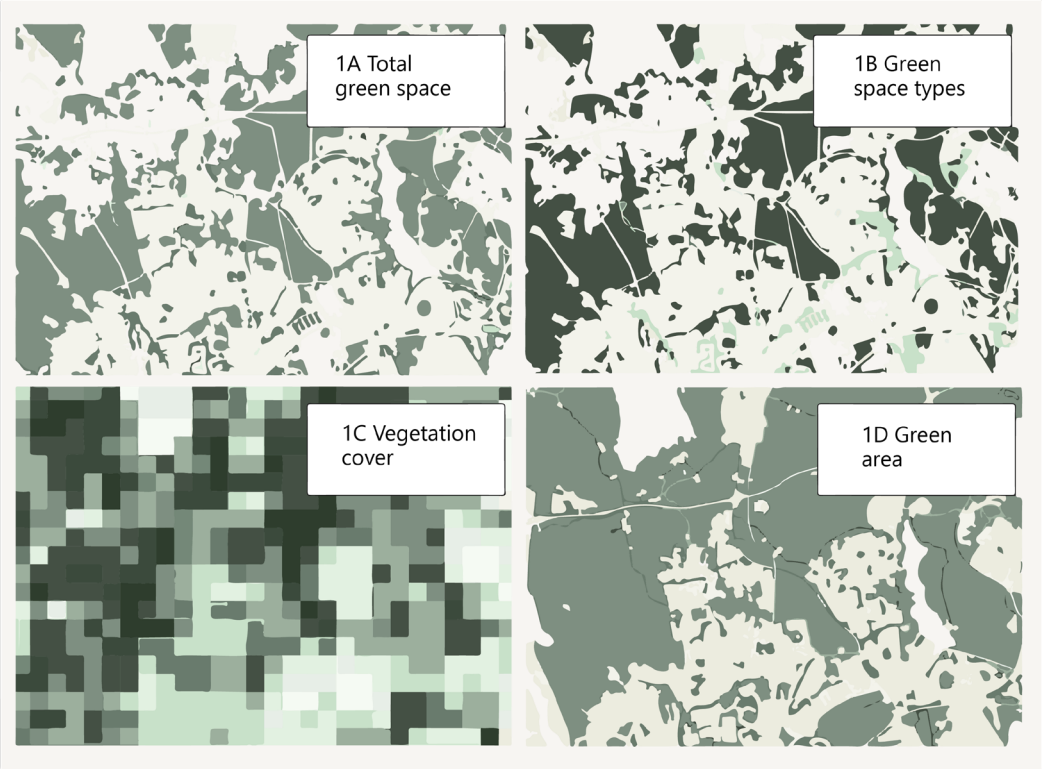


Figure 1. The four different green space indicators (total green space, green space types, vegetation cover, and green area) illustrated by map sections from Täby. The same map section is presented in each of the maps.

[5] https://www.copernicus.eu/

nature in Täby using a scale from 1 (poor) to 10 (very good). Overall, residents in Täby reported good access to green spaces with almost 76% of the respondents rating their perceived access to green spaces as 8 or higher.

Results from a correlation analysis showed that the objective indicators strongly correlated with each other, which means that all objective indicators showed a similar pattern of green space distribution. However, the objective green space indicators did not significantly correlate with the perceived indicator on access to green space (Nordh et al., forthcoming). This suggests that people's perceptions of green space access in Täby were not the same as their actual access. In Figure 2, we present a map of Täby municipality divided into 38 demographic statistical areas (DeSO).[6] Here we illustrate results of one objective green space indicator (the total proportion of land area devoted to parks, forests, and cemeteries within each DeSO area) and the perceived indicator of access to green space presented as mean values on the map. Darker colours indicate a higher proportion of green spaces within the DeSO area, while higher mean values show that respondents perceive their access to green space within the DeSO area as very good. Interestingly, as depicted in the figure, the highest mean values do not always correlate with the darkest green colour.

The mismatch between perceived and objective indicators of green space is found by others (e.g., Mazumdar et al., 2020; Reid et al., 2022; Leslie et al., 2010; Zhang et al., 2021), and we can only speculate why these discrepancies exist. As pointed out by other scholars, it may have to do with the quality of the green spaces (Leslie et al., 2010). Poor quality may imply that people do not perceive the green space as accessible or usable. Alternatively, high quality may compensate for or mask poor access—in other words, residents may perceive higher access to green space when they perceive the green space to be of high quality. There may also be physical barriers in the environment, such as roads or railways, hindering access. In this study, such aspects are only considered in the perceived indicator, not in the objective ones. Furthermore, perceived indicators may also consider socio-cultural aspects. For example, families with a tradition of using green spaces in the neighbourhood for recreational purposes are perhaps more likely to pay more attention to green space access. Importantly, perceived access to green space should not be considered as a proxy for objective access to green

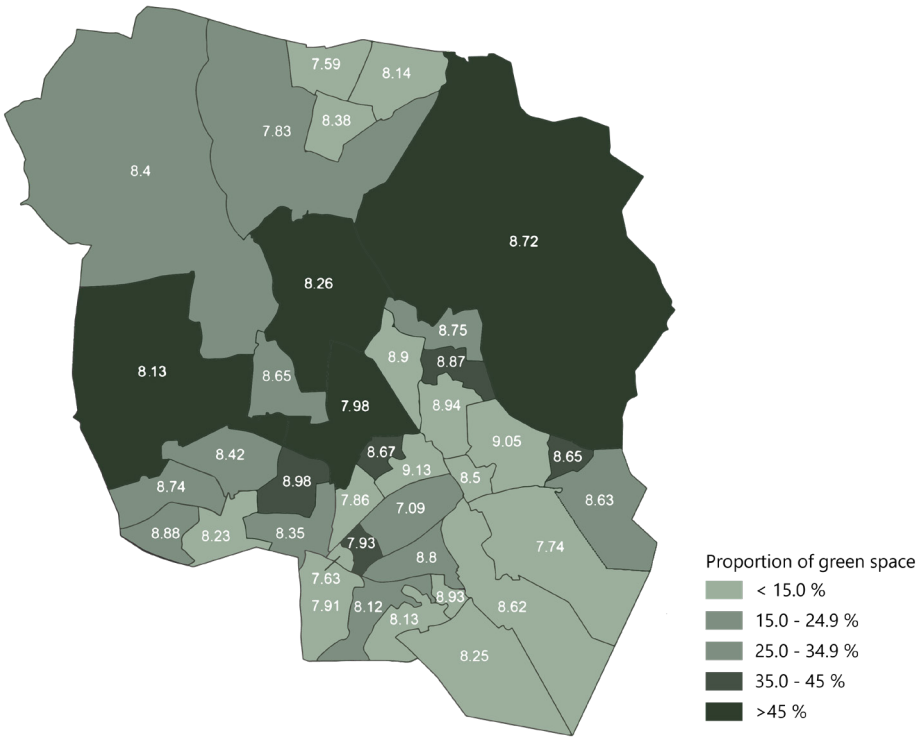


Figure 2. Objective and perceived green space in Täby.

[6] Demographic Statistical areas (DeSO) is a Swedish nationwide division that follows the county and municipal boundaries (see https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/deso---demografiska-statistikomraden/). The Nordic counties use different geographical areas which makes comparison challenging.

spaces and vice versa (Orstad et al., 2016); rather, both indicators provide unique information, and the most comprehensive analysis about green space access emerges when objective and perceived indicators are analysed together.

As described previously, both national and worldwide data sources for computing objective indicators of green spaces access are available for all municipalities in the Nordic countries. However, data on perceived access to green space is not openly available. Municipalities must either collect such information themselves or retrieve it from local surveys carried out by local, regional, or national authorities. Thus, the possibility to conduct comprehensive analyses with objective and perceived indicators varies between countries as well as municipalities within the Nordic Region. Box 2 provides an overview of advantages and disadvantages of using perceived and objective indicators of access to green space in planning practice.

Measuring people's health using different indicators

Collection, analysis, and usage of relevant health indicators are essential for monitoring public health. Without health indicators it is not possible to evaluate population health over time or understand why health differs across groups and contexts (Murray et al., 2002). Moreover, it would be impossible to know whether public health and planning interventions, such as development of green space, really have an impact on people's health (Salomon et al., 2003). Health embodies an array of meanings and dimensions (Bickenbach, 2017). This means that it can be measured in numerous ways, and it is recommended that indicators are comprehensive and reflect the health status of individuals throughout the course of their lives (Murray et al., 2002; Murray et al., 2000). It is outside the scope of this chapter to provide a full account of existing definitions and indicators of health. Rather, we will highlight some key points and features of health indicators that are important for planners and practitioners to know about as they can be evaluated in tandem with the green space indicators previously described.

Let us start with two consensus points about health that have been reached in the literature. First, health is multi-faceted and is comprised of both physical and mental dimensions. Thus, multiple indicators are required to assess different aspects of health. Second, health is an attribute of an individual, but aggregated measures are used to describe health in groups of the

Box 2. Pros and cons of planning with objective and perceived green space indicators.

The green space indicators we have used in the NORDGREEN project (total area of green space, total area of different green space types, total green area, mean distance to green space, and perceived access green space) have strengths and weaknesses.

OBJECTIVE GREEN SPACE INDICATORS:

- Give an overview of available green space within the municipality or other spatial scales.
- Can easily be compared over time and hence be used to indicate changes in the physical environment or show trends in planning practice.
- Can, when combined with health indicators, show inequalities in access to green space within the municipality or other spatial scales.
- Are often collected on a municipal or neighbourhood level, as it is difficult to compute objective indicators based on individuals' access to green space.
- Are limited when it comes to capturing qualities of green spaces.
- Only capture people's objective access to green space, not their actual exposure to, or use of, green spaces.
- Do not consider physical barriers.

PERCEIVED GREEN SPACE INDICATORS:

- Give an understanding of how the inhabitants perceive their everyday environment.
- Include perceived barriers, both environmental and personal.
- Are, in comparison with objective indicators, more time consuming and costly to collect. This type of data should preferably be collected in cooperation with researchers.
- May be difficult to collect due to lack of engagement from residents.

population (Bickenbach, 2017; Salomon et al., 2003). This means that results are generalised, even though individuals within a subgroup of the population may have a range of health conditions. In addition to these two key caveats for working with health-related research, an important characteristic of any health indicator is whether the indicator is objective or perceived (Cleary, 1997). Objective health indicators are measured independent of people's experiences (e.g., life expectancy or a clinical diagnosis). Perceived indicators, on the other hand, are based on an individual's experiences and perceptions. The most common perceived indicator of health status is self-reported health, which is typically assessed by asking people to rate their overall health (Cleary, 1997; Bombak, 2013). After the launch of the Ottawa Charter for health promotion (WHO, 1986), there has slowly been a shift in focus from preventing diseases to promoting health and well-being as an overall public health goal in the Nordic countries (Kickbusch, 2003; Raphael, 2014). This shift has also led to a stronger focus on using perceived indicators to assess people's health and well-being of relevance for supporting public health work (Carlquist, 2015).

In the NORDGREEN project, we have collected available objective and perceived health indicators for the case municipalities (see Table 1). By taking a glance at the selection of indicators presented in Table 1, we see that the indicators represent aggregated measures for each municipality and cover both objective and perceived aspects of health. The indicators have been obtained from official statistics (i.e., Statistics Denmark, Statistics Finland, Statistics Norway, and Statistics Sweden) and from statistics provided by the public health authorities and agencies in each country. Even if all countries in the Nordic Region are egalitarian states with social welfare support systems, there are differences in health in the populations between municipalities (Kinge et al., 2019). As illustrated in Table 1, Täby scores highest on life expectancy for both men and women and has the lowest proportion of obesity in the population when compared to the other NORDGREEN municipalities. When assessing self-perceived health, Aarhus stands out from the rest with 86% of the population reporting good perceived health.

From Table 1, it is also evident that differences exist when it comes to whether health indicators are openly accessible in the Nordic countries. For Ii municipality it was not possible to obtain any health indicators at the municipal level. Hence, only information on life expectancy for men and women in North Ostrobothnia, the region in which Ii is situated, are presented in the table. For municipalities in Norway and Sweden, a variety of indicators can easily be retrieved by anyone. In some municipalities, indicators are available on a municipal level (Table 1), but in other municipalities, such as Stavanger, data is also obtainable at the district level. With district level data, one can compare the health status of inhabitants living in different districts within a single municipality.

In Figures 3 and 4, we have used perceived health data

Table 1. Health indicators for the municipalities in the NORDGREEN project (using 2021 data).

INDICATOR	ESPOO	STAVANGER	TÄBY	AARHUS[1]	VILHELMINA	II[4]
Life expectancy for men (years)	80.9	81.2	83.0	81.6	78.8	79.2
Life expectancy for women (years)	85.3	84.8	86.4	81.6	84.1	84.8
Obesity (% of total population)	16.8	14.0	9.0	-	22.0	-
Incidence heart attack (per 100,000 inhabitants)[2]	-	220.0	193.5	-	313.5	-
Incidence stroke (per 100,000 inhabitants)[3]	-	190.0	218.3	-	299.3	-
Good self-perceived health (% of total population)	75.2	78.0	76.0	86.0	63.0	-

[1] Aarhus reports life expectancy for both genders together.
[2] ICD-10 code: I21
[3] ICD-10 code: I64
[4] The numbers are for the North Ostrobothnia region of Finland in which Ii is located.

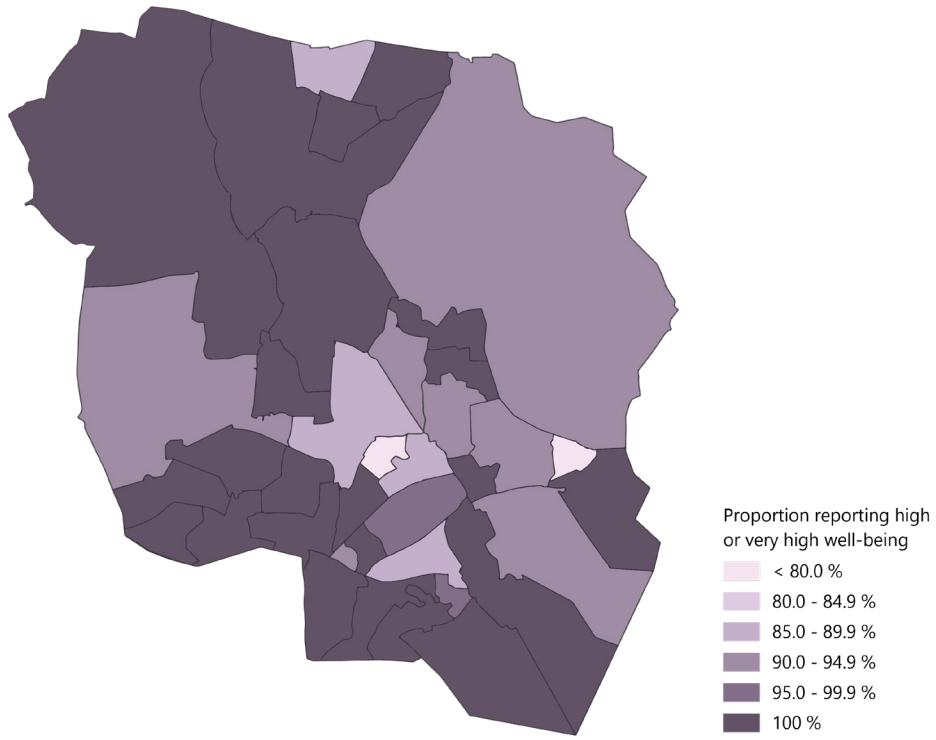


Figure 3. A visual presentation of the proportion of residents reporting high or very high well-being in the DeSO areas in Täby. Note that, overall, a high proportion of respondents rated high or very high values for perceived well-being, which explains why the visualisation focuses on values above 80%.

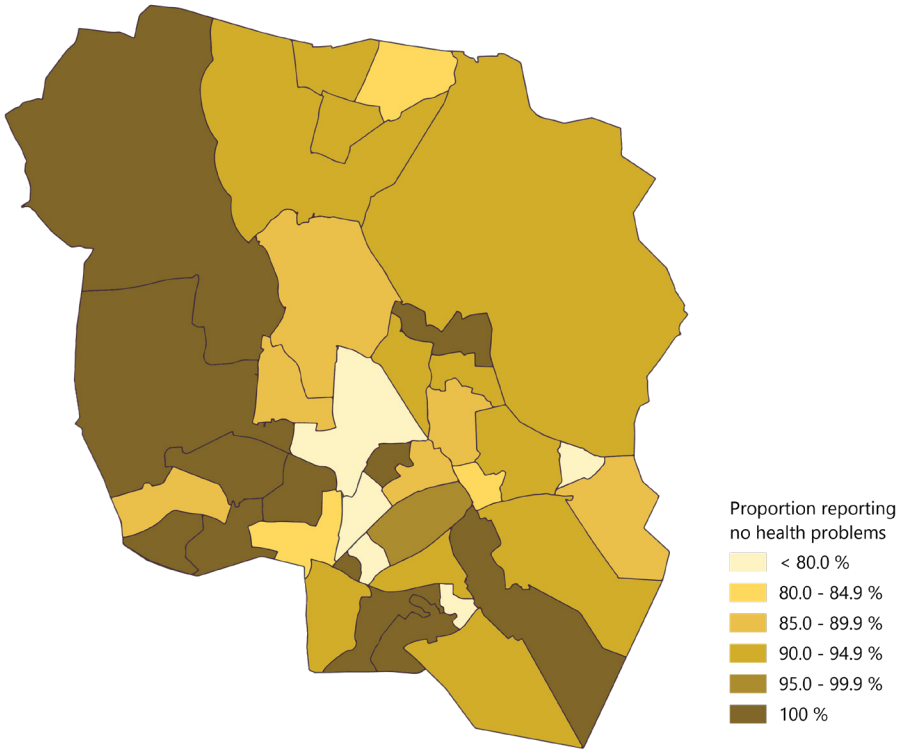


Figure 4. A visual presentation of the proportion of survey respondents reporting no health problems in DeSO areas in Täby. Note that, overall, a high proportion of respondents rated few health problems (good health) which explains why the visualisation focuses on values above 80%.

from the national citizen survey (Medborgarundersökningen) in Täby in 2021 to present a couple of health indicators on the neighbourhood level. In this survey, participants were asked to rate their well-being—"Do you think you can be who you are and live your life the way you want in your municipality?"—and health—"Because of your health, do you find it difficult to participate in activities or cope with tasks that most other people can cope with?" In Figures 3 and 4, we present differences in the proportions reporting "high or very high well-being" and "no health problems" across all DeSO areas in Täby. Darker colour means a higher proportion of survey respondents reported high or very high well-being. As shown, there are some DeSO areas in which the proportion of the population reporting high well-being overlaps with those reporting no health problems. However, it should be kept in mind that respondents in Täby overall score very high on both well-being and health.

Thus far, we have described how indicators can be used to compare health across groups and contexts. In Box 3, we summarise some pros and cons with using objective and perceived health indicators in planning practice.

Box 3. Pros and cons of planning with objective and perceived health indicators.

OBJECTIVE HEALTH INDICATORS:

- Provide an overview of the health status of the inhabitants living in the municipality.
- Are not openly available for all municipalities.
- May be accessible through payment in cooperation with researchers. There exist several indicators gathered by authorities and researchers such as the citizen survey in Täby.
- Are often presented on a municipal (aggregated) level, but under some circumstances, it is possible to retrieve neighbourhood data upon request.
- Are often less time-consuming to obtain compared to perceived indicators when the indicators are openly available.

PERCEIVED HEALTH INDICATORS:

- Give an understanding of how inhabitants perceive their health.
- Are feasible and inclusive measures that capture different aspects of health.
- May be less appropriate for identifying health inequalities due to bias associated with the participants' socioeconomic status. (People of high socioeconomic status tend to be more likely to respond to health surveys.)

DISCUSSION AND KEY MESSAGES

In this chapter, we have presented several indicators on access to green spaces computed objectively using GIS. We also present one indicator capturing inhabitants' perceived access to green space derived from a citizen survey. Furthermore, we have compiled health data on objective indicators such as life expectancy, obesity, and incidence of heart attack and stroke, as well as perceived indicators such as self-perceived health, perceived well-being, and perceived absence of health problems. As highlighted in the beginning of the chapter, substantial evidence has linked green space to improved health in the population. This underscores the relevance of monitoring green space and health indicators for planning purposes. However, planners need knowledge and tools to be able to map, monitor, and analyse both green spaces and health data in useful ways that can support planning of health promoting environments. Green space indicators are well known to planners. Both in their education and working life, planners are trained to do various kinds of green space analysis including analysis of access to green space, as shown in this chapter. However, health data is a relatively unfamiliar source of information to planners, and this was raised as a common challenge at the beginning of this chapter. Moreover, planners seem to ask for knowledge on how to implement health data in the planning practice. Using examples from studies in Täby, we have used this chapter to illustrate how health indicators can be applied in practice and what advantages and disadvantages are important to bear in mind when working with such indicators. The indicators have been presented individually as separate map layers that provide valuable knowledge by themselves (i.e., the planners can identify neighbourhoods with low green space access or low health status).

Figure 5. Green space and health indicators can be combined in the planning process to find areas that need particular attention when developing health-promoting municipalities.

The layers can also be stacked on top of each other and can thus provide possibilities to explore where indicators overlap and where there are potential challenges in the physical environment or in the populations' health status (Figure 5). With such joint analyses, it is easier to pinpoint particular neighbourhoods or areas that need attention (i.e., DeSO areas scoring low on both access to green space and health). In any given planning situation, planners need to be able to identify priorities and make decisions. A lot of the priorities made in a municipality are based on political decisions and priorities. But with insights gathered from a combination of green space and health indicators, planners can more easily argue for directed measures, such as an increase of parks within a specific DeSO area.

Based on this research, we recommend that planners consider the following key messages when applying objective and perceived indicators of green space access and health in their local contexts.

- Even if health statistics are presented as numbers (e.g., mean values, minimum, or maximum) they can easily be visualised as maps (as in Figures 3 and 4) and therefore speak the same language as spatial green space data.

- Aggregated health data on a municipal level retrieved from, for example, national statistics give an overview of the health status of the inhabitants, but the scale of the districts is, at times, very large, and finer grained, local-level data is needed. Hence, we encourage municipalities to cooperate with national authorities to address the need for local (district) level data. For example, in the national citizen survey used in the NORDGREEN project (*Medborgarundersökningen)*, municipalities can add their own questions as a supplement to the battery of standardised questions used by Statistics Sweden who is responsible for conducting the survey. This provides a possibility for municipalities to build on an already established survey rather than initiating additional surveys, which also reduces the risk of survey-exhaustion among residents. The authorities usually collect data on a regular basis. Such regularity is important to be able to compare changes in the physical environment or among the population over time. Despite the increased risk of survey-exhaustion, we also encourage municipalities to use

local surveys, preferably collected in cooperation with researchers or in combination with more qualitative methods such as interviews and workshops. With local surveys, planners can reach specific neighbourhoods and target groups of interest.

- Both perceived and objective indicators of health data are needed. The objective indicators presented in this chapter are all valuable health indicators and can be downloaded from registers such as Statistics Sweden or the public health agency of Sweden, or similar authorities in the neighbouring countries. However, perceived indicators are not always available, and municipalities sometimes must collect their own data or add questions to existing surveys, as mentioned above. As briefly described in the section on health indicators, there is currently a stronger focus on using perceived indicators to assess people's health and well-being to support public health work. In Norway, new recommendations for measuring health and well-being have been developed (Nes et al., 2018). These recommendations include a minimum set of questions that can be used to collect relevant data (see Box 4).

- Both perceived and objective indicators of access to green spaces are needed and cannot be a proxy for each other. We also differ between potential and actual accessibility, which is not addressed in this chapter. The objective indicators (i.e., land use and land cover) may be easier to download from available open access sources such as Lantmäteriet. However, perceived indicators are crucial to get a better understanding of how residents perceive their access to green space.

- Green space data based on GIS is often coarse (low spatial resolution), resulting in indicators assessing presence and proportion of green space. This means that such data neither provide place specific details about the spaces under study nor capture qualities within the green spaces. Hence planners need to conduct local fieldwork mapping considering qualitative aspects of green space to analyse green space at a more detailed level. Such qualitative analysis can be based on, for example, experiences such as the Perceived Sensory Dimensions (see BACKGROUND and DESIGNING chapters; Stoltz & Grahn, 2021).

- Finally, finding the optimal objective green space indicators is a challenge, and further research is needed. In planning practice, there will always be a need to map both objective and perceived green space indicators. We highlight the importance of collaborating with researchers to choose relevant available indicators or collecting new indicators to ensure that urban planning decisions are well-informed.

Box 4. Examples of relevant questions for measuring health and well-being (based on recommendations from Nes et al., 2018).

- Overall, how satisfied are you with your life at the moment? Responses are given on a scale from 0 (not satisfied) to 10 (very satisfied).
- Overall, to what extent do you feel that what you do in life is meaningful? Responses are given on a scale from 0 (not meaningful) to 10 (very meaningful).
- Think about the last 7 days. To what extent were you (i) happy, (ii) worried, (iii) sad, (iv) annoyed, (v) lonely, (vi) engaged, (vii) calm and relaxed and (viii) anxious. Responses are rated on a scale from 0 (not at all) to 10 (to a large extent).
- Overall, how do you perceive your own health? Responses are given on a scale from 1 (very poor) to 5 (very good).

OBSERVING

PUBLIC PARTICIPATION GIS AS A PARTICIPATORY PLANNING TOOL FOR HEALTHY CITIES

MARKETTA KYTTÄ, SAANA ROSSI, & ANNA KAJOSAARI

ABSTRACT

Citizens' experiential, local knowledge is a vital component of urban planning, especially if it can be gathered, shared, and utilised via a place-based and context-sensitive, yet scalable method. Public Participation GIS (PPGIS) offers planners, managers, and municipal officers—as well as private and third sector actors—an opportunity to gather map-based, experiential knowledge and use it for analyses alongside objective, institutional GIS data expanding the reach and scope of participation and adding to the level of detail which can be captured via surveys. In this chapter, we offer: (1) practical guidelines for creating a PPGIS survey and sharing and utilising the results, (2) an introduction to PPGIS methods via case examples from municipal and academic contexts, (3) examples of different levels of PPGIS data analyses ranging from exploratory to predictive analysis, and (4) examples of how PPGIS knowledge can be used to inform planning for the promotion of health and well-being. The chapter is based on intensive collaboration between municipalities and researchers in the NORDGREEN project, aiming to promote the use of citizen knowledge in planning practice. We hope it can provide useful insights for developing digital participation and integration of citizen knowledge into planning outcomes.

PUBLIC PARTICIPATION GIS—AN OVERVIEW

In the Nordic countries, participatory planning has been an elementary part of planning practice for decades. Engaging citizens of different ages, backgrounds, languages, experiences, and relationships with their environment is challenging, especially if the aim is to realise large-scale public participation. In this chapter we present digital Public Participatory Geographic Information System (PPGIS) as a method which can reach wide and diverse groups of citizens to gather place-based knowledge via online mapping tools. The accompanying place-based approach is especially usable in the study of health outcomes related to the use of everyday environments and the exposure to specific settings, like green areas

Within the past several decades, there has been extensive development and testing of various public participation methods and tools for urban planning.[1] In recent years, planners have developed and utilised digitally supported public participation methods, which became particularly valuable during COVID-19 lockdowns in 2020 and 2021 to engage people from their own homes.

One of the most widely used online methods is PPGIS, which provides digital means to support map-based dialogue and data collection (see Box 1). Maptionnaire[2] is a software that provides an advanced version of PPGIS methods. The software enables the creation of community engagement activities, systematic and comprehensive data collection, analysis, and reporting of data and activities. Originally developed at Aalto University in Finland, Maptionnaire has been used in 40 countries in more than 10,000 projects. As of 2022, more than 500,000 survey participants have provided over 10 million map-based responses within the Maptionnaire platform (Kyttä et al., 2023-a).

Maptionnaire has been used both in academic research projects and in public participation processes. The participatory planning projects vary in geographical scale, stretching from nationwide surveys to single neighbourhoods or small-scale green areas. In terms of project topics, green and blue-area planning and management projects—together with transportation planning projects—comprise over half of the cases for which Maptionnaire has been used (Kahila-Tani et al., 2019). Helsinki, Stockholm, New York, Denver, San Francisco, Edinburgh, and Copenhagen are among the many cities that have used Maptionnaire in their community engagement processes (Kyttä et al., 2023-a). While many planners utilise the tool during the initiation stage of planning projects, others apply it during the evaluation phase to gain feedback from the public after project implementation (Kahila-Tani, 2015).

In NORDGREEN, Maptionnaire has been used by local urban planners to study how citizens engage with their everyday environments and green spaces across four Nordic towns and cities: Espoo and Ii in Finland, Stavanger in Norway, and Vilhelmina in Sweden. Maptionnaire enables civil servants to extract citizens' experiential knowledge in the form of participatory mapping. Participants respond to survey questions by tagging geographical locations that correspond with their use of or perceptions towards those spaces. The four NORDGREEN cases provide insights into how PPGIS can be used to plan cities that improve human health and well-being by identifying how citizens interact with their existing urban landscapes. Research and city partners in the four case cities developed and implemented PPGIS surveys with the overall aim of

Box 1. What is PPGIS?

Public Participatory Geographic Information System, or PPGIS, refers to the use of mapping methods (mainly digital) to collect and reflect users' needs, interactions, and opinions about certain geographical areas (Haklay & Francis, 2017). It is a process of engaging the public in developing and using spatial information to improve the quality of decision-making processes, often about land use, preferably in the early stages of planning (Brown & Kyttä, 2014). More generally, the approach allows the broader public to provide experiential knowledge regarding their living environment as well as suggestions and ideas for improving existing areas. PPGIS can also be used in place-based research on human-environment interaction, for example, in studies concerning environmental health promotion.

[1] See, e.g., https://participatory.tools
[2] https://maptionnaire.com/

Table 1. Overview of the four PPGIS surveys in the NORDGREEN project.

	ESPOO *My Espoo on the Map*	II *Everyday environments and well-being in Ii*	VILHELMINA *Development of Kittelfjäll and Övre Vojmådalen*	STAVANGER *Green space usage and perceived health*
DATA COLLECTION PERIOD	2 August–31 October 2020	13 May–31 July 2021	25 March–1 May 2021	October–December 2021
FINAL SAMPLE SIZE	6,605 participants and 69,839 location markings	400 participants and 3,484 location markings	340 participants and 1,025 location markings	575 participants and 1,133 location markings
SURVEY TOPICS	• Everyday use of urban spaces. • Perceived quality of the living environment. • Views on future land use planning and management. • Perceived health and quality of life. • Previous participation and attitudes towards public participation.		• General ideas and suggestions for future development. • Previous experiences of respondents about public participation, and attitudes towards public participation. Use and needs of different stakeholder groups (residents vs visitors) in summer/ winter seasons	Citizens' activities and use of recreational outdoor spaces.
RESULTS	The survey data has been used as input for several ongoing planning projects. The city of Espoo has developed new ways to store PPGIS data and transparent practices to tell about the ways PPGIS data has informed planning. Together with planners, specific topics were chosen for closer analysis.	The responses of the participants highlighted the need for public services and maintenance of public recreational spaces in less populated areas of the municipality. The results can potentially serve as a basis for later participatory budgeting projects.	The implementation of alpine skiing, hiking,and biking trails were the most popular suggestions for the development of the area. Residents and visitors expressed different perspectives: visitors suggested development of seasonally related activities, while residents suggested development of basic services, such as gyms, shopping, and service centers.	The survey showed that respondents value the time they spend in nature and that the development of green spaces in the municipality gets a lot of support. Wishes for the development of blue areas were highlighted including the upkeep of bathing areas and urban hiking trails along the coast.

using the results to inform local land-use processes and cross-sectoral management of green spaces. Table 1 presents the basic information about each of the four surveys.

In addition to variations in sample size, the surveys differed from a spatial perspective. While Espoo focused on the everyday use of urban spaces, Ii considered the development of green areas in a context with resource limitations. Vilhelmina and Stavanger both looked at the use of green areas according to specific population groups (tourists, inhabitants, and vacation homeowners in Vilhelmina, and various socioeconomic groups in Stavanger). PPGIS surveys in Espoo and Ii targeted the entire cities geographically, while in Vilhelmina and Stavanger, the surveys were implemented in specific areas to meet the local needs and interests of the cities. Together, these four cases provide a range of examples for how green spaces can be developed to achieve public health outcomes in cities within Nordic

countries.

Throughout the project, researchers and planners from the municipalities have been in close collaboration to determine how to use the survey results to inform future development in their respective areas. In Espoo, where the survey results have been available longest, the goal for the survey was that it would provide experiential participatory knowledge as background material for all future planning processes. For this purpose, the results were uploaded as their own layer in the municipal geographic information system (LocusCloud) where they are available to planners similarly to any other GIS data.

STEP-BY-STEP DATA COLLECTION WITH PPGIS

Online platforms such as Maptionnaire have the advantage of potentially engaging a larger number of participants to collect spatial information or seek solutions across diverse segments of the society. A recent study that reviewed over 200 Maptionnaire surveys used by cities in participatory planning cases showed that Maptionnaire surveys reach 467 participants on average, without the use of incentives (Kahila-Tani et al., 2019). This means that this online platform can reach a relatively large number of voluntary participants compared to other participatory engagement strategies, like focus group meetings and public hearings. Although the Maptionnaire tool can be used in facilitated workshops or in-person surveys (for example, to help target underrepresented groups; Fagerholm et al., 2021-b), PPGIS data is most often collected online so that each respondent answers the survey independently (Kyttä et al., 2023-a).

What kind of data can be collected with PPGIS?

The data collected with PPGIS can be characterised as "active sensing" knowledge. This refers to place-based knowledge from people about their experiences and behaviour that is purposefully collected with specific questions in mind. In contrast, "passive sensing" data refers to place-based "big" datasets from people that are automatically collected (e.g., via smart phones; Grêt-Regamey et al., 2021).

A wide variety of knowledge can be collected through PPGIS (see Figure 1), and place-based data can be combined with traditional survey data.

At the core of PPGIS knowledge is the mapped, place-based data (geographic information most often represented as points, routes, and areas) about current or future environments. Examples of knowledge related to current settings (Figure 1, Category 3) include preferences, attitudes, or values related to specific places, knowledge about lifestyles and everyday practices of people, and the mapping of environmental phenomenon and problems (citizen science). In participatory planning, the most interesting place-based data typically concerns future wishes, visions, and preferences of people (Figure 1, Category 4; Fagerholm et al., 2021-b; Kyttä et al., 2023-a).

In addition to place-based data, traditional survey-data can also be collected with a PPGIS survey. Other collected data typically include questions related to people's backgrounds (Figure 1, Category 1) like age, gender and education level. It may also be relevant to collect some general knowledge from the individual participants regarding their attitudes, for example,

Figure 1. Five types of knowledge that can be collected with PPGIS surveys.

towards environmental issues (Figure 1, Category 2). Finally, it is possible to collect knowledge related to possible outcome variables that are used in further analysis of the data (Figure 1, Category 5). Examples of these variables are neighbourhood satisfaction, perceived quality of life, and perceived health (Fagerholm et al., 2021-b; Kyttä et al., 2023-a).

In the NORDGREEN surveys, planners asked a variety of questions depending on the focus of the survey (as shown in Table 1). Surveys in Stavanger and Vilhelmina had a more thematic focus, while in Espoo and Ii, the surveys covered questions for almost all five categories.

How to collect data with PPGIS?

When collecting data with PPGIS, three main strategies have been used: volunteer sampling, random sampling, and purposive sampling (Box 2; Fagerholm et al., 2021-b; Kahila-Tani et al., 2019) In the NORDGREEN cases, all three strategies were used.

Random sampling generally results in the best representation of the study/target population (Brown, 2017); therefore, researchers most often use this data collection strategy in research projects. However, in planning practice, planners use random sampling less frequently due to the expense of sending personal invitations to potential participants. Instead, planners most commonly collect data through volunteer sampling. Volunteer sampling is useful for planners because, according to the legislation of some countries, efforts should be directed at reaching the entire public concerned. Therefore, city planners feel obliged to arrange openly marketed surveys instead of random sampling. Purposive sampling strategy is also useful in cases where there is interest in learning from a certain population group. It can also be used to achieve a better balance in relation to some background variables, proportionate to the population. For example, it is often difficult to reach inhabitants who speak languages other than the nationally recognised languages or to reach members of society with low levels of education, but in PPGIS surveys, it is rather easy to provide many language options (Nummi & Harsia, 2022).

The NORDGREEN project exemplifies some of these methods. The City of Espoo complemented random and volunteer sampling with purposive sampling targeting adolescents. Through this work, they collected data from approximately 2,500 students in upper secondary schools. Innovative purposive sampling was developed by the city's participatory planning expert, who developed a ready-made plan for two teaching lessons for the school. The teaching session planned around the survey emphasized the importance of sensitivity to the everyday living environment and of becoming an active citizen. The students were asked to take photos of important places in their living environment, and after discussing their preferences in groups, they filled out the survey. The Espoo case highlights how the three sampling strategies complemented one another to provide results that were representative of the city's population.

Maptionnaire has been designed to accommodate GDPR legislation. While the platform can be used for participatory mapping with all citizens, including vulnerable groups, the project leaders are responsi-

Box 2. Sampling methodologies for public participation in urban planning.

VOLUNTEER SAMPLING
Volunteer or crowd-sourced sampling refers to reaching the PPGIS survey participants through traditional media or social media. The link of a PPGIS survey can be openly shared in various social media platforms or through traditional media channels like newspapers or through posters and flyers with QR codes.

PURPOSIVE SAMPLING
Purposive sampling means selective sampling, where those who organise the data collection rely on their own judgment when choosing members of the population to participate in the PPGIS surveys. Example include collecting data from schools or from local entrepreneurs.

RANDOM SAMPLING
Random samples can be drawn from national population or household registers. It is possible to define the characteristics of people included in the sample (e.g., age, residence, or size of household). People who belong to the sample are typically approached via letters to invite them to participate.

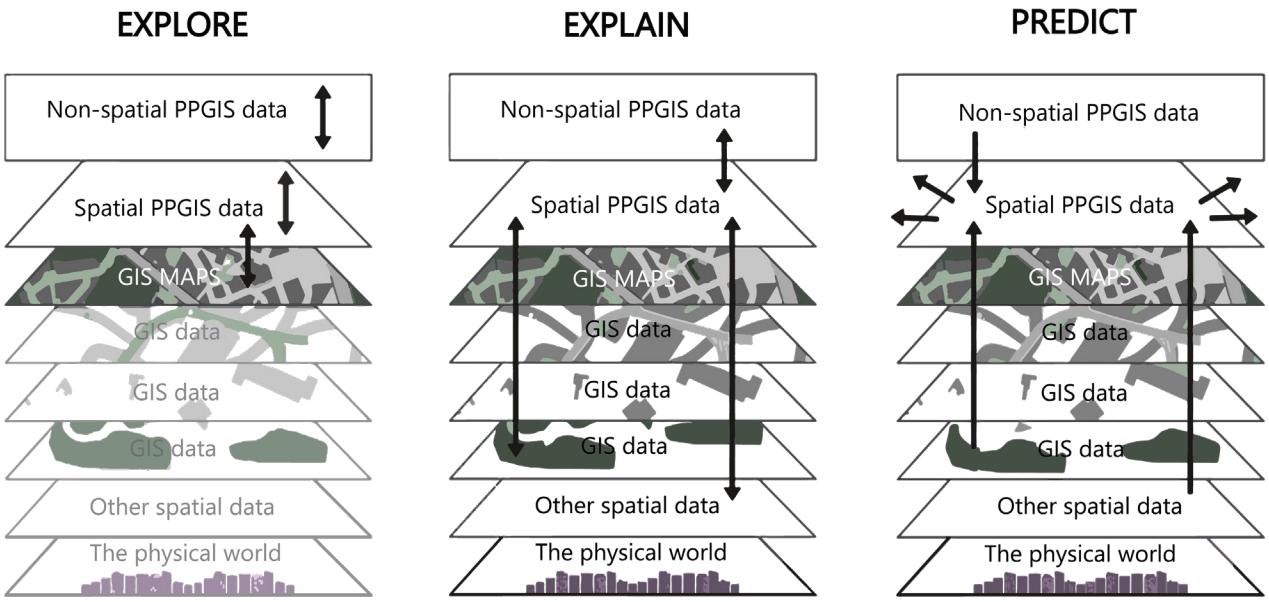


Figure 2. Three levels of PPGIS data analysis (Fagerholm et al., 2021-b).

ble for designing participatory mapping projects that comply with ethical standards, including how people are recruited, the survey designed, how data is stored over time, and how the reporting and communication of these data are arranged (Kyttä et al., 2023-a).

PPGIS DATA ANALYSIS

PPGIS datasets can be analysed at various levels ranging from simple, descriptive analyses to sophisticated, predictive models. A three-phase framework (Figure 2) describes the different types of analyses, which all have their uses in planning.

The Exploratory Phase

The *exploratory* phase refers to the exploratory and descriptive analysis. Exploratory analyses can provide thematic or descriptive overviews of citizens' use of an area or wishes related to a planning process. Planners can also use exploratory analyses to visualize data for planning and communication. The analysis functions built into the Maptionnaire service enable this type of analysis, which can be carried out without previous GIS skills. Therefore, this work is generally accessible for planners and stakeholders without experience using digital place-based knowledge.

Exploratory analysis typically means making a visual analysis of map markings. Spatial patterns are identified one variable at a time and can be compared across other variables. Thematic maps and charts are often created to examine the spatial patterns. It is also important for analysts to clean the data before proceeding to more advanced phases of analysis. This can be done by detecting, correcting, and removing any inaccurate spatial records (such as test responses or clearly mistaken or misleading mappings) and organising the data for analysis. Such data manipulation may include value (re)classification (such as converting open responses into codes or text inputs into numbers), data (re)ordering, data queries, and removal of outliers.

By using the Maptionnaire service analysis tools, planners can use this phase of analysis to gain insights into topics which respondents found most important and places that gained most attention in various survey categories. Box 3 provides an example of the exploratory analysis phase with the dataset from Ii.

Box 3. Mappings related to the preservation of existing and the development of new green areas.

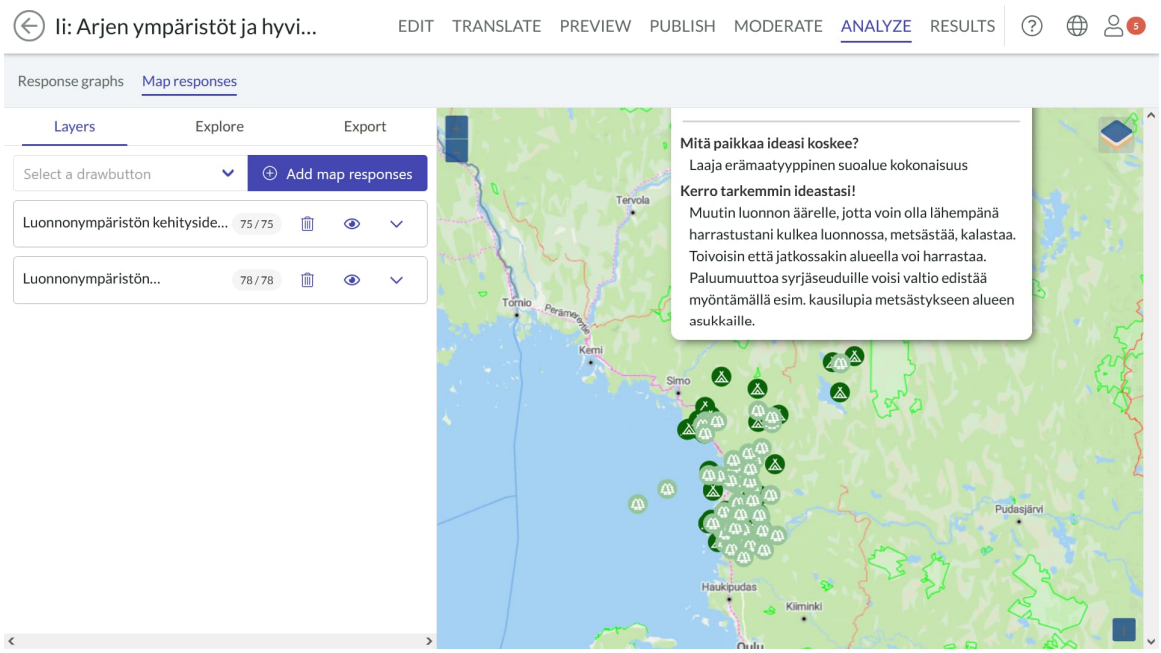


Figure 3. Maptionnaire interface for analysing residents' map markings and open comments of natural areas in Ii (suggestions for preservation and new developmental ideas).

Permanent and seasonal residents of Ii were asked to map locations for the preservation of existing green areas as well as new development ideas of green areas (Figure 3). Using the Maptionnaire platform, this information is presented on a map with comments from the respondents including arguments for why they would like to preserve—or how to improve—the green areas. After the initial exploration of the data, the dataset can be exported to a GIS program or another program for further analysis.

The overall responses from the Ii survey highlighted the need for public services and maintenance of public recreational spaces in sparsely populated areas of the municipality. The results will inform the development of recreational areas in Ii and could potentially serve as a basis for participatory budgeting projects to be voted on by residents.

The Explanatory Phase

The *explanatory* phase aims to look closer at the PPGIS data and typically means the simultaneous analysis of soft, experiential GIS data and hard, traditional GIS data about the characteristics of the physical environment. A wide variety of methods have been developed for these kinds of diagnostic analyses (see Fagerholm et al., 2021-b). GIS experts or researchers typically perform this level of analysis since it requires expertise in analytical methods. Through data examination, practitioners can learn how people feel about or use a place in which a certain design or planning solution has been implemented (among other things). This kind of knowledge provides interesting feedback for planners about the success of various solutions. Boxes 4–6 provide examples of the explanatory phase of analysis from NORDGREEN. These analyses have been designed together with planners, and they address topical planning challenges for Espoo.

Box 4. Redefining Espoo neighbourhoods.

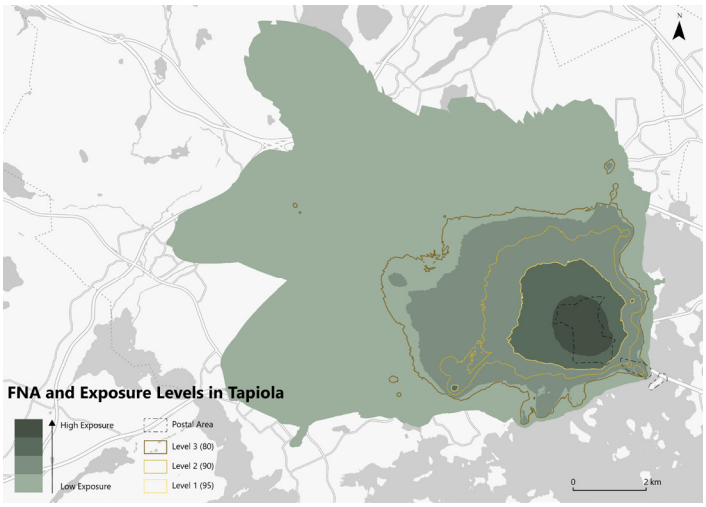


Figure 4. The redefinition of the functional borders of Tapiola neighbourhood based on residents' mobility patterns and various exposure levels.

In Espoo, resident-mapped places helped the planners to understand the daily mobility of residents living in different neighbourhoods. In some neighbourhoods, most daily activities were located within the neighbourhood, indicating that many of the residents' needs were met by the local services and amenities. In other neighbourhoods, the residents travelled longer distances with many daily trips extending to local municipal centres and neighbouring municipalities.

Information on the residents' mobility patterns were used to suggest a new division of the neighbourhood with new neighbourhood borders as an alternative for the existing administrative neighbourhoods (Figure 4). This analysis helped planners to visualize functional neighbourhood areas and to understand the mobility patterns of residents living in different parts of the urban area. While some of these new neighbourhoods were similar to existing administrative areas, many existing neighbourhoods did not correspond to the residents' actual mobility patterns. This suggests that, while administrative areas are often important in organising planning activities and planners' work, they do not always correlate with the daily practices of residents, such as the use of services, recreational areas, or other public open space (Hasanzadeh et al., 2023).

In Espoo, this detailed knowledge of residents' mobility patterns and functional neighbourhoods assisted planners in developing the city's service network, transportation system, and green-blue infrastructure.[3]

[3] See Hasanzadeh et al. (2023) for more information on how PPGIS was used to help redefine Espoo neighbourhood boundaries.

Box 5. The prioritisation model used in Espoo to identify areas for management or development.

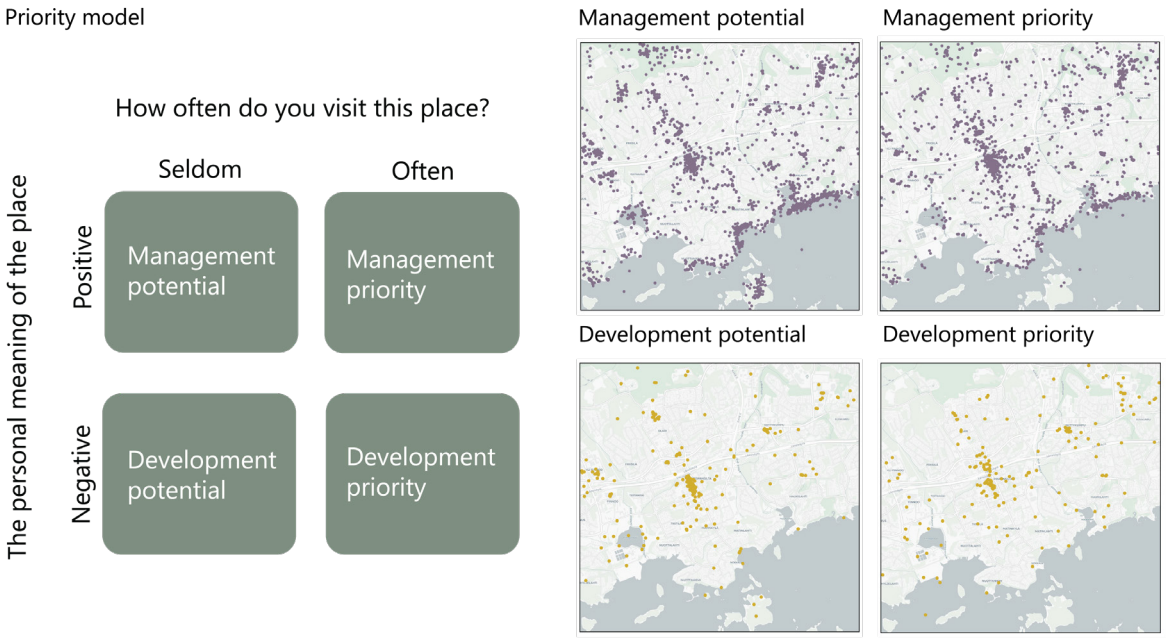


Figure 5. The prioritisation model used in Espoo to identify areas for management or development.

In the NORDGREEN project, we asked whether it is possible to prioritise knowledge from participants based on how citizens perceive and use urban spaces in their everyday lives. By using measures such as frequency of use and perceived quality of everyday places, NORDGREEN researchers identified several priority categories: development priority and development potential, consisting of primarily negatively perceived spaces, and management priority and management potential, consisting of primarily positively perceived spaces (Figure 5). We found that respondents associated negatively perceived places often visited with reduced quality of life, solidifying that planners may need to prioritise development in these areas. We also found that a rather high share of these places corresponded with the city's existing planning areas, meaning that there is strong potential to apply this knowledge, and development needs have already been identified by the municipality (Kyttä et al., 2023-b).

The purpose of the prioritisation model is to help planners strategically prioritise and use the large knowledge base from citizens' everyday life to inform planning and management. The findings of this study are promising in helping cities allocate their limited resources to areas that most urgently need improvements. In PPGIS surveys, the majority of mappings often concern positively valued places. In the case of Espoo, approximately 90% of mapped places were positive). If citizens are satisfied with a large majority of existing places, these places should be developed and managed sensitively. Simultaneously, the prioritisation model highlights a small but significant group of places (most typically located in traffic areas and densely built urban areas) that are both negatively perceived and unavoidable in everyday life, and thus have a negative impact on residents.[4]

[4] See Kyttä et al. (2023-b) for more information on the prioritisation model.

Box 6. Analysing citizens' views on the future development of Espoo.

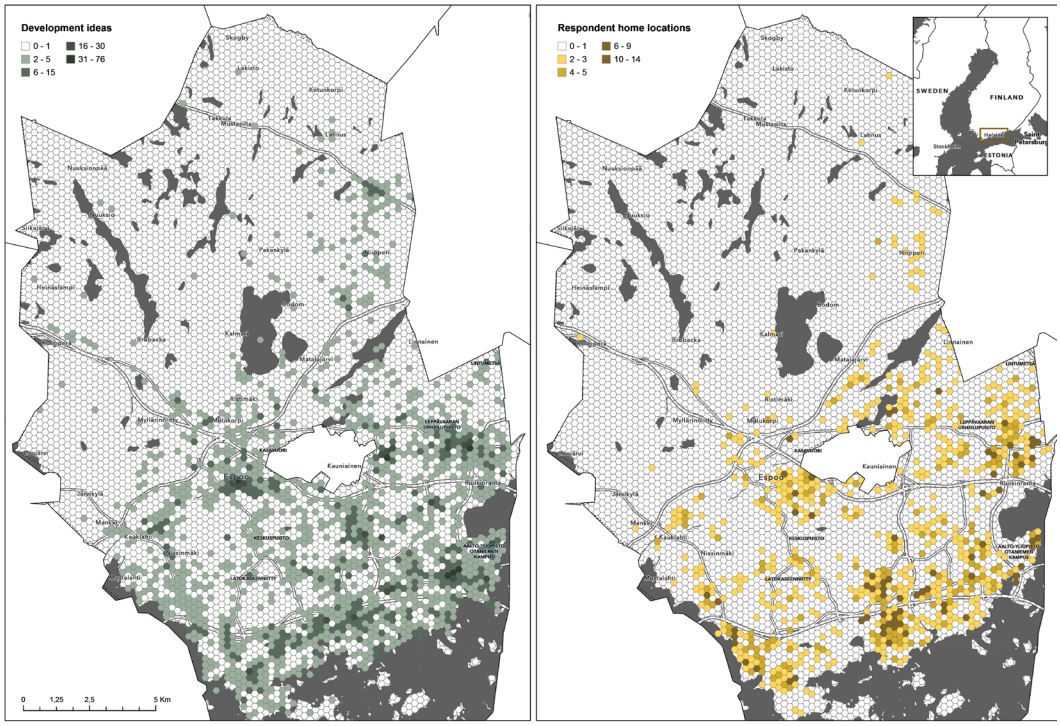


Figure 6. Mappings showing citizens' suggestions for areas of development (left) and their residential location (right).

Respondents of the Espoo survey also mapped suggestions for places that should receive attention over the upcoming years in the city's urban and green infrastructure planning. These suggestions were related to availability and quality of public and private services, the city's green and recreational environments, the local transportation system, and urban densification (Figure 6).

Over 30% of these suggestions were mapped in areas that were already identified as future planning areas by the City of Espoo, suggesting a level of agreement between citizens' and planners' views. However, the locations of these suggestions also show that citizens are mostly interested in planning activities near to them, as nearly 40% of mapped places were located no further than 2 km from the respondent's home (Kajosaari et al., 2023).

One in four of the mapped development suggestions were related to Espoo's green and recreational environments, indicating a clear citizen interest in the development and maintenance of urban green infrastructure. On a more detailed level, these suggestions were related to diverse green space qualities, including maintenance, ideas for facility improvement, connectivity of walking and cycling paths, and accessibility to these areas from different parts of the city. In addition, a considerable portion of suggestions emphasised the cultural and ecological values of certain green spaces and advocated for protection status. Common to all suggestions was that they provided local, place-based knowledge about specific, identifiable green environments in contrast to general, city-level planning aims.

In Espoo, analysing the citizen-mapped development ideas has provided valuable knowledge of the views, values, and ideas of the local population regarding their living environments. This information has been integrated into the city's planning support system and is currently used at different planning levels.[5]

[5] See Kajosaari et al. (2023) for more information regarding citizens' perspectives of future development in Espoo.

The Predictive Phase

The *predictive* phase of PPGIS analysis is about generalising the mapped knowledge so as to apply the knowledge to other contexts—such as potential future realities. The analysis helps planners to gain a deeper understanding about potential impacts of changes in the environment, and it can help planners compare the effects of alternative planning scenarios on, for example, the environment, mobility, residents' behaviours, and residents' perceived quality of the area. Since this analysis involves integrating multiple data sources to predict and model PPGIS data, the predictive phase typically requires advanced expertise. There are not yet many examples of this level of PPGIS data analysis; the case from Espoo presented in the Box 7 is one rare example.

Box 7. Understanding green space quality.

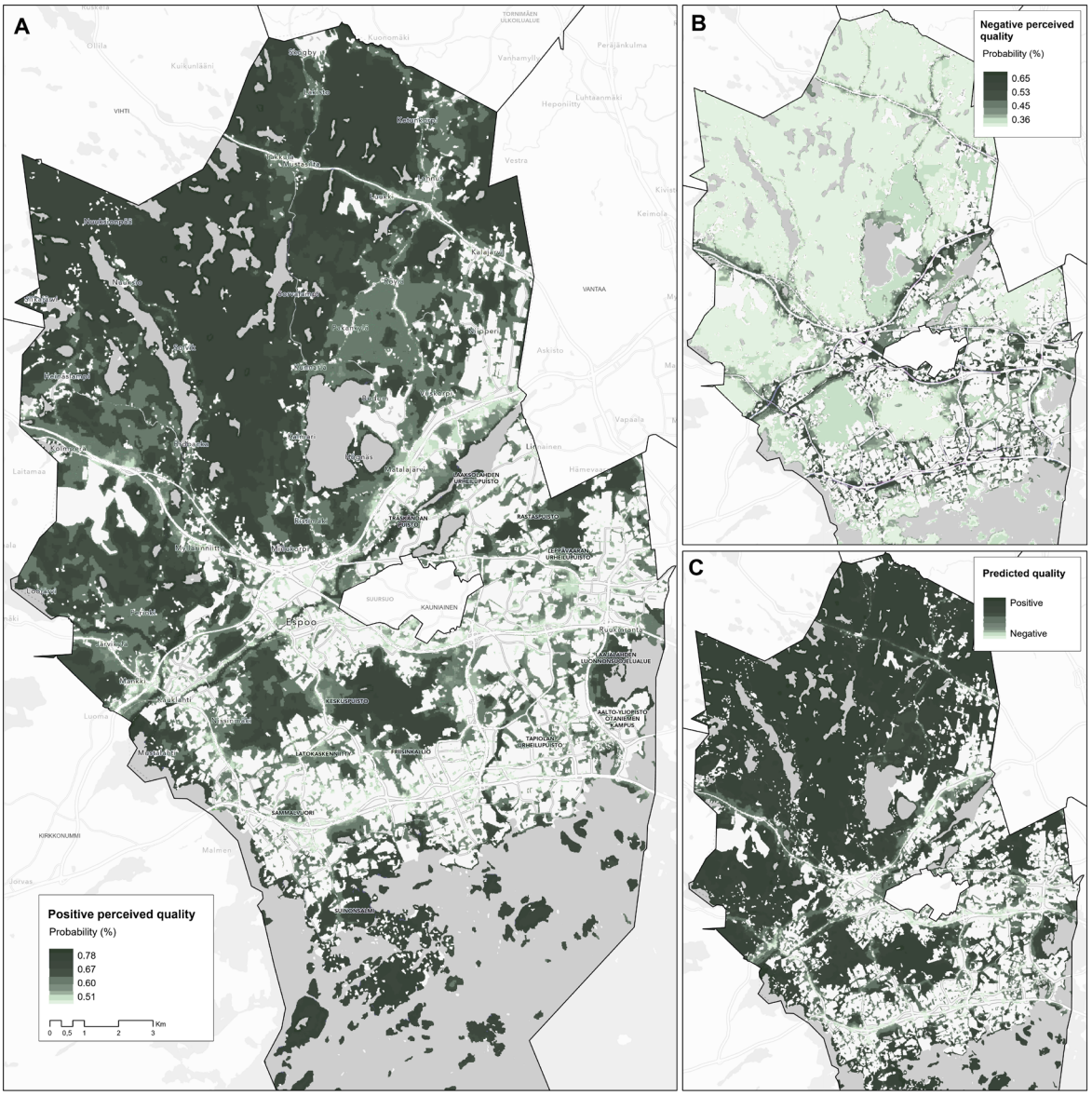


Figure 7. Positive and negative perceived quality of green space in Espoo.

In Espoo, respondent-mapped knowledge of green spaces helped planners understand which green space characteristics are especially valued by the local population and encourage green space use.

Espoo residents mapped over 8,500 places located in green spaces and answered questions about the quality of these places. High perceived quality most often corresponded to green spaces with high biodiversity and green spaces with blue elements, such as Espoo's coastline along the Baltic Sea or inland lakes and rivers. Green spaces that were exposed to daytime noise (e.g., spaces in the vicinity of heavily trafficked roads) had the lowest perceived quality.

These results were used to predict green space quality throughout the entire city of Espoo. The resulting map (Figure 7) helps to understand where in the city green areas with high perceived quality are available for local residents and where residents need to travel longer to reach these areas. Information on green space quality also helps to identify green spaces with local and city-level importance. Results of the analysis show that understanding both green space quality and quantity is important, as quality encourages green space use and, consequently, the health and well-being benefits gained by use of and exposure to green environments (Kajosaari et al., 2024).

In planning practice, mapping the perceived quality of urban green spaces provides a method to understand what green space characteristics are highly valued by the local population and how they are distributed within the planning area. The model can potentially be used in the master planning process to reveal the impacts of various versions of the plan on the perceived quality of green spaces.[6]

Various levels of data analysis in planning practice

For planning purposes, exploratory analysis often provides sufficient insight; through these methods, the planner can, for example, determine the location of hot spots (i.e., places that many people have marked positively, or areas with a concentration of markings suggesting needs for improvement). However, if the analysis ends here, practitioners will miss the full potential of PPGIS (i.e., experiential, place-based datasets combined and analysed with traditional GIS datasets). When combining experiential knowledge with structural analysis, the planner can potentially gain valuable feedback about planning solutions, including knowledge about the experiential dimensions related to urban structural characteristics, land use patterns, zoning, etc. The explanatory phase enables planners to answer critical questions, like what level of urban density is perceived most positively by inhabitants (Kyttä et al., 2016). The final, predictive phase goes one step further by answering, for example, how the inhabitants' use of green spaces would change if a new plan was realised.

When analysing PPGIS and applying the results in planning, it can be tempting to cherry-pick evidence that is politically welcome or fits with the preconceived ideas of the planner (Kahila-Tani, 2015; Kahila-Tani et al., 2019; Krizek et al., 2009). However, the cherry-picking phenomenon cannot be totally avoided as the data processing in planning projects always takes place in sequences of human interaction. To avoid this, a planner may reflect on the findings to learn how much they align with their own views and expectations. It is a good sign if the analysis reveals some surprising results.

THE USE OF PPGIS DATA IN THE STUDY OF ENVIRONMENTAL HEALTH PROMOTION

Recently, researchers and urban planners have been focussing on health outcomes related to urbanisation. While environmental health research has blossomed during the last decades, the findings reveal a complex view of the health impacts related to various urban planning solutions: Urbanisation seems to pertain to both health problems and to the possibilities for promoting healthier lifestyles. Evidence from several research fields about the ways urban structural characteristics can promote health is somewhat conflicting, which makes it difficult for urban planners to apply environmental health research findings in practice.

The traditional first wave environmental health research concentrated on the illness-producing mechanisms of the physical environment. During the last

[6] See Kajosaari et al. (2024) for more information regarding citizens' perspectives on quality of green spaces.

30 years, this paradigm has given way to the current, second wave environmental health research that studies the health-promoting qualities of physical environment. This shift occurred after lifestyle-related health problems became a major concern in public health policy and brought new actors like urban planners to the field: "Planning and health is big news," planning and policy researcher Marlon Boarnet wrote in 2006.

Nevertheless, the current evidence base of the field reveals confusing results. On the one hand, there is fairly compelling evidence to show that a compact urban structure with high neighbourhood accessibility encourages active lifestyles, increases the probability of walking and cycling to school, errands, and work (Durand et al., 2011; Sallis et al., 2016), and therefore contributes to positive physical health outcomes. Evidence shows that urban sprawl is related to lower levels of daily physical activity and higher risks of being overweight and having hypertension (Ewing et al., 2003).

On the other hand, the literature concerning the health benefits of natural environments shows that proximity to nature associated with low density building promotes mental health as a setting for stress restoration (Korpela et al., 2010). Even the risk of mortality is lower if the exposure to green space is guaranteed (Hu et al., 2008).

Evidence concerning urban structure characteristics that promote *social health* is even more complex. The literature concerning the relationships between health and various aspects of social capital and social cohesion have sometimes shown positive health outcomes associated to urban neighbourhoods (Mohnen et al., 2011) but, in other studies, have revealed more complex associations between contextual variables and social dimensions of health (Ziersch et al., 2009).

Using PPGIS surveys in the Helsinki metropolitan area, Kyttä et al. (2016) found that urban density increased the perceived quality of the urban environment in central parts of the city by bringing everyday services close. Also, in suburban settings, urban density was associated with nearby services, but in this case, this decreased perceived environmental quality. What should be done in suburbs to change the situation? The same PPGIS dataset also revealed that the places inhabitants marked as positive were significantly more green than negative places. These results call for a need to combine density and green space—both have something positive to offer. In this study, only mediational associations (not direct ones) were found between urban structural characteristics and perceived health.

These findings suggest that, rather than density level or green structure proportion alone, health is promoted by complex, contextual processes that are probabilistic or possibilistic by their very nature, rather than deterministic (Kyttä et al., 2013). Therefore, some researchers (King et al., 2002; van Loon & Frank, 2011) have proposed that environmental health promotion research should develop ecological models and perform analyses of the complex, situational environment-behaviour processes at different scales of the environment.

The key to understanding the health and well-being outcomes of different environments is understanding how people *use* the environment. Without a proper understanding of the environmental characteristics to which people are exposed in their daily lives, we cannot fully understand the ways an environment promotes or hinders our health and well-being. Surprisingly enough, in most studies of environmental health promotion, the environment is studied only through subjective, verbal descriptions, without any objective measures (Rinne et al., 2022). PPGIS offers a unique way to combine objective characteristics of places with place-based knowledge about people's behaviour, preferences, and experiences.

RECENT PPGIS RESEARCH ABOUT ENVIRONMENTAL HEALTH PROMOTION

To understand the environmental characteristics which individuals are exposed to in their daily lives, we need a dynamic understanding of the ways individuals use urban space and form their individual activity spaces. *Individual activity space* comprises places that individuals visit regularly as part of their daily, voluntary, or necessary activities (such as work, shopping, walking a dog, or visiting a park). Researchers have developed various ways to measure individual activity spaces that reveal direct associations between urban structural characteristics and health. Examples include the home range model and the residential exposure model (Figure 8) and the centricity typology (Figure 9). These different methods of measuring individual activity space shed light on various aspects of environmental health promotion.

By way of example, Laatikainen et al. (2018) found a positive association between green space and health when exposure was assessed with the individualised residential exposure model. The same dataset revealed a positive correlation between perceived well-being and walkability index and the length of pedestrian and bicycle roads when using a home range model. This example highlights how planners sometimes extract rather different results depending on how they analyse the data. Some methods are especially useful for determining the availability of environmental opportunities that promote active travel and related health outcomes, while others can provide insights into the mechanisms of how actual exposure to green spaces can enhance well-being.

It is noteworthy that individual activity spaces do not only concentrate around homes; they can also form several clusters of destinations. Thus, it is possible to create a typology of various lifestyles with mono-, bi-, and polycentric activity spaces (Hasanzadeh et al., 2021). The results among both old and young adults show that a monocentric lifestyle is associated with better perceived health than bi- or polycentric lifestyles. According to these results, localised living (in which people actively use services in their vicinity) seems to have positive health outcomes.

Environmental health research often struggles to differentiate individual aspirations for healthy living from the possible health-promoting characteristics of the environment. Does the environment really have the ability to promote health, or is it more a question of adopting an individual, healthy lifestyle which people carry on regardless of where they live? A study by Laatikainen et al. (2019) showed that certain characteristics of the built environment are associated with active everyday mobility regardless of one's personal interest towards maintaining an active or healthy lifestyle. These characteristics included residential density, intersection and public transportation stop density, and the number of sports places. Even people who were not keen to invest in their own well-being were more active when living in areas with these characteristics. Another study by Ramezani et al. (2021) found that when people moved to an area that promoted active mobility, they changed their daily mobility habits towards more active and sustainable travel modes, and

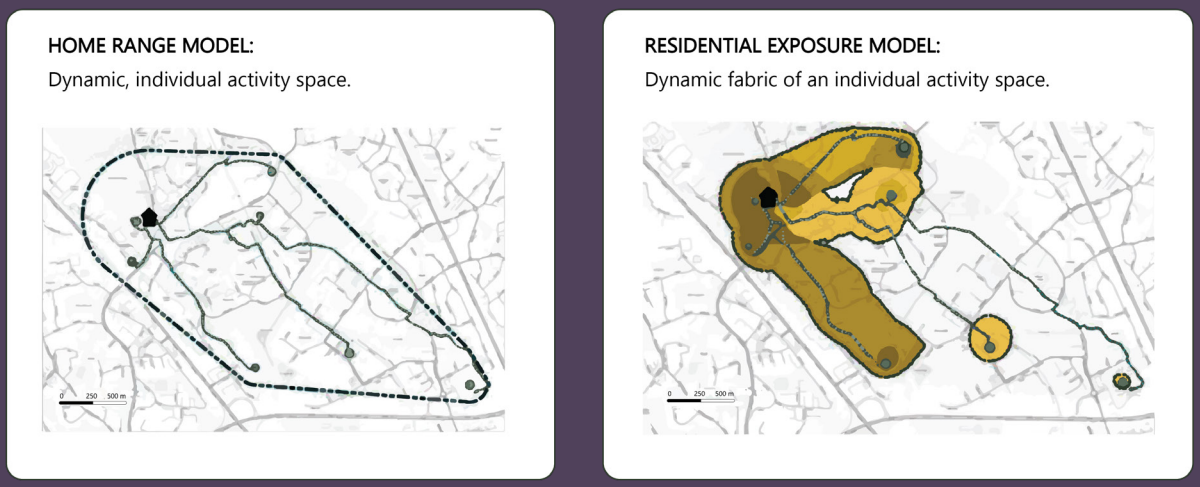


Figure 8. Home range and residential exposure models (Hasanzadeh, 2018).

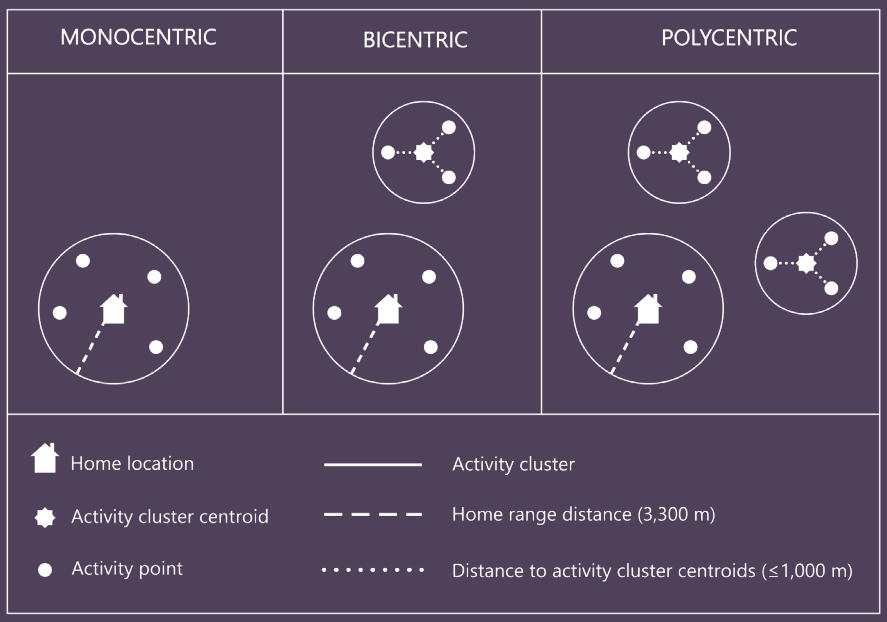


Figure 9. Centricity typology (Hasanzadeh et al. 2021).

even their attitudes changed. These studies suggest that our environments seem to have the power to nudge behaviour change.

While dense and accessible settings promote active mobility and physical health outcomes, green environments have additional health benefits to offer. Studies focusing on green exercise suggest that physical activity undertaken in green environments provides greater mental health benefits than physical activity in indoor or other outdoor settings (Kajosaari & Pasanen, 2021). Stress reduction and relaxation during physical activity are most likely to be experienced near blue spaces and in large (> 30 hectares) urban and recreational forests, while nature enjoyment is associated with natural environments of all sizes. These results suggest that exercising near blue spaces and in large natural areas provides additional restorative benefits compared to exercise undertaken in other outdoor environments.

The COVID-19 pandemic provided researchers with the possibility to study the role of green areas in especially challenging circumstances. A study in Helsinki revealed that residents were more likely to visit urban green areas closer to their homes during the pandemic compared to before the pandemic (Korpilo et al., 2021). Patterns of use were associated with the quality of residential green areas—for example, people sought out forests nearby one's home and tended to avoid parks and recreation areas to escape the pressures of lockdown, maintain social distance, and avoid overcrowding. Especially more outdoor-oriented, intensive users of natural recreational areas actively searched for new areas to avoid crowds. Similar results were found in another study in Turku (Fagerholm et al., 2021-a): nearly half of the people in the study increased outdoor recreation during the pandemic. The most frequently visited recreation sites were near forests and semi-natural areas relatively close to respondents' residences.

PPGIS studies interested in health outcomes have rarely aimed to map health benefits directly related to specific settings. An exception is a study by Brown et al. (2014) which asked participants to identify spatial locations where they engaged in various types of physical activity and where they received physical, mental, or social health benefits from the environment. They found that different urban park types provided different opportunities for physical activity. Community parks provided the greatest overall quantity of benefits, but these parks were most important in providing social benefits. Linear and sports parks were important in providing physical benefits, while natural parks provided important environmental benefits like simply observing and enjoying nature. Linear parks provided the greatest overall physical health benefits, while other park types provided important mental and social health benefits.

THE USE OF PPGIS DATA IN PLANNING AND MANAGEMENT: CONTEXT-SENSITIVE, ACCESSIBLE CITIZEN KNOWLEDGE FOR VARIED SCALES

A number of factors—ranging from personalities, experiences, and capabilities to tools, resources, and organisational culture—affect how participatory knowledge may be used in planning processes (Table 2). Over the course of the NORDGREEN project, we collected insights from planners, managers, and practitioners in various sectors to identify and reduce potential barriers and strengthen supporting practices and structures for sharing participatory knowledge among experts and back to the public.

1. Making a wide scope of experiential knowledge accessible

Planners can use PPGIS surveys and results to gather information for a specific planning project, or they can develop surveys with a wide range of uses in mind. The results can be integrated into existing municipal geographic information systems to provide easy access to experiential knowledge for strategically planning and managing urban spaces. Surveys with small geographic or thematic scopes can be employed to deepen the existing understanding of an area or its specific characteristics, and surveys with large scopes can provide a layer of background knowledge ideal for use in early planning stages. Ideally, map-based participatory knowledge forms one layer of participation that can be enhanced with more dialogical methods either face-to-face or online (Kahila-Tani et al., 2019).

2. Adaptive processes for municipalities of different scales

Influential participation requires good practices to process, utilise, and communicate the knowledge gained from citizens within municipalities and among stakeholders involved in planning processes. Depending on the scale of the organisation, municipalities and planners may use different formats to disseminate and utilise citizen knowledge meaningfully in their everyday work. We found that, in a large municipality, a core group of people is typically responsible for gathering large-scale survey information for undefined future planning processes. However, this core group does not include all future users of the results. This makes it challenging to meet the needs of the intended users and communicate the information and its usefulness to the wider group of users (Table 3; Rossi et al., 2023).

Table 2. How do different factors in planning organisations support the application of PPGIS knowledge in planning practice (Rossi et al., 2023)? Key considerations for integrating participatory knowledge.

USERS' CAPABILITIES AND RESOURCES	PLATFORMS	ORGANISATION CULTURE
• Are all the people with relevant roles and expertise involved in participation processes and using results? • Do the intended users have time to plan surveys and analyse the results? • Do the intended users have GIS skills or access to GIS experts? Is the support of other experts or researchers available? • Is training provided by the municipality to utilise new tools? • Do the people involved in creating the survey or using its results have underlying attitudes that might affect how they perceive citizens' inputs?	• Is there an existing platform that can be used to share the results? • How does survey metadata get delivered? • Who is responsible for maintaining the data and updating it (if necessary)? • Is the platform accessible for municipal employees in different sectors, such as planning, management, technical, and education departments, among others?	• Is leadership supportive of dedicating resources to the development of participation? • Is participatory knowledge valued in the municipal organisation? • Is participatory knowledge valued by politicians? • Is there an atmosphere of communicating freely about planning challenges with citizens and stakeholders? • Are governance networks formed in a way which promotes sharing of relevant participatory knowledge?

Table 3. Considerations for planning PPGIS surveys that provide usable knowledge to planning processes, based on Rossi et al. (2023).

	PLANNING AND MANAGEMENT	DECISION-MAKING	COMMUNICATION TO PUBLIC
IDENTIFYING NEEDS	Look up existing PPGIS and other knowledge and identify gaps. Only collect new knowledge where none exists.	At what stage do decision -makers need what type of information?	What themes and topics are central in public discussions of planning? Which groups are typically underrepresented?
PLANNING THE PPGIS SURVEY PROCESS	Plan and secure resources for clean-up, communication, and in-depth—preferably collaborative—analysis of the survey results.	How can PPGIS knowledge be delivered to and easily accessed by decision-makers?	In what stage of planning should data be collected?
USING PPGIS SURVEY RESULTS	Gather key findings from survey results, and consider planning proposals based on these. What changes should be made based on citizens' experiences and needs? Document how the results affect priorities and planning outcomes.	PPGIS results can be used to thematically visualise citizens' inputs, providing politicians with a better understanding of various citizen groups' needs.	PPGIS results can form a basis for more collaborative public participation. Show existing knowledge, deepen understanding, invite open debate, and report how results have impacted planning proposals.
FOLLOW-UP AND EVALUATION	If possible, use follow-up survey data to see how changes in the environment have influenced people's behaviours and perceptions of the area.	Are PPGIS results used as part of political or public planning discussions? Did decision-makers have access to the knowledge they needed?	Gather feedback from the public about perceived impact of results.

In small organisations, those who will personally use the results to inform their work—such as planners within a specific planning project—can often gather the knowledge themselves. When identifying what kind of knowledge to collect, it can be helpful for planners to include perspectives and experiences from different sectors of the organisation. This helps to ensure that the knowledge collected will be useful in future projects.

The challenge of working in organisational silos seems to affect knowledge-sharing among actors in large municipalities differently than in small municipalities. In large organisations, internal communication can be very difficult if contact between departments is limited and unsystematic; whereas, in small organisations, collaboration between public and private actors to carry out public duties can pose greater challenges. PPGIS surveys can collect citizen knowledge that is relatively easy to transfer and visualise, but it is important for planners to consider the practical needs of other departments or actors in the planning and results-sharing stages for this to succeed.

3. Participatory survey processes need to be integrated into existing practices to be effective

In the NORDGREEN project, we have developed methods and identified best practices in using PPGIS knowledge to inform planning outcomes and have also developed ways to share these results in the planning organisation so they can be used in any future project concerning the same areas. The results suggest that in order to improve planners' access to PPGIS knowledge and increase the likelihood of it impacting planning outcomes, municipal organisations need a deep com-

mitment to integrating survey results within existing planning practices.

The results of the Espoo survey have been used, for example, in a detailed planning project in Kauklahti and a strategic planning project in Viiskorpi-Kalajärvi. In both cases, the survey results have informed both the planning work and the participation process. Planners used the survey data as background for initial stages of planning. In later stages, citizens were invited to deepen, validate, or contradict the understanding of citizens' behaviours, needs, and wishes in the area. People involved in the NORDGREEN project, as well as planners outside the project, have also written articles for the Espoo website about the collection and use of the MyEspoo data (Figure 10). This form of open reporting about the use of results creates transparency in the analysis process and makes the material more approachable to interests citizens.

Map-based, experiential data of citizens' behaviour and perceptions of local environments can provide a wealth of knowledge for land-use planning and participation processes. In this chapter, we have given an overview of how planners and researchers can design PPGIS surveys and analyse and utilise the results to plan environments which promote healthy lifestyles and improve well-being.

Figure 10. Home page for MyEspoo project.[7]

Collaborative analysis and knowledge-sharing are key to evidence-based planning. If planning organisations can dedicate resources to sharing knowledge, they can potentially eliminate redundancies in data collection, improve accountability to the public by showing how data is utilised, and create a basis for evaluating planning outcomes from the citizens' perspectives. While PPGIS should not be used to replace traditional forms of participatory planning, when used conscientiously, it can lift the quality of public participation, planning, and decision-making to a new level.

[7] See https://www.espoo.fi/en/housing-and-building/city-planning/read-about-and-participate-city-planning/my-espoo-on-map for more details.

REGULATING

INTEGRATING HEALTH PERSPECTIVES IN MUNICIPAL GREEN SPACE PLANNING AND MANAGEMENT

ANNA SUNDING & THOMAS B. RANDRUP

ABSTRACT

While the Nordic countries are considered world leading in creating conditions for human health and well-being, challenges such as segregation and inequity are increasing. As societal challenges rise, so does the need for cross-fertilisation of sector-specific competences, as well as alignment between policymaking, planning, management, and operational activities. The Nordic countries share key similarities, having highly autonomous municipalities with similar organisational structures. However, the prevailing organisational structures often constitute a challenge for cross-departmental initiatives, creating silos and lacking links between vision and action. To address these organisational concerns, this chapter uses a programmatic alignment framework to describe three intra-organisational levels for municipal organisations to consider: (1) the *strategic* level of vision development, (2) the *tactical* level of planning and management, and (3) the *operational* level of implementation. In this framework, vertical and horizontal alignment provide categories for ensuring that knowledge from relevant sectors is integrated and aligned throughout the entire governance structure. In this chapter, we describe and exemplify how planning and management is organised at the municipal level, and how alignment of visions and resources can be used to foster health-promoting green spaces. Using examples from the Nordic municipalities of Vilhelmina and Täby (Sweden), Espoo (Finland), and Aarhus (Denmark), we describe and discuss the importance of programmatic alignment across organisational levels, and we show how planners and managers can integrate aspects of human health and well-being at different spatial and organisational levels.

INTRODUCTION

Modern urban society poses an array of complex challenges. This means that green space planners and managers face a multitude of issues in their daily work, including climate change, biodiversity loss, and increased demands on green spaces to improve human health and well-being. In a municipal context, practitioners constantly need to identify and prioritise strategic actions—be it for education, social care, or green space management—while working under increasing demands to act holistically and systematically to address issues in a synergistic way.

While planners and managers can play a fundamental role in contributing to solutions optimising the health and green space nexus, these issues cannot be solved by planners and managers alone. To secure health-promoting qualities of urban green space in the long term, planners and managers need to integrate knowledge related to both urban planning and management and human health and well-being (see, e.g., Stigsdotter, 2005). In this chapter, we discuss how organisational perspectives need to be taken into consideration to create a stronger connection between green spaces and human health and well-being.

In a Nordic context, urban green space often comprises publicly accessible areas owned primarily by the municipality (Randrup & Jansson, 2020-a). Public urban green spaces can constitute more than 50% of total urban land cover (Haase et al., 2020) and may include parks, woodlands, cemeteries, allotment gardens, and playing fields, as well as smaller green spaces located within residential areas (Cvejić et al., 2015). Such spaces provide numerous opportunities for recreation, spiritual engagement, social interaction, and physical activity, which enhance human health and well-being. Such values are considered ecosystem services (Millenium Ecosystem Assessment, 2005), and the quantity of ecosystem services depends on the physical qualities and functions of the spaces (Haines-Young & Potschin, 2010). Urban green space planning and management are key processes affecting the degree to which such services are provided in the urban environment (Jansson et al., 2020).

As shown throughout this handbook, creating health-promoting green spaces can be accomplished through many approaches. In this chapter, we describe a framework to understand how alignment of planning and management can frame and steer the development of green space to promote human health. First, we discuss the organisation of Nordic municipalities. Next, we present how the Nordic countries are working in different ways to promote health within green space planning and management, and we present four examples from NORDGREEN cities. We conclude with several key messages on how to better integrate human health and well-being aspects into green space planning and management.

THE NORDIC PLANNING SYSTEMS

While the Nordic countries share general similarities in their planning systems, there are national differences related to the roles of regional and national authorities, as well as which planning instruments are regulative or voluntary (Lidmo et al., 2020; Figure 1). As a rule, Norway and Finland have more legally binding plans and stronger influence from regional and national levels, while Sweden and Denmark have less. Still, while the Nordic national planning legislation gives guidance on primary focus areas for comprehensive municipal plans, it grants municipal autonomy for each local government to interpret and implement different aspects, such as the relationship between green space and human health and well-being. This means that two municipalities—even within the same country—may have very different ambitions and outcomes.

In the NORDGREEN project, we have focused on four Nordic countries: Denmark, Finland, Norway, and Sweden. In these countries, plans range from the comprehensive plan (which reflects political long-term ambitions and large-scale prioritisations for the entire municipality at policy level) to regulating detailed plans and strategies at the tactical level, to short-term operational plans, relating to maintenance. (These three organisational levels will be discussed in further detail below.) Therefore, discourses, strategies, and goals stated in comprehensive plans should be aligned with a range of other policies to guide and shape the priorities of green space planning and management, including the potential promotion of health. For municipalities to improve green spaces, they must apply long-term visions and overall policies that anticipate green space improvements and align these actions to project activities at the operational level.

MUNICIPAL PUBLIC HEALTH RESPONSIBILITIES AND PLANNING

The Nordic countries share several similarities in how they organise their respective health services. For example, the four countries mentioned above assign

Figure 1. An overview of the Nordic municipalities and national differences on support for green space on the local level (Lidmo et al., 2020) and in formal public health responsibilities (Helgesen et al., 2014).

public health-promoting responsibilities to municipalities by law or through national policies (Helgesen et al., 2014). From the public health perspective, the Finnish Health Care Act explicitly states that all areas in the municipal organisation are responsible for promoting public health, not just the health department (Finlex 30.12.2010/1326, §12). Similarly, the Norwegian Public Health Act emphasizes the municipal responsibility in providing an overview of the state of health in the municipality, and such an overview should guide the municipal planning strategy (LOV 2011-06-24 nr 29, §5-6). In Denmark, the Association of Danish Municipalities (KL) has recommended that all municipalities develop a cross-sectional public health policy (Aarestrup et al., 2007), while Sweden has national goals on public health intended to guide work on regional and municipal levels (Swedish government, 2002).

The planning legislation in all Nordic countries integrates prevention of harm to humans and the environment. Swedish planning legislation promotes development that ensures a healthy and good environment for present and future generations (SFS 1998:808, §1), but otherwise describes health in a preventative manner, in terms of avoiding risk and ill-health. A change in Swedish regulation entails that the value of ecosystem services should be known and accounted for in relevant decisions, which will include decision-making processes such as planning (Miljödepartementet, 2012). The Danish Planning Act legislates that the municipal strategies produced every four years shall promote the interaction between decisions on environmental, transport, business, social, health, educational, cultural, and economic factors (LBK nr 287, 16/04/2018, §33). The Finnish Planning Act states that the comprehensive

plan must make opportunities for a safe and healthy living environment which takes different population groups into equal consideration (Finlex 5.2.1999/132, §5). In Norway, the Planning and Building Act also explicitly states that plans should promote public health and counteract health inequalities, and planning should promote coherence through cross-sectorial coordination and collaboration, both vertically and horizontally (LOV 2008-06-27 nr 71, § 3-1).

Analysing the national health legislations from a programmatic alignment perspective, one can argue that the institutional incentives for cross-departmental collaboration are stronger in Finland and Norway through their respective legislation, while in Sweden and Denmark, such collaborations depend on ambitions anchored in the municipalities.

ORGANISATION OF NORDIC MUNICIPALITIES

The Nordic countries share overarching similarities in the organisation of their public administrations. However, the local level government, or municipality, has high autonomy. This means that municipalities can make decisions without extensive interference from regional or national levels. There is no national standard for how municipalities organise themselves; and Nordic municipalities have a long tradition of organising as they see fit, resulting in various organisational structures. Therefore, municipal organisational setups differ when it concerns efforts to exploit the potential of green areas to promote human health and well-being. The heterogeneous nature of municipalities' organisations means that there is no set solution or "best practice" for all. However, there are basic similar organisational structures and, within these, a strategic approach to integrate all relevant parts of the organisation is key to ensuring that green space planning and management promotes public health, from vision to implementation.

When looking at a municipal organisational structure, three organisational levels can be identified: (1) the *policy* level of vision development and goal setting, (2) the *tactical* level of institutional development and functioning, and (3) the *operational* level of implementation (Randrup & Jansson, 2020-b; Singh et al., 2021; see Figure 2).

At the *policy* level, strategies and visions are created to guide future development. In a municipal setting, policies are, in principle, driven by global, national, and regional demands and policies, defined by local politicians.

At the *tactical* level, the municipal administration responds to the policy level. Here, planning is an important tool as overarching plans and strategies are needed to set a direction for a politically supported development. At the tactical level, the municipal organisation is based on thematically different departments focusing on individual tasks such as health, social, culture, or technical aspects (often including green space planning and management).

The *operational* level represents the more practical, and often service oriented activities performed by a municipality. From a health care perspective, this includes the care performed in elderly homes, while in green space management, this includes activities related to maintaining green spaces. Such activities should ideally represent the implementation of the visions and strategies formulated on the policy and tactical levels.

Across these three organisational levels, there are two important components that make up programmatic alignment: *horizontal alignment*, which describes the connections across departments at the same organisational level, and *vertical alignment*, which describes the linkages between organisational levels (as shown in Figure 2).

The departmental structure is efficient and helpful for achieving optimal functional specialisation. Because of the specialisation, every department has different "languages," norms, and values, each related to the specific domain they cover. While there are benefits to gathering knowledge and solving tasks thematically, organising work in this way has disadvantages as well. Organisational silos are a commonly mentioned challenge (e.g., Scott & Gong, 2021, de Waal et al., 2019), meaning that different departments or units must overcome organisational and administrative barriers to interact with one another. On the other hand, as the complexity of societal challenges increases, so do demands for cross-departmental collaboration. Figure 2 illustrates how horizontal alignment occurs when municipal strategies are anchored among several departments (Singh et al., 2021).

Vertical alignment occurs when a politically approved vision or strategy is based on standards or norms handled or developed at the tactical level and executed at the operational level. This means that a specific topic is coherently treated from the policy level to

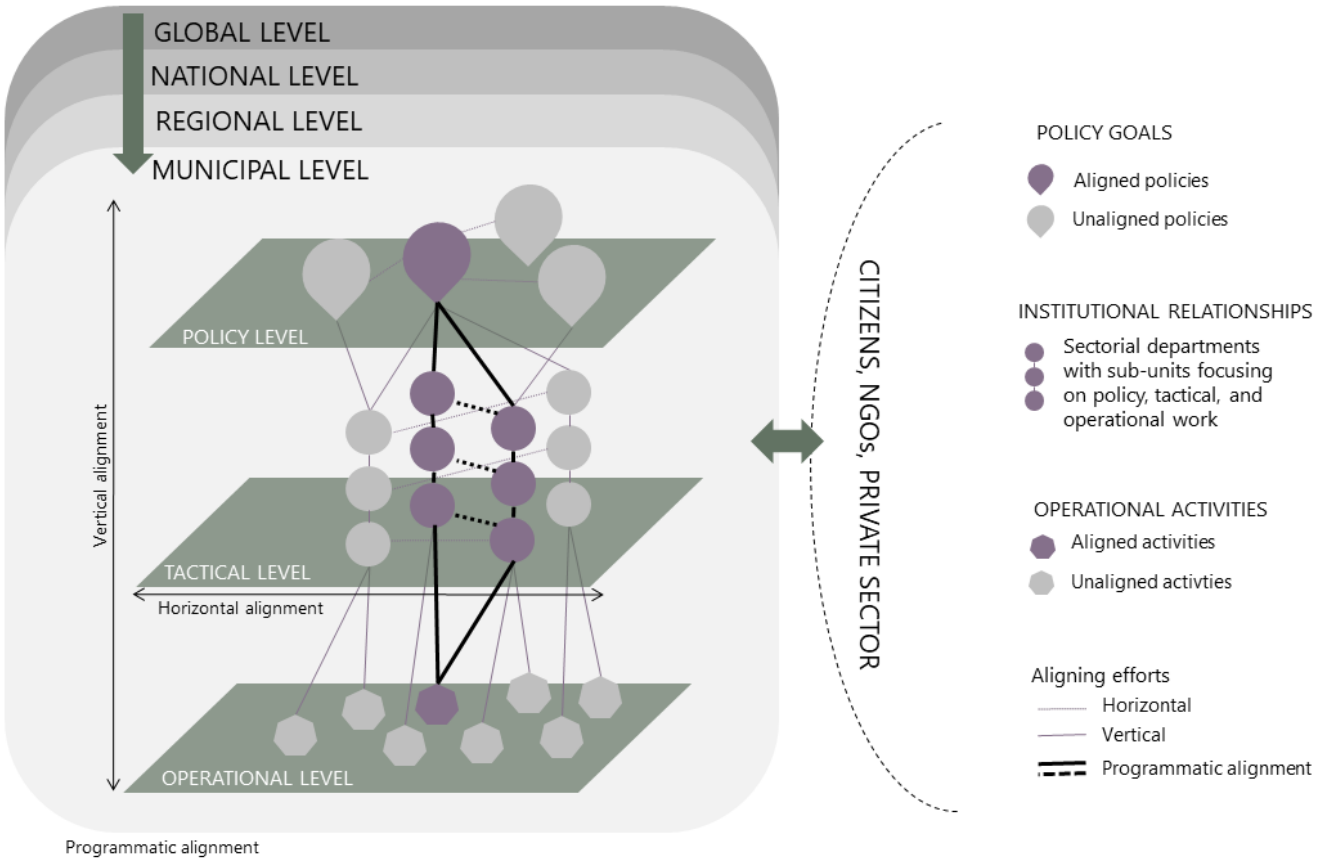


Figure 2. Horizontal, vertical, and programmatic alignment of the three organisational levels present in a municipal organisation (adapted from Randrup & Jansson, 2020-b, and Singh et al., 2021).

the operational level. For example, a municipal green space policy may be based on a thorough analysis of resources, needs, and opportunities. This policy is then operationalised via planning and related maintenance operations. From a governance perspective, this cannot be done in isolation; Nordic municipalities are increasingly collaborating with external actors, and they include citizens, specific user groups, NGOs, and the private sector in a wide array of interactions on different organisational levels.

If an organisation has a disjointed approach across the three levels, this will mean that initiatives at the policy level are not implemented, and activities at the operational level are taking place without consideration of the municipality's politically set visions. While visions and strategic initiatives can emerge on the operational and tactical levels, they should ideally be agreed upon at the policy level to respect the elective democracy, while also securing and aligning long-term sustainable development in the organisation. Vertical alignment is not a one way, top-down approach, but also requires bottom-up initiatives, based on local knowledge, professional initiatives, and input to the policy level.

The municipal organisation is responsible for ensuring that political visions are achieved through coordinating distinct and overlapping activities. Both vertical alignment and horizontal alignment are central for successful collaboration within the municipality. In other words, policy, tactical, and operational levels must be in sync, and, simultaneously, the different government divisions must overcome inherent barriers which exist between specialised departments (e.g., health and green space planning and management). *Programmatic alignment* occurs when both the horizontal and vertical components collaborate on a specific issue. As programmatic alignment spans the entire organisation, there is not one responsible role or function to guide the continuity throughout the organisation. Instead, programmatic alignment requires all relevant levels and sectors to be involved and contribute through their respective responsibilities. Here, both green space planners and managers, as well as health planners, have the responsibility for ensuring that issues relating to green spaces and health involve all relevant per-

spectives, both horizontally and vertically.

THREE CHALLENGES TO ACHIEVING PROGRAMMATIC ALIGNMENT

Within the NORDGREEN project, we studied the planning and organisational connections between green space and human health and well-being. Our methodological approach involved analysing municipal plans on the policy level and interviewing green space planners, managers, and public health strategists on the tactical level. Based on these studies, we found that there are differences in both formal structures and informal cultures relating to the promotion of public health through green space planning and management. However, all countries share common challenges related to both vertical alignment (i.e., coherence from vision to implementation) and horizontal alignment (i.e., collaborating across departments). We present the three most prominent challenges below.

1. Unclear goals for connecting green space and human health

Our study showed that Nordic comprehensive plans, regardless of national origin, often have a general description of the relationship between green space and human health and well-being (Sunding et al., forthcoming). For example, plans describe how the outdoor environment needs to promote health and prevent disease, but with no further clarification on what this entails or requires. This is partially supported by a recent survey showing that roughly 30% of Swedish municipalities include public health issues in their comprehensive plans (SKR, 2018). A generic approach to describing the relationship between green space and human health and well-being fails to acknowledge that health outcomes may vary according to the properties and functions provided by green spaces, as well as the demands and needs of different user groups. For example, certain activities require spaces of a certain size, and activities for rest and de-stress might not be compatible with activities that are noisy or energetic, such as team sports (see also DESIGNING chapter).

2. Lack of long-term funding

Planning processes are often long and relatively slow procedures. Anchoring new planning and management initiatives at the policy level is a key part of the process, and it is crucial for implementation. However, our studies revealed that politicians often require an economic rationale to approve new ideas, putting pressure on planners to justify activities through cost-minimising efforts. For green space planning and management, this can be detrimental as, in many instances, politicians approve the development of new spaces without ensuring funding for long-term management (Randrup et al., 2021). Since green spaces are dynamic, they need to be managed to ensure long-term quality and relevance. The lack of long-term funding illustrates the need for strong vertical alignment between policymaking, planning, and operational management of green spaces.

3. Coordination constraints

As societal challenges become more complex, the need to involve more experts within different fields grows. To navigate these complexities, municipalities can align expertise to identify potential conflicts and synergies between departments via thematic plans. While financial limitations cause some concerns, time shortage is often the more straining aspect; planners may struggle to develop a specific cross-departmental project, including its new, cross-disciplinary relations, on top of other day-to-day tasks.

Lack of coordination between departments also relates to activities carried out on the operational level. For example, within a single municipality, green spaces may be operationally managed by several departments, which means that an overall vision of integrating human health and green spaces may be addressed in some green spaces, but not necessarily in all of them.

HOW TO INTEGRATE HEALTH IN GREEN SPACE PLANNING ACROSS SPATIAL AND ORGANISATIONAL LEVELS

The following section presents four examples that offer insights on how to pursue programmatic alignment for health-promoting green space planning and management. These examples emphasise how planners and managers can integrate the health perspective throughout plans, and how programmatic alignment can be approached related to the responsibilities and remits of each organisational level.

Vilhelmina: The integration of human health and well-being at *policy* level

Vilhelmina is a rural municipality in Northern Sweden. Though it is the ninth-largest municipality in Sweden in terms of area, the municipality is relatively small in population (259th smallest of 290 total Swedish municipalities). In general, rural municipalities face the challenge of limited resources in relation to the widespread

area under their governmental jurisdiction (Vilhelmina Municipality, 2018), limiting, e.g., the number of thematic plans that can be produced. Vilhelmina faced this challenge by including public health in the comprehensive plan.

In 2018, Vilhelmina's comprehensive plan was created as part of the research project *Grön översiktsplanering i fjällen* (Green Comprehensive Planning in Mountainous Regions).[1] The plan was developed with emphasis on translating research into practice to create a tool for long-term landscape planning in mountainous municipalities. During the process, participation was a central theme: 40 high school students and 78 citizens participated in focus groups in which they provided knowledge and co-formulated the visions and the plan's main objectives. Researchers gathered the material and further developed the visions, which were based on additional group meetings. By including a range of actors in the development of the plan, the municipal planners shifted their attention from an administrative focus to a more strategic focus, where planning and keeping the process running, as well as utilising co-created material, became central.

> *"Vilhelmina addresses the programmatic alignment challenge by (1) having a clearly stated focus on public health and related land use in the comprehensive plan at the policy level, and (2) by making sure that the most overarching planning documents on the tactical level prioritise actions across all departments at both tactical and operational levels."*

Vilhelmina's comprehensive plan addresses human health and well-being from an ecosystem services perspective, with a landscape perspective permeating the plan. In this case, public health is seen as an outcome of the natural environment and therefore dependent upon it. The plan relates to the national goals for public health and describes how future developments will increase psychosocial health and better public health. The plan includes complementary, practical guidelines for the overarching themes. For example, the plan states that the landscape perspective provides a holistic approach, and thus ecological, social, and economic aspects of different types of land use must be made more explicit in municipal planning and decision-making (Vilhelmina Municipality, 2018).

From a governance perspective, the plan states that collaboration with local groups is to increase to develop accessible areas for outdoor recreation (*friluftsliv*) close to residential areas (Vilhelmina Municipality, 2018). By making public health an explicit part of the comprehensive plan, Vilhelmina shows how visionary and strategic land uses can be used to address public health challenges.

The comprehensive plan must be regularly updated to maintain its relevance and to guide the strategic work of the municipality. To ensure that the planning process continues, the comprehensive plan also includes a work strategy. The strategy establishes which actors are responsible for updating the plan and includes an evaluation protocol as well as a time-plan for implementation. A priority list ensures that activities are integrated into the everyday municipal work within and across departments. By including such tactical work as part of the comprehensive planning process, planners optimise resources and enable the plan's long-term relevance. As such, Vilhelmina addresses the programmatic alignment challenge by (1) having a clearly stated focus on public health and related land use in the comprehensive plan at the policy level, and (2) by making sure that strategic planning documents on the tactical level prioritise actions across all departments at both tactical and operational levels.

Täby: Integrating public health in green space planning at the *tactical* level

In Täby, Sweden, the development of a new comprehensive plan (Täby Municipality, 2022-a) influenced the creation of a new green plan. By making a strategic decision to create the two plans in parallel, planners could build knowledge around green issues to better support the comprehensive plan. The 2022 green plan *Halva Täby Grönt* (Half of Täby Green; Täby Municipality, 2022-b) directly addresses one of the five themes in the new comprehensive plan: healthy and biodiverse. In line with national regulation, the green plan uses an ecosystem services approach to describe benefits derived from green spaces.

Citizens contributed to the green plan via digital

[1] https://www.storslagnafjall.se/forskningsprojekt/gron-oversiktsplanering-i-fjallen/

surveys, where they could emphasise which aspects of the green areas they appreciated and what could be improved regarding, for example, travel times and accessibility. Planners also visited several schools and senior centres to help children and elderly residents fill out the survey. These engagement efforts resulted in more than 1,100 responses. Additionally, planners conducted focus group interviews with 80 citizens who expressed interest through the digital survey. The focus groups sought to capture citizens' perceptions of the qualities of green spaces relating to health aspects, such as which areas were used for relaxation, social interaction, physical activity, and play.

By making health outcomes a clear focus of the plan, planners were able to establish consensus with politicians at an early stage. The health perspective had already been introduced in the previous green plan from 2005, meaning that the new plan could build on its legacy. As such, the development of a health perspective in green planning can be seen as a long-term process. By building rationales and arguments on older plans, planners create strategic long-term development of upcoming plans and future work.

"Täby's green plan anchors the health perspective on a political level by connecting to the visions of the comprehensive plan, unfolding and specifying goals and targets, and creating practical guidance for implementation in terms of design and management on the tactical and operational levels."

A key challenge for developing thematic plans, such as Täby's green plan, is the amount of data and facts required to make a thorough plan. Planners must strike a balance between collecting data that can support the plan while refraining from becoming too detail-oriented for decision-making. Plans tend to become outdated much faster if they contain a lot of detailed information or guidance, specifically in relation to health-promoting green space, where developments are progressing relatively fast.

Täby's green plan anchors the health perspective on a political level by connecting to the visions of the comprehensive plan, unfolding and specifying goals and targets, and creating practical guidance for implementation in terms of design and management on the tactical and operational levels.

Espoo: Collaborating across departments on *tactical* and *operational* levels for health-promoting green spaces

While plans set an overall direction for what to achieve, designated departments carry out the day-to-day work. However, many departments face the challenge of identifying cross-departmental synergies and thus horizontal alignment.

When creating *Espoo's Integrated Action Plan for health-responsive blue-green infrastructure* (Espoo Municipality, 2022), enabling horizontal alignment was a key focus. The plan was produced as a part of an EU project under URBACT called Health&Greenspace.[2] The EU project had a set focus and a specific working method. Therefore, Espoo needed to integrate directions from the larger project into the daily work of the municipality while also expanding knowledge on health benefits of green spaces. "We knew that the issue of people's health is the job of more or less everybody in the city, in some way, so in every department, there would be colleagues interested in this topic," explained one member of the project team.

However, early in the project, the project team acknowledged difficulties in identifying relevant individuals or units within the organisation responsible for integrating health and green space. To form a cross-departmental working group, the project team began identifying all departments and units involved in aspects of health benefits of green space. The project group described each department's specific responsibilities relating to health and green space in the Integrated Action Plan. Additionally, all municipal networks and programmes relating to green space and human health and well-being were identified. This process became a tool for identifying relevant actors and securing horizontal alignment for future projects.

While the plan itself works as a tool to identify responsible and relevant actors, the project team felt that the most important outcome of the project was the forming of a cross-departmental network. The network continues to meet informally on a biannual basis.

[2] https://urbact.eu/networks/healthgreenspace

The Integrated Action Plan provides four main goals to guide the work of promoting health through green spaces in Espoo: (1) nature in public services, (2) citizen-driven city, (3) planning and management of blue-green infrastructure, and (4) information-based urban development. Relating to each main goal, the plan identifies ongoing or planned actions showing how the municipality can integrate the concept of health promotion into its work. Each action specifies: (1) responsible lead agencies; (2) key partners; (3) budgets; (4) timescales for implementation and delivery of proposed actions; and (5) indicators for monitoring the implementation of the plan.

> *"While the plan itself works as a tool to identify responsible and relevant actors, the project team [in Espoo] felt that the most important outcome of the project was the forming of a cross-departmental network."*

By clarifying the operational details of each action, such as when it will be carried out and by whom, the plan helps to ensure vertical alignment across the municipal organisation.

Aarhus: Bridging departments on the *tactical* and *operational* levels to create health-promoting green spaces

While a network of informal connections between different departments offers opportunities for joint projects and increased engagement, another way of increasing collaboration among departments is via more formal urban transformative capacities (Wolfram, 2016). In Aarhus, Denmark, this meant introducing "strategic bridge builders" whose main objective is to bring departments closer together.

The strategic green bridge builder is a professional role shared between two departments—the Technical and Environmental Department, and the Health and Care Department. The initiative was conceived during a thematic seminar focusing on how to contribute to the future welfare of the municipality through co-creation processes. Initially, the role was tested out with a defined time limit of 2 years, but it was prolonged on a project basis due to its success. The initiative started out with smaller test activities (e.g., the outdoor environment of nursing homes), but it progressively grew to deal with larger public spaces as well.

As a response to the lack of horizontal alignment and power of organisational silos, the purpose of this strategic approach is to align policies and practices between the two departments to create more value for citizens. The specific focus in Aarhus is to promote horizontal alignment via projects creating nature-based solutions and human health dimensions in relation to specific target groups.

The strategic green bridge builder works with site-specific development of green areas. The process of choosing sites to work with starts by identifying "inactive" green spaces (unused or little-used spaces) based on chosen criteria, such as city areas where unemployment is high and/or income levels are low. The next step includes identifying potential actors, both within different municipal departments as well as local user groups or NGOs, to initiate a co-creation process for transforming the inactive space. The practical outcomes or physical results of the process are also created together with the involved actors, meaning that the bridge builder needs to be sensitive to the variety of potential user groups and their respective needs to make sure that all relevant actors are included. Like the Espoo example, this process could also result in added benefits such as increased awareness among relevant actors regarding existing possibilities beyond those created in the project itself (e.g., the nursing home staff become aware that there is a park nearby).

While every project revolves around different actors and different challenges, the bridge builder holds the overall responsibility for ensuring that changes implemented to activate the space from a social perspective are combined with technical aspects—such as introducing stormwater management features. The role also involves identifying relevant experts, for example, to calculate the required stormwater retention capacities. A key goal for each project is that engagement continues after the initial development is finished. This is secured via the formation of user-driven communities based on user groups identified by the bridge builder, which are involved during the process.

Co-creation processes that are user-based, or user-driven, represent a new way of approaching planning, and these may demand a different set of skills and resources than what has been used previously. In Aarhus, the process leader—in this case, the green

bridge builder—is seen as a crucial and unique actor by co-workers because these responsibilities could not have been added on top of day-to-day work within either of the two departments. Employing a green bridge builder is an innovative approach that enables the municipality to gather experience through a range of projects, which creates a feedback loop to guide future work in the organisation.

> *"By developing the role of a bridge builder, Aarhus Municipality has taken a crucial step towards horizontal alignment. Now, continued work is needed to include more departments in this approach."*

By developing the role of a bridge builder, Aarhus Municipality has taken a crucial step towards horizontal alignment (Aarhus Municipality, 2020). Now, continued work is needed to include more departments in this approach. Additionally, the implementation of strategic goals ensures that overarching visions are turned into operational action by helping to implement strategic goals across departments, thus also strengthening the vertical alignment.

KEY MESSAGES: INTEGRATING HEALTH ASPECTS INTO PLANNING AND MANAGEMENT

This chapter has described the need for public planning organisations to integrate urban green space planning and management with human health and well-being on the municipal level. Based on the three key challenges, and the four examples within NORDGREEN cities, we have outlined two key messages for practitioners to move forward:

1. Connect public health to spatial planning and management on all organisational levels

The prerequisites for health-promoting green spaces start at the *policy* level (e.g., in the municipal comprehensive plan). To secure sufficient space to support a wide array of health benefits, the plan needs to clearly state its pursued goals. For example, in relation to health-promoting green space, the plan needs to recognise that different attributes of green spaces support different uses and potential health outcomes. Aspects such as the size of the space need to be secured at land-use level since this cannot be amended later in the planning process.

At the *tactical* level, planners need to clarify conditions for how human health and well-being is derived from green spaces. This can be done by using an ecosystem services approach, where public health can be directly associated with how humans benefit from green spaces. Thus, synergies, interdependencies, and conflicting interests between different land uses becomes more visible. As such, it is also important to prioritise health outcomes related to specific target groups. A stronger focus on health, described more clearly in relation to particular green spaces and particular users, can solidify the value of green space in the face of densification and transform the approach from a general equality perspective to an equity perspective.

On the *operational* level, it is important to get an overview of ongoing activities across departments—and even units within departments—to align and harness potential synergies (such as resource synergies). This can be done by mapping out which activities already exist, and who is doing them. A stakeholder analysis including both internal and external stakeholders may serve as a valuable tool in this process to create an overview of interests and potential added resources.

2. Align visions, actions, and departments

The concept of programmatic alignment offers a way to assess how health-promoting green space is handled within all parts of the organisation. It also helps to identify key aspects to be addressed for optimized planning and management processes. Vertical alignment is vital to gain a meaningful connection between visions, plans, and actions, while horizontal alignment is vital for creating synergies between different departments (e.g., those related to human health and well-being, and those dealing with green spaces).

Working cross-departmentally allows for more thorough integration of financial resources, knowledge, and personnel. However, it is important to assign responsibilities for each action and budget holders for the initial investment, as well as for potential long-term financing. Further, co-financing between departments can serve to bring two (or more) departments together via platforms that can withstand fluctuating levels of resources. This can strengthen information-sharing and communication as joint policy argumentation can work to strengthen arguments on both sides.

Fluctuating funding and time-limited projects are the basis for many innovation projects, often described as experiments. These can work as an experience pool for up-scaling within or beyond the department. As such, an individual project can work as a pilot, enabling method development which can be expanded upon later. A time-limited project, such as in the Aarhus example, lowers the threshold for experimental approaches, but it can also imply drawbacks as it risks becoming a token approach to long-term change. Therefore, it is important to create strategies for integrating the time-limited, project-based knowledge into the rest of the organisation. One way of doing this can be to instate a bridge builder—a formal, permanent role working in two departments and dedicated to connecting them.

Collaboration with academia can offer additional resources in terms of financing, time, and knowledge, but as with all types of collaboration, it also requires dedicated internal focus and resources. When collaborating with external stakeholders (e.g., citizens or academia), it is important to balance engagement initiatives with available resources and stakeholders' expectations. However, such shifts in approaches may generate innovation and should be viewed as an investment for dealing with the future complexity of challenges facing modern society.

DESIGNING

IMPROVING GREEN SPACE DESIGN BASED ON HEALTH DESIGN THEORY AND ENVIRONMENTAL PSYCHOLOGY

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ABSTRACT

Given the importance of going outdoors for health and well-being, researchers have developed evidence-based models based on extensive research to enable a comprehensive and time-efficient use of evidence in design, planning, and management. Together, the three evidence-based models—the four zones of contact, the quality evaluation tool, and the triangle of supportive environment—describe crucial zones and environmental qualities of green spaces which support and inspire people in general as well as people with particular needs, to use the outdoors. The aim of this chapter is to present the evidence-based models and to describe a four-step process to guide practitioners on how to use the models in green space development. The evidence-based working process does not replace established practices; rather, it is intended to complement existing practices of municipalities or offices working with green space development. Therefore, even if multiple municipalities use the same models, the results are always unique to each site and context. Based on the work within the NORDGREEN project, we have found that the models are useful for projects in varying scales and contexts, and with varying target groups, to support, inspire, and inform green space design, planning, and management for health and well-being.

INTRODUCTION

Physical inactivity, involuntary loneliness, and stress-related ill health are all public health challenges that cities face today. Evidence concerning the relationship between nature and human health and well-being can benefit planners and practitioners working to address these issues. Outdoor environments in people's everyday environments have the potential to enable and inspire physical activity, to stimulate social meetings and interaction, and to contribute to overall health and well-being. Thus, if planners are equipped with evidence confirming the importance of nature and greenery for human health and well-being, this information can strengthen arguments for green space in cities and for green space design. However, to guide health-promoting design, planning, and management of green spaces, practitioners working with these issues need evidence concerning which kinds of outdoor environments can have a positive impact on peoples' everyday life (e.g., in the home, in the workplace, and during recreation in the city's parks). Practitioners also need further evidence concerning the specific environmental qualities that promote comfortable outdoor living, physical activity, social interaction, and recovery.

To enable a comprehensive and time-efficient use of evidence in design, planning, and management, researchers have synthesized a large body of research into evidence-based models (Grahn, 1991; Bengtsson & Grahn, 2014; Bengtsson, 2015; Stoltz & Grahn, 2021). These evidence-based models describe crucial zones and environmental qualities of green spaces which support and inspire people in general, as well as people with particular needs, to use the outdoors. By applying these models, practitioners can add valuable insights relating to public health into urban planning processes at different scales. Starting in the early stages of urban planning processes, the models can help planners address land use and the overall layout of the urban landscape to develop health-promoting environments. The models can also help practitioners to become aware of which aspects may be important to consider in the management of outdoor environments. In this chapter, we will present three evidence-based models that can be used to guide the design and development of health-promoting, outdoor environments—specifically green spaces in urban areas.

The chapter is divided into four parts. First, we describe the development of the evidence-based models and provide a comprehensive explanation of the models themselves. In the second section, we present a four-step process to guide practitioners on how to use the models when developing and managing green areas. The third section provides hands-on examples from one of the NORDGREEN project sites in Stavanger, Norway. We conclude the chapter with several key messages based on our project experience.

EVIDENCE-BASED MODELS FOR HEALTH-PROMOTING DESIGN, PLANNING, AND MANAGEMENT

Research shows that having access to and visiting green spaces are beneficial for health and well-being (see BACKGROUND). To make use of such evidence in design, planning, and management, researchers have developed evidence-based models based on extensive and interdisciplinary research (Grahn, 1991; Bengtsson & Grahn, 2014; Bengtsson, 2015; Stoltz & Grahn, 2021). Alnarp Rehabilitation Garden, located in Southern Sweden, has been a key site where researchers from different disciplines have tested and further developed these models. This garden is specially designed based on research in landscape architecture, environmental psychology, horticulture, physical therapy, occupational therapy, and medical science (Grahn et al., 2022). The garden has been used in research and teaching since 2002. Since then, various stakeholders and target groups have provided their perspectives, continuously shaping the development of the garden's content and form.

The models have been applied to a wide range of projects where environments have been (or will be) developed to support and promote health and well-being. These real-life projects include the development of green structure plans of hospital areas in Region Jönköping in Sweden, the development of several connected green areas in Täby, Sweden, and, in the context of the NORDGREEN project, three projects in Stavanger, Norway (a central park, an industrial area, and a schoolyard). The diverse physical conditions, activities, and target groups between these projects has enabled researchers to further investigate and develop the models in varying contexts. In all projects mentioned above, principles of participatory action research (Katoppo & Sudradjat, 2015) have been used, meaning the researchers are engaged in design and planning activities.

THREE EVIDENCE-BASED MODELS

In the NORDGREEN project, we have worked with three evidence-based models: the four zones of

contact; the quality evaluation tool, and the triangle of supportive environment. Though they can be used individually, the models complement one another and can be used together to provide designers with a holistic view of the environment in question. Design processes have been described as a method of solving complex problems (Rittel & Webber, 1973); therefore, practitioners cannot approach the process as a checklist or expect to find a simple solution. Evidence-based models intend to complement and support the complex problem-solving methods with which green space designers, planners, and managers are already working.

Four zones of contact with the outdoors

This model describes different zones in the physical environment where (direct and/or indirect) interaction with the outdoor environment has the potential to promote health. As shown in Figure 1, the model identifies four zones in which health-promoting interaction with the outdoor environment can take place: (1) from within a building (e.g., views and daylight from windows); (2) from inside transition zones (e.g., conservatories, greenhouses, balconies); (3) in a garden or park (the project site itself); and (4) in the surrounding environment.

The principal model of four zones of contact with the outdoors can be helpful to practitioners in designing, planning, and managing Zone 3 green spaces—areas connected to buildings (such as courtyards or gardens) or other urban green spaces without buildings. The model not only takes into account the impacts for those engaging in the project site zone but also those occupying the surrounding spaces of Zones 1, 2, and 4. For instance, when designing a pocket park in a city (i.e., a Zone 3 space) elements such as trees, other vegetation, and water could have an impact on people who see the pocket park from their window (Zone 1), their balcony (Zone 2), or as they pass by on the street (Zone 4). Zone 4 is particularly relevant for practitioners to gain a picture of the project site in its larger context and thus Zone 4 links to green structure planning. Zone 0 has been added to the model in Figure 1 to identify zones inside buildings that completely lack contact with the outdoors (Oher, 2016). In a city planning context, Zone 0 can be used to identify areas with a low degree of natural features and greenery and thus highlight the need for green space development in an area. Table 1 presents descriptions of the zones in public green space contexts as well as examples of questions to answer in an evidence-based working process.

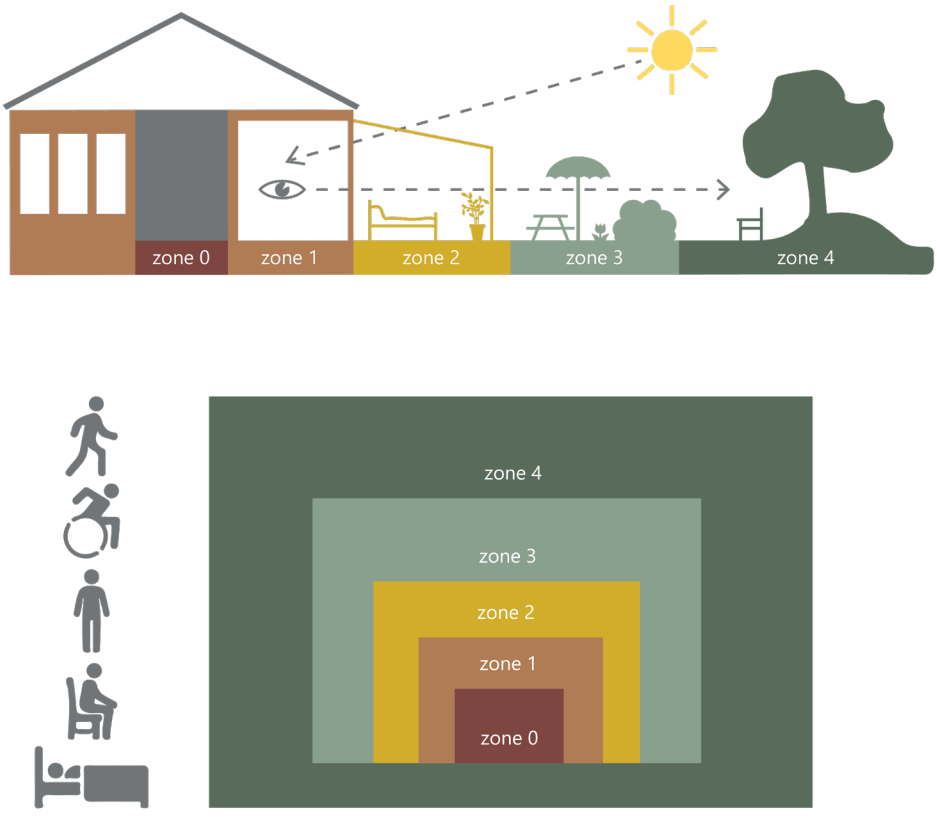


Figure 1. The principal model of four zones of contact with the outdoors. Top illustration: section; bottom illustration: plan view. Figures to the left present body positions to consider for universal design (Bengtsson et al., 2018). Illustrators: Jenny Lilja/Boverket and Anna Bengtsson.

Table 1. Descriptions of zones, and questions to use to identify and describe relevant zones in a development project.

ZONE	QUESTIONS TO CONSIDER DURING PROJECT DEVELOPMENT
ZONE 4: THE SURROUNDING ENVIRONMENT Properties and features of the surrounding environment that provide a picture of the project site in its larger context.	Z4.1 Is there anything in the surroundings that can contribute positively to the project site?
	Z4.2 Is there anything in the surroundings that can contribute negatively to the project site?
	Z4.3 What housing areas, workplaces, etc. exist in the surroundings for which the project area can be a health-promoting resource (e.g., within 300 meters, within 1,500 meters, etc.; see Table 4)?
	Z4.4 Do housing buildings and workplaces in the surrounding area have access to their own green spaces on their own plots?
	Z4.5 How is the overall supply of green spaces around the project site (see Table 4)?
	Z4.6 Is it possible for people with varying abilities and functions to be able to use and experience green spaces around the project site?
ZONE 3: GREEN SPACE SUCH AS A PARK OR GARDEN (I.E., THE PROJECT SITE) Depending on the size and character of the project site (see Table 4), it might be a resource for many people both within Zone 3 and in the other zones.	Z3.1: What is the size of the project site?
	Z3.2: Are there any buildings with activities within the plot (e.g., housing, school, hospital, business, other workplaces)?
	Z3.3: Is it possible for people with varying abilities and functions to be able to use and experience the project site?
ZONE 2: CONTACT WITH THE OUTDOORS FROM INSIDE TRANSITION ZONES (E.G., CONSERVATORIES, GREENHOUSES, BALCONIES) Zone 2 consists of built structures that provide protection and comfort and, at the same time, a great degree of contact with the outdoor environment. Zone 2 increases the opportunities for health-promoting contact with the outdoors.	Z2.1: Is there access to Zone 2 within the project area?
	Z2.2: Is it possible to experience the project site from Zone 2 (e.g., from housing buildings and workplaces *within* the project area)?
	Z2.3: Is it possible to experience the project site from Zone 2 (e.g., from housing buildings and workplaces *outside* the project area?
ZONE 1: CONTACT WITH THE OUTDOORS FROM WITHIN A BUILDING (E.G., VIEWS AND DAYLIGHT FROM WINDOWS) The project site represents a health-promoting opportunity for people who live and work in buildings in the area due to window views of nature and greenery.	Z1.1: Is it possible to experience the project site from Zone 1 (e.g., from housing buildings and workplaces *within* the project area)?
	Z1.2: Is it possible to experience the project site from Zone 1 e.g., from housing buildings and work places *outside* the project area?
ZONE 0: ZONES WITH A LOW DEGREE OF NATURAL FEATURES AND GREENERY Zone 0 is relevant to identify in relation to the project site in order to clarify the importance of investing in the project site.	Z0.1: What Zone 0 areas (in the sense of low degree of natural features and greenery) exist in and around the project site?

Table 2. Types of green spaces (according to size) and critical distances for potential health-promoting effects. Adaptation of table from Grahn and Stoltz (2021).

GREEN SPACE	MINIMUM SIZE (≈HA)	MAXIMUM DISTANCE FROM HOUSING (≈M)
Recreation area	>100	5,000
City park	>20	2,000
District park	5 - 7	1,500
Neighbourhood park	1 - 2	300
Pocket park/urban greenery	<1	<300

Green areas of different sizes fulfil different functions. And while residents can benefit from green areas located at various distances from their homes, it is important that people have access to nearby green space that encourages them to go outdoors more often (and potentially live healthier lives as a result, see BACKGROUND). Many studies show a strong correlation between proximity to green areas and people's health (see NUMBERING). In their research on the impacts of urban green space for health and well-being, Grahn and Stoltz (2021) have categorised different types of green spaces according to their size. Based on their general functions and abilities to attract users, they have suggested maximum distances that such green areas should be located from housing (Table 2).

This information is useful for the implementation of the four zones model as it provides a basis to investigate relevant distances for people to use the project site (Zone 3) and to describe the overall supply of green spaces around the project site (e.g., in Zone 4). However, as Grahn and Stoltz (2021) point out, the health-promoting potential of any given green space depends on a large combination of factors and especially the qualities of the green spaces.

The quality evaluation tool (QET)

The quality evaluation tool (QET) is an evidence-based design model that helps practitioners to analyse the qualities related to the target group, the activity, and the physical environment. The tool supports design that leads to: (1) environments that benefit users' health and well-being, (2) environments that meet a variety of users' needs and desires, and (3) environments that are accessible and useful.

The QET was developed to encompass a wide range of needs and preferences of people in general as well as people with particular needs (i.e., vulnerable groups) (Bengtsson & Grahn, 2014). Thus, the QET describes 19 evidence-based environmental qualities which are divided into two groups: (1) qualities for people to be *comfortable* to use outdoor environments, and (2) qualities for people to experience *stimulation* and positive contact with outdoor environments.

The first group contains six environmental qualities that designers should pursue to enhance the comfort of people in outdoors environments, i.e., comfortable design (see Table 3). These qualities support people's ability to use the outdoors and are important to consider throughout the green area so that everyone can use the space on equal terms, in line with the UN Convention on the Rights of Persons with Disabilities (United Nations, 2015).

The second group contains 13 environmental qualities of stimulating design and concerns contact with nature and surrounding life (Table 4). These are qualities which promote stimulation of senses and mind, and which people desire and prefer in the outdoors. They encourage people to go outdoors, either to find social or physical activities or to find solitude and peacefulness. Among the qualities described in Table 4, eight of them are adopted from the "perceived sensory dimensions" (PSDs) identified by Grahn and Stigsdotter (2010; see also Stoltz & Grahn, 2021). These dimensions correspond to qualities that people generally seek in green areas to meet their personal needs and preferences. The remaining qualities are based on research on vulnerable user groups (e.g., older people and people in need of special care; see Bengtsson & Grahn, 2014). As shown in Table 4, the qualities are divided into two sections in relation to the gradient

Table 3. Environmental qualities for people to be comfortable in the green area.

QUALITY	DESCRIPTION
Closeness and easy access	The area is close at hand for users. It is easy to spot and easy to access
Entrance and enclosure	The entrances are clear and welcoming. The enclosure of the outdoor environment (hedges, fences, etc.) corresponds to the level of protection that is needed by the users.
Safety and security	a) Risks of physical discomfort are very small, such as the risk of falling or slipping, risks of poisonous plants, etc. Ground coverings are accessible in terms of width, surfaces, edges, and slopes. The distance between benches suits users and there are handrails to hold where needed. (b) The risks of psychological discomfort in the outdoor environment are very small; the outdoor environment is appealing, without intrusive elements that can be interpreted negatively.
Familiarity	The green area appears to be a natural part of the environment as a whole and the various elements and activities that the green area offers are easy to comprehend.
Orientation and wayfinding	The design of paths, places, landmarks, nodes, and edges is clear and helps users to understand and to be able to orient themselves in the outdoor environment. For people with difficulties in orienting themselves, it is important, for example, that paths do not lead to dead ends and that a variety of places along the paths provide opportunities for different experiences and activities.
Different options in different kinds of weather	Paths and places offer variation in terms of sun, shade, protection from the wind, and shelter from the rain.

of challenge, which will be described in the following section. In practice, for example, designers can evaluate which of the 19 environmental qualities are present or lacking in existing sites and use this understanding in their design.

The triangle of supportive environment

The triangle of supportive environment was originally developed in a doctoral thesis by landscape architect and biologist Patrik Grahn (1991). The model was later used as a concept in the original design of Alnarp Rehabilitation Garden[1] (Grahn et al., 2022), and it has been used as a basic principle for green structure planning and for public park programmes to strive for universal design in public areas (Åshage & Bengtsson, 2019; Bengtsson et al., 2020). The triangular model (Figure 2) provides several categories for understanding an individual's perceived needs and preferences corresponding to the physical and social stimulation of an outdoor environment. The four categories broadly describe four different kinds of engagement that an individual may seek out in a public green space based on his or her mental health status.

Research has shown that stressed people may be sensitive to particular kinds of stimulation and may therefore seek to avoid highly stimulating qualities (Grahn et al., 2010; Stoltz & Grahn, 2021). The base of the triangle describes preferences and needs of those who are sensitive to overstimulation and who seek inward-directed involvement within a public green area. For example, someone experiencing stress may seek a place within the natural environment that is calming, more isolated, undemanding, and requires less active attention. The top of the triangle describes those who need outward-directed involvement. They seek out environments with more people and would like to share experiences with others. According to the model, emo-

[1] https://www.slu.se/institutioner/institutionen-for-manniska-och-samhalle/miljopsykologi/alnarps-rehabiliteringstradgard/

Table 4. Environmental qualities for stimulation and positive impressions.

QUALITY	DESCRIPTION
HIGHLY STIMULATING QUALITIES	
Contact with surrounding life	The space offers possibilities to take part in life, for example, to experience people, animals, and movement.
Social opportunities (social*)	There are opportunities for entertainment as well as places where it is possible to meet other people. In these places there are plants and other things to talk about. There are seating options that make it easy to meet and socialize outdoors.
Joyful and meaningful activities	There are places for sedentary activities (e.g., relaxing, drinking coffee, reading), social activities, and physical activities. There are walking paths that can be used for exercise as well as for leisurely walks. There are opportunities for children to play and interact with the outdoor environment.
Culture and connection to past times (cultural*)	There are places in the outdoor environment that provide an opportunity to be fascinated by human culture and values. There are objects that stimulate memory. Plants and elements of the outdoor environment give the place its own character and meaning.
Openness (open*)	There are inviting open green spaces overlooking nature and plants.
Species richness and variety (diverse*)	There are areas with species richness in terms of plants and/or animals that give varying expressions of life.
Sensory experiences of nature	There is the opportunity to see, feel, hear, smell and taste what nature offers, such as trees, plants, flowers, fruits, animals and insects. There is an opportunity for nature experiences of sun, sky, wind, water, sunrise and sunset.
Seasons changing in nature	It is possible to follow the year's changes in nature, partly with your senses but also through experiences and activities in the outdoor environment.
LOW STIMULATING QUALITIES	
Symbolism and reflection	There are elements in the outdoor environment that can give rise to symbolism and metaphors between one's own life and nature. The experience of timelessness in the vicinity of a large moss-covered rock is one example.
Space (cohesive*)	There are areas that give the feeling of entering an undisturbed world or coherent whole, for example, in a beech forest.
Serene and peaceful (serene*)	There are peaceful places in the outdoor environment that are neither overpopulated nor have disturbing elements. Well-kept areas with soothing elements of water and/or greenery offer relaxation, peace and silence. Pleasant sound of water is especially soothing.
Wildness and nature (natural*)	There is the opportunity to experience nature on its own terms. There are areas where plants appear to have come by themselves and where they are allowed to develop freely.
Secluded and protected (shelter*)	There are surrounded and secluded green places where you can do whatever you want, be left alone, have private conversations or just watch other people from a distance.

* Qualities that correspond to the eight PSDs as named by Stoltz and Grahn (2021).

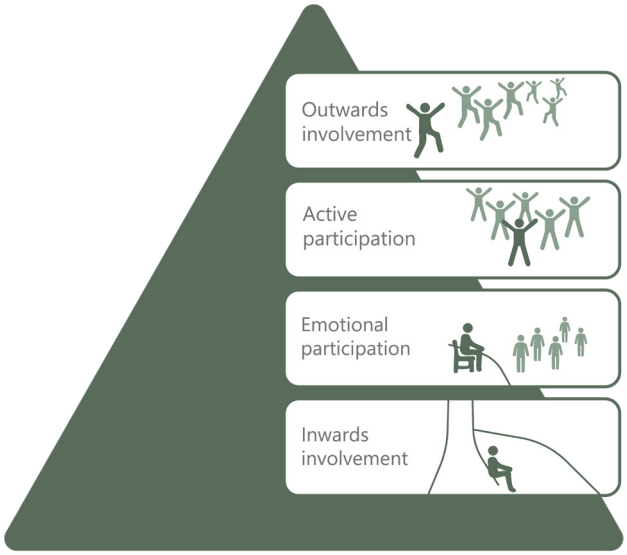


Figure 2. Triangle of supportive environment.

tional participation and active participation illustrate the two steps in the successive transition between the base and the top of the triangle. In these steps, as people feel less stressed and vulnerable, they seek more and more social stimulation and action. First, from a distance, just looking at other people involved in activities, and then, by actually participating in activities together with others. The triangular shape indicates that the more stressed and vulnerable a person feels, the greater the possible positive impact of the physical environment. Additionally, the stressed and vulnerable persons at the bottom of the triangle, are depending more on the physical environment to meet their needs, and therefore the design and content of the physical environment become more important.

The triangle of supportive environment is useful in design processes because it clarifies a connection between people's mental state and their need for different types of environments. The triangle model can be used at different scales but with the same overall intention—namely to strive for variety in the physical environment that meets the varying needs and preferences of different users. Furthermore, the model connects to overall theories concerning restorative environments (see, e.g., Bengtsson & Grahn, 2014; see also BACKGROUND). Restorative environments here refer to environments and environmental qualities that aid restoration from stress.

The triangle of supportive environment provides the theoretical basis for the QET. The 13 qualities of stimulating design can be arranged on the triangle of supportive environment in a *gradient of challenge* (Figure 3). The gradient provides a spectrum to analyse how some environmental qualities place higher demands on our attention. In other words, the qualities require directed attention versus soft attention, using

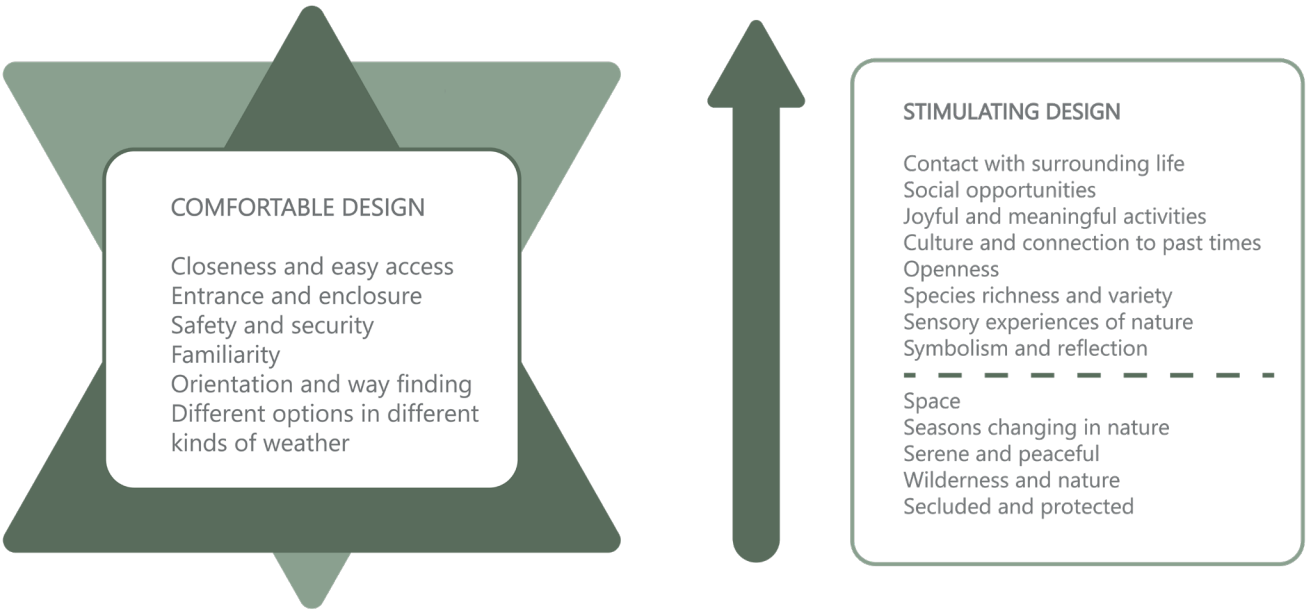


Figure 3. The 19 environmental qualities from the QET integrated into the triangle of supportive environment model. The qualities of comfortable design are important to consider throughout the green area. The qualities for stimulating design follow the gradient of challenge and are broadly divided into two sections. The qualities in the top section offer greater stimulation and demand more attention than the qualities in the bottom section.

the terms of Attention Restoration Theory (see BACKGROUND; Kaplan & Kaplan, 1989; Kaplan, 1995). The more stimulating qualities—those that require directed attention—are listed at the top of the gradient, while the less stimulating qualities—which demand less attention (soft fascination) and provide more restorative functions—are listed further down the gradient. The gradient of challenge reveals that some environmental qualities are hard to combine because they sit at opposite ends of the spectrum. On the other hand, qualities that are close along the gradient are more compatible.

Importantly, different target groups might have opposing needs in relation to the triangle of supportive environment and the gradient of challenge. The original shape of the triangle has its base at the bottom line, showing target groups that are sensitive to overstimulating environments (e.g., people experiencing stress) with a greater need for more restorative qualities. However, the shape of the triangle would be inverted in terms of target groups that are instead sensitive to under-stimulating environments (e.g., people in need of social interaction), showing a greater need for more stimulating qualities in the environment. This is reflected through the inverted triangle in Figure 3.

It might be beneficial for practitioners to protect and develop existing environmental qualities in line with the gradient of challenge. This may be especially relevant when working at different scales (e.g., in green structure planning as well as developing individual parks). This will ensure access to both stimulation and restoration to meet the varying needs of people who visit the green space. It is important to note that the order of the qualities for stimulating design is approximate and needs to be fine-tuned in relation to each project depending on users and the contextual conditions of the physical environment.

The evidence-based models presented in this chapter are not designed to limit the experience of creative freedom; rather, they are meant to improve practitioners' awareness concerning important environmental features to provide for human health and well-being. Using evidence-based models in the design process is a qualitative way of generalisation (Lewis & Ritchie, 2014), meaning that practitioners can interpret the models in their own way, based on their own experience, and that they can convert the models to the specific project at hand. Thus, the evidence-based models do not present solutions to copy but knowledge and information to support, inspire, and inform green space design, planning, and management for health and well-being. Green space development, informed by evidence, can lead to reduced costs in the form of ill health, care, and sick leave. In addition, nature and greenery provide important ecosystem services such as biodiversity, air and water purification, and climate regulation that contribute to increased resilience (Coutts & Hahn, 2015). Thus, every development project that, in a conscious manner, takes advantage of the health-promoting potential of nature and greenery means an investment in a sustainable society that is better equipped to meet major global challenges. Having described the evidence-based models in general, the following section provides guidance for practitioners on how to use the models in an evidence-based working process.

THE EVIDENCE-BASED WORKING PROCESS: GUIDANCE FOR PRACTITIONERS

To apply the evidence-based models, green space designers, planners, and managers can follow an evidence-based working process. This process includes the following phases:

- Phase 1: Identifying existing zones and health-promoting environmental qualities
- Phase 2: Identifying user perspectives
- Phase 3: Designing green spaces
- Phase 4: Conducting a post-occupancy evaluation

The first three phases do not have to be performed in a strict order but can be combined with already established practices in green space development. The final phase, the post-occupancy evaluation, is a means for planners to reflect on the process and outcome for the benefit of future projects. Table 5 provides an example of how to work with the zones of contact (Tables 1 and 2) and the environmental qualities (Table 3 and 4) in each of the four phases. The work process is further described in the subsequent text and visualized with illustrative examples.

Phase 1: Identifying existing zones and health-promoting environmental qualities

The first phase is part of the site investigation for the green area. In this phase, green space developers can use the principal model of four zones of contact and the environmental qualities from the QET to make an inventory of zones and qualities in and around the

Table 5. Example of how to work with environmental qualities and zones of contact in the four phases.[2]

OBJECTIVE	METHOD	DESCRIPTIVE RESULT	RESULTS OVERVIEW
Phase 1: Identifying zones and health promoting environmental qualities	Site investigations, professional assessments	Professional description of the predesign appearance and relevance of each environmental quality in relation to each relevant zone.	Predesign overviews of environmental qualities in different zones
Phase 2: Using evidence-based models to integrate user perspectives	Dialogues, questionnaires, surveys, professional assessments	Professional description of users' needs and preferences in relation to each environmental quality in each relevant zone.	Users' ratings of importance of each environmental quality in each relevant zone (e.g., rating 1-5 with 1 being the lowest importance and 5 the highest importance)
Phase 3: Using evidence-based models in the design phase	Proposal development for green space development and management	Professional description of priorities and measures for each environmental quality in each relevant zone, based on the results of Phases 1 and 2.	Overviews of environmental qualities in different zones in the proposal
Phase 4: Using evidence-based models in a post-occupancy evaluation	Post-occupancy evaluation, site investigations, dialogues, surveys, professional assessments	Professionals' and users' evaluation of to what degree the implemented proposal lives up to the intentions of the proposal.	Overviews of professionals' and users' post-design rating of appearance of environmental qualities in different zones, e.g., to be compared with the overviews from Phase 3

project site. Identifying existing zones and qualities provides basic information about the physical environment related to land use and the overall layout of the urban landscape. This provides planners and designers with increased understanding of the site, and the potential of the site to serve as a health-promoting resource, both as a visiting destination (Zone 3) and as a viewpoint (from Zones 1, 2, and 4).

The working process is often qualitative, i.e., the practitioners describe (through text, illustrations, or photos) the appearance and relevance of the environmental qualities in each zone. In addition, overviews of environmental qualities in different zones could be created, e.g., by using numerical ratings and/or shade of colour to indicate the degree of appearance of different qualities in different zones on a site plan.

Phase 2: Using the evidence-based models to integrate user perspectives

The second phase forms part of the user investigation for the green area in question. In this phase, the zones and qualities are used in dialogues and/or questionnaires to study users' perspectives of the green area in question. The methods used in dialogue-processes and with target groups can differ depending on the context and aim of the project. In some cases, it is important to capture the perspective of a broad mix of users, e.g., when developing a public park. In other cases, it is important to understand the needs of one specific user group in depth, e.g., when developing a schoolyard or care facility. In Phase 2, Tables 3 and 4

[2] Details on how to describe and rate results in the different phases have been elaborated upon in several bachelor's and master's theses from the Swedish University of Agricultural Sciences (SLU; see, e.g., Oher, 2016; Liljegren, 2017; Nilsson, 2019; Tigerschiöld, 2019; Åshage, 2020; Carlsson & Sinclair, 2022; Westerlund, 2023).

can be used as a basis to ask users about their needs and preferences in relation to the environmental qualities. The information could be compiled in a description on the importance of each environmental quality in relation to each relevant zone. It is also possible to produce average values of the importance of each environmental quality in each relevant zone, as described in Table 5.

For projects operating within restrictive timeframes, green space developers could alternatively make use of the environmental qualities in a simplified way. Instead of asking about each specific environmental quality listed in Tables 3 and 4, practitioners could use the overarching categories from the QET (qualities of comfortable design, highly stimulating qualities of design, and less stimulating qualities of design) as a point of departure. One possible way to do this is to ask about users' overall wishes and needs for (1) comfort, (2) stimulation from nature and surrounding life, and 3) restoration and relaxation.

Phase 3: Using the evidence-based models in the design phase

The third phase forms part of the design process for the green area in question. Based on the results of Phase 1 and Phase 2, green space designers can propose measures for environmental qualities and zones. To strive for sustainable solutions and ensure that the health perspective can be maintained in the long term, in this phase, management experts are invited to ensure that management perspectives are integrated into the process. As in Phase 1, overviews of environmental qualities in different zones could be created, e.g., by using numerical ratings and/or shade of colour to indicate the degree of appearance of different qualities in different zones on a site plan.

In the presentation of the proposal, it might be useful to describe overall intentions regarding environmental qualities for people to be comfortable versus qualities for people to be stimulated from nature and surrounding life without describing each specific quality from the QET. In addition, the triangle of supportive environments and the gradient of challenge are useful as overall design guidelines to strive for variety in the physical environment that meets the range of needs and preferences of different users at different scales.

Phase 4: Post-occupancy evaluation

The post-occupancy evaluation phase takes place after the project site has been built and occupied by users. The focus of this phase is to follow up on the intentions of the proposal, in relation to all environmental qualities and zones and describe, for each quality and zone, if the intentions have been fulfilled. In this phase, ratings for the appearance of each environmental quality could be compared to the intention ratings from Phase 3.

This phase is important to continuously learn more about health-promoting environmental qualities in relation to different zones, and how to increase the health potential of green areas. As in the other phases, the work should complement established evaluation practices in green space development, such as process follow-up, follow-up on the physical environment a certain number of years after completion, and recurring user surveys. In the next section, one of the projects in Stavanger will be used as an illustrative example for the first three phases of the evidence-based work process. At the time of writing this chapter, the project has completed Phases 1 through 3.

APPLYING EVIDENCE-BASED MODELS IN HAMNEVIKA, STAVANGER

Hamnevika (Figure 4) is a former industrial area situated 2.5 km south of the city centre of Stavanger. The former Esso-property and Hamnevika marina make up a total of 28,000 m^2 and is surrounded by the fjord to

Figure 4. Project site for developing a green recreational area in Hamnevika. Illustration: Martina Andersson, Stavanger Municipality.

the East, residential area in the north, a large factory area to the south and the city centre of Hillevåg at west. The railway north/south indicates the boundary in the west.

The development of Hamnevika as a recreational area follows the municipality's recommendation of providing green areas within 300 m from residences. Before the revitalisation of this area, the inhabitants pointed out the development site in Hamnevika as an important green area for residents living in a larger area (Hillevåg and Kvalaberg; see Figure 5). Since nearby residents have limited access to other green areas in the neighbourhood, the size of the development area is one of its most important qualities to enable design of a green recreational area that meets different users varying needs.

Creating social meeting points and green areas of high quality are identified by the municipality as some of the most important measures to create a greener and more health-promoting city district. This development project illustrates a context and challenges that are relevant for many of today's landscape architects and urban planners as it aims to re-design a no longer used industrial site, by addressing the health-promoting potential of the place, seeking to meet the needs of residents in a city that is growing denser.

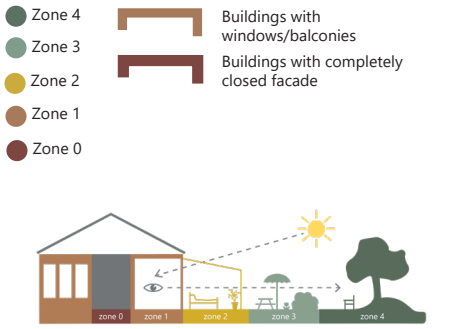
The examples presented here show how the evidence-based models were used in this particular context following an evidence-based working process. Additional work was done in this area (e.g., inventories of biodiversity, storm water management, technical construction, etc.). Although not included in this chapter, such aspects were integrated in the programme proposal guiding future development of the site.

Figure 5. Area of the development site (yellow circle) in relation to residential area subject to revised planning (*områdeløft*, marked in yellow). Illustration: Martina Andersson and Anna Åshage.

Phase 1: Identifying existing zones and health-promoting environmental qualities

Identifying the four zones of contact with the outdoors

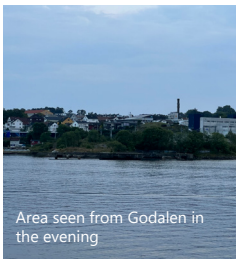
The principal model of four zones of contact with the outdoors (see Figure 1, Table 1) was used to identify existing zones within the development site and in the surrounding built environment and to describe the perceived contact among these zones (Figure 6). The presented landscape analysis also zooms out and recognises how the development site is experienced from zones beyond the site, in the surrounding environment. Even in these areas, contact with the development site has the potential to serve as a health-promoting resource, for instance through visual contact from inside residential buildings (Zone 1) or from balconies (Zone 2). The analysis also identifies an existing industrial building next to the development area, currently without any visual contact with the site, where it is possible to create contact with the site in the future (e.g., by opening sight lines to the area from Zone 1 and/or Zone 2).



The principal model of four zones of contact with the outdoors (Bengtsson et al., 2018)

Figure 6. Identification of zones in the development area and contact with the site from surrounding buildings on development site. Plan illustration and photos: Martina Andersson, Stavanger Municipality.

The four zones model can also be integrated with the analysis of the environmental qualities of stimulating design, as was done in Hamnevika (Figure 7) by analysing the qualities "contact with surrounding life," "social opportunities/social," and "joyful and meaningful activities." The illustration shows how these qualities are represented on the development site and points out connections between the site and the surrounding environment for experiencing these qualities.



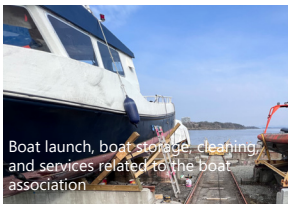


Figure 7. Illustration showing how the four zones of contact model was combined with an inventory of several environmental qualities of stimulating design. Plan illustration and photos: Martina Andersson, Stavanger Municipality.

Example of inventory of environmental qualities for people to be comfortable in the green area (comfortable design)

Each of the environmental qualities of comfortable design were analysed over the whole development site. Some environmental qualities were analysed one by one, as in the example of "different options in different kinds of weather" (Figure 8), showing weather conditions important to consider for designing places that are sheltered and comfortable to use. Other qualities were efficiently analysed and combined (Figure 9). In another context, other combinations of environmental qualities might be relevant to analyse together. In addition to the visual record of the qualities, the landscape architect also described (in text) important aspects to consider in future development explaining in detail how the quality was represented in the area, highlighting risks and possibilities to consider in future development of the place and illuminating different user groups' varied and sometimes contradictory needs.

Figure 8. Plan illustration visualising one environmental quality of comfortable design—"different options in different kinds of weather"— on development site. Plan illustration: Martina Andersson, Stavanger Municipality.

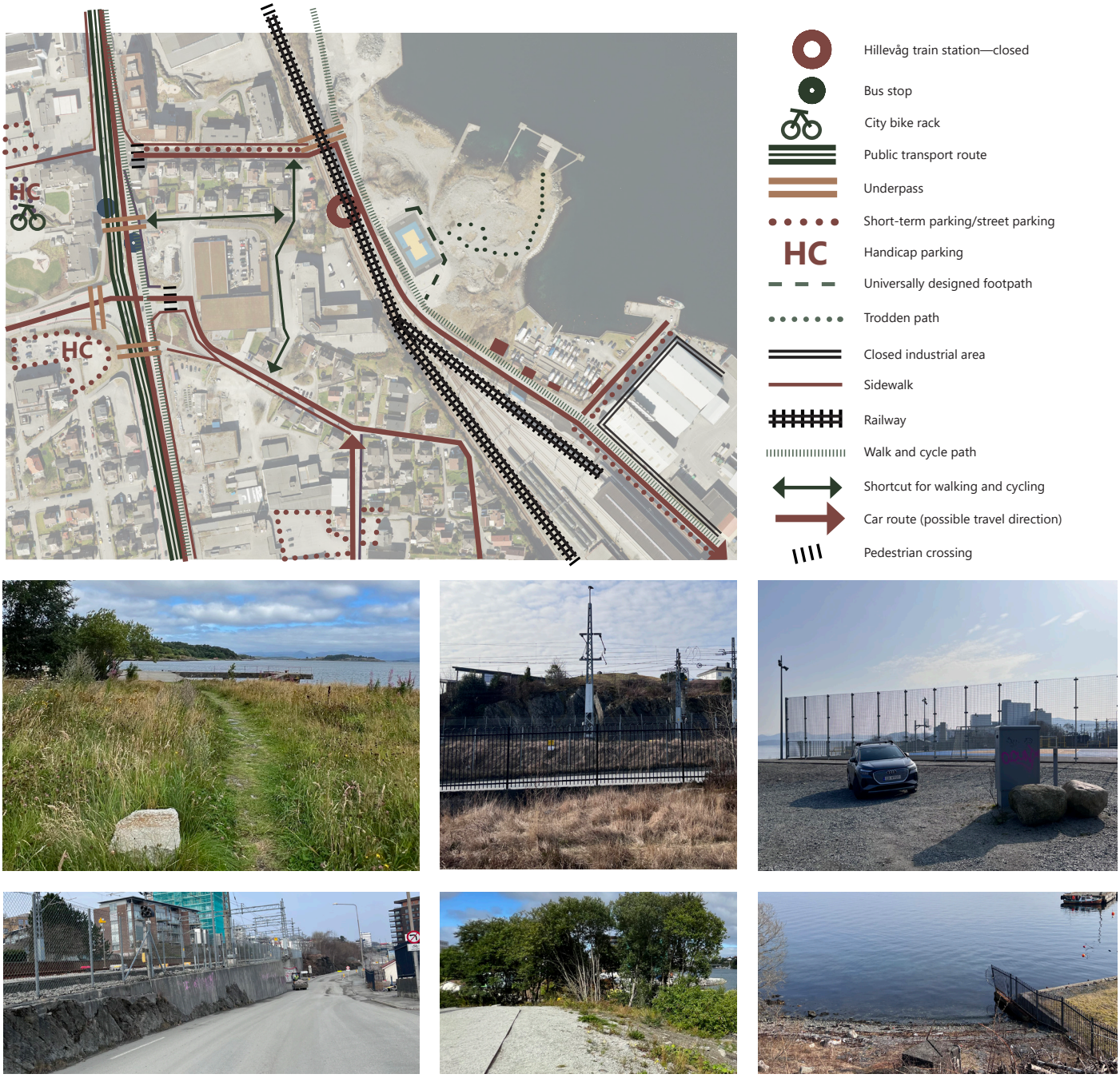


Figure 9. Combined analysis of environmental qualities of comfortable design—"closeness and easy access" and "orientation and wayfinding"—in relation to the development site. Photos and illustration: Martina Andersson, Stavanger Municipality.

Photos are informative to use for describing aspects that are not easily described schematically. The landscape architect used a photo summary (Figure 10) to highlights aspects to consider for strengthening environmental qualities of comfortable design in future development to make the site accessible, safe, and comfortable to use.

Beautiful footpaths
Trampled footpaths give a special experience when walking out to the old concrete structures, but the area is not accessible to everyone.

Fencing
A number of different fences in the area divide up the functions and prevent movement across zones where it has been/is dangerous to move. The fences around the ball field serve a function, but the surrounding fences are perceived as an obstacle.

Walking connections to the area
An uninteresting underpass is the main access to the project area today. This can be made significantly more attractive.

Lighting
Sufficient and attractive lighting is lacking in almost the entire project area. Driveways and the activity areas have lighting, which creates light pollution for the rest of the area.

Construction and unsafe crossings at the edge of the water
Construction and sharp edges make the area along the waterfront unsafe. This zone has great potential for improvement and could become the most attractive places to spend time in the future.

Figure 10. Photo summary highlighting aspects for strengthening environmental qualities of comfortable design in future site development. Photos and analysis: Martina Andersson, Stavanger Municipality.

Example of inventory of environmental qualities for people's access to nature and surrounding life (stimulating design)

The aim of conducting an inventory of environmental qualities for stimulating design, i.e., qualities that give people access to nature and surrounding life, was to identify in which sub-areas of the site these qualities were represented. While some sub-areas may have a high amount of these qualities, other areas may have them to a lesser degree, or they may be missing altogether. By making this analysis, the landscape architect could determine which sub-areas had the greatest potential for developing such qualities while also considering if there were any aspects of the environment that led people to negatively perceive the environmental qualities.

The landscape architect presented the results of the analysis in plan illustrations, visualised with photos showing important aspects to consider in future site development. Just as in the inventory for comfortable design qualities, these photos were accompanied by descriptions of specific qualities that were important to safeguard in future site development. The analysis also highlighted qualities that were missing or were poorly represented on the site. Different approaches were used to present the analysis of different qualities, e.g., photos connected to specific places on the site were used to visualise the qualities "culture and connection to past times" and "symbolism/reflection" (Figure 11) while "openness," "space," and "serene and peaceful" qualities were visualised with coloured areas combined with topological markers and symbols marking vantage points (Figure 12).


7. Retaining walls with bleached graffiti and an old ladder


8. Boat launch and boat storage, Hillevåg boat association (1945?)


9. "Thirsty", Sandra Vaka, 2022

10. "Samtaler", Line A. Dalmar, 2022


1. Hetlandskaien


2 and 3. Pier construction at the water edge (from 1950s/60s)


4 and 5. Remains from silos from industrial plant (from 1940s/60s)


6. Manhole in tidal zone overgrown with algae


11 and 12. John Derek Bishop, 2022

Figure 11. Plan illustration with photos visualising how environmental qualities of stimulating design—"culture and connection to past times" and "symbolism/reflection"—are represented on the development site. Photos and illustration: Martina Andersson, Stavanger Municipality.

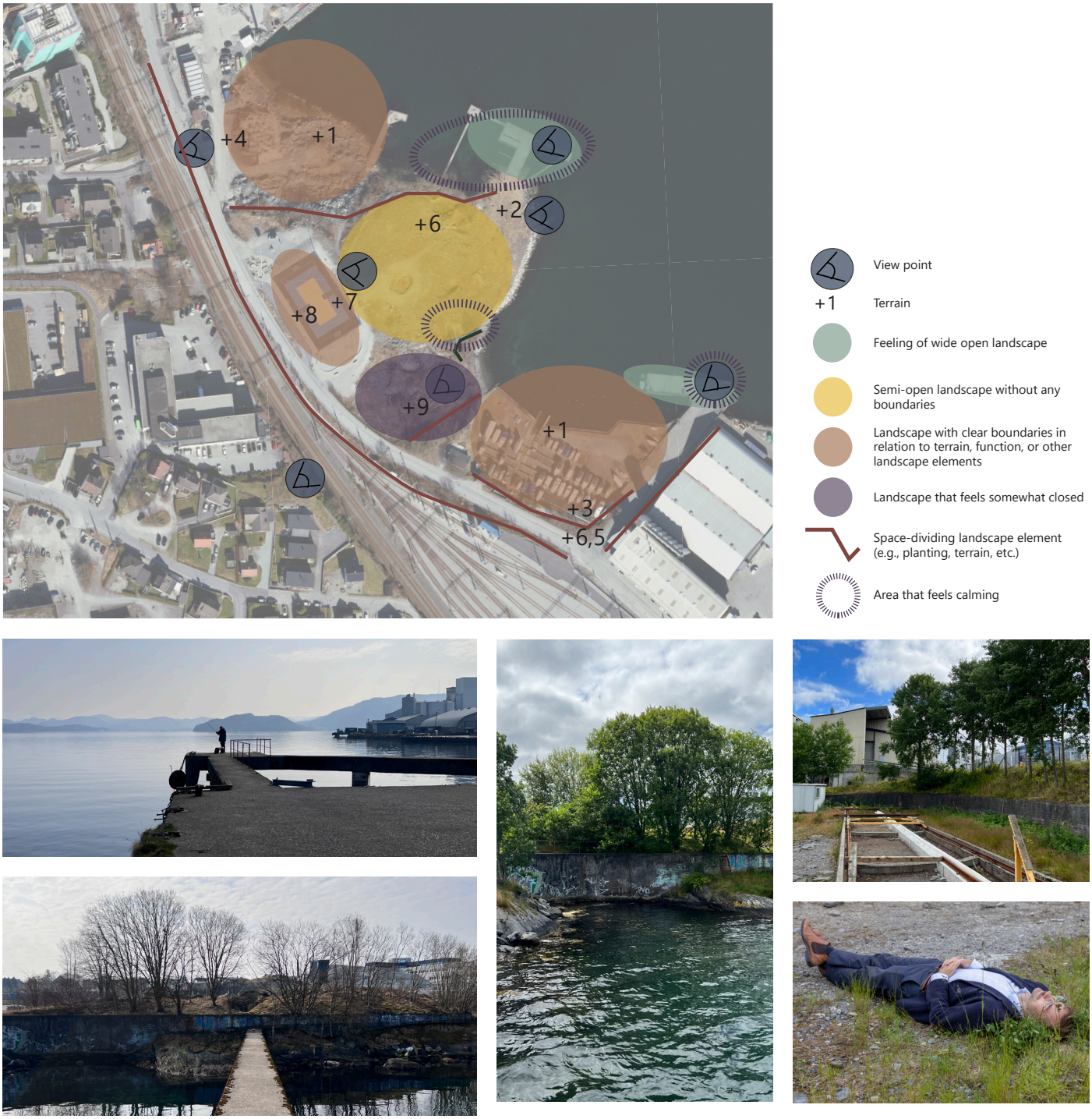


Figure 12. Inventory of the environmental qualities of stimulating design—"openness/open," "space/cohesive," and "serene and peaceful." Photos and illustration: Martina Andersson, Stavanger Municipality.

Phase 2: Using the evidence-based models to identify user perspectives

The mapping of user needs in relation to the Hamnevika site involved a variety of stakeholders including different associations and local users (e.g., fishermen using the marina). In addition, needs of residents living in the neigbourhood were included by means of an existing municipal mapping at neigbourhood level.[3] The mapping provided demographical data and highlighted local health challenges. Based on these user investigations, the landscape architect identified access and size of the area as important qualities to enable design of a green recreational area that could meet varying needs of nearby residents (Figure 13).

During this phase of the design process, the landscape architect also identified and summarised information about different users' needs and preferences with regards to how they may use the green area during different seasons (Figure 14).

Figure 13. Map of nearby areas and their main uses in relation to the development site. Illustration: Martina Andersson, Stavanger Municipality.

[3] See Stavanger's Handlingsplanen til Områdeløftet Hillevåg 2022-2023

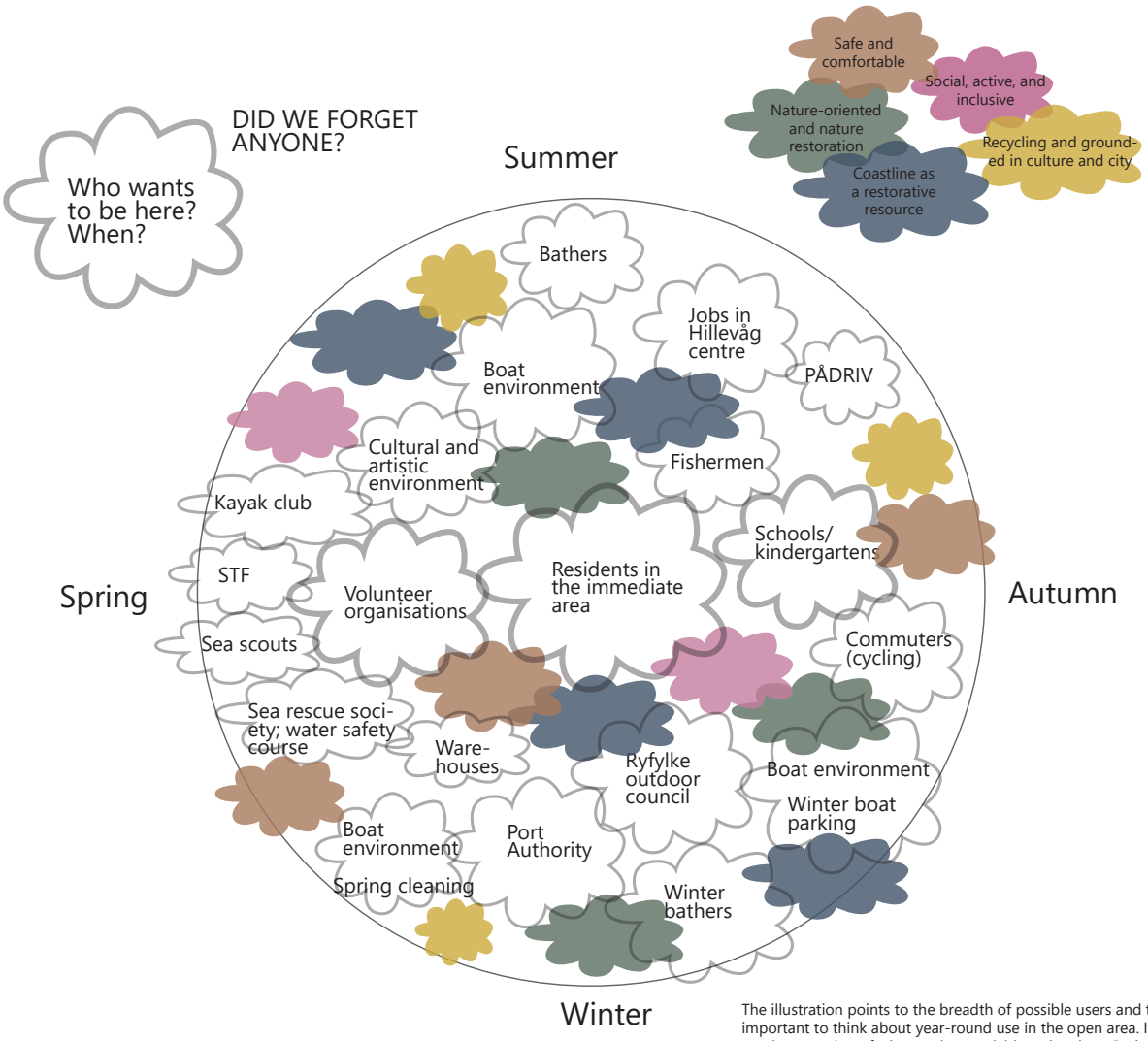


Figure 14. Summary of investigated user needs around the year related to development of Hamnevika. Summary and illustration: Martina Andersson, Stavanger Municipality.

The summary of user needs was then organised into five thematic categories that relate to the evidence-models, and also included other aspects to address in this context (Figure 15). Based on this information about local users' needs and preferences, the landcape architect grouped these categories into conceptual colour-coded design themes which were used in Phase 3 to guide the design process.

The design themes included: "safe and comfortable" (orange) which relates to comfortable design qualities; "social, active, and inclusive" (pink) and "recycling and grounded in culture and city" (yellow) which relate to highly stimulating design qualities; and "the coastline as a restorative resource" (blue) and "nature-oriented and nature restoration" (green) which relate to low stimulating environmental qualities. The yellow and green categories also address and integrate other sustainability aspects such as reuse of materials, nature restoration, control of invasive species, etc. These categories were used to formulate a design vision and conceptualize design themes aiming to guide the development of a health-promoting green space.

Phase 3: Using the evidence-based models in the design phase

In this step, the results from the previous phases were combined and used to inform design decisions. The programme proposal condensed and synthesized the information from the site analysis (Phase 1) and the user investigations (Phase 2), and conceptualized this information into a vision (Phase 3) for the future development of the site based on the five design themes

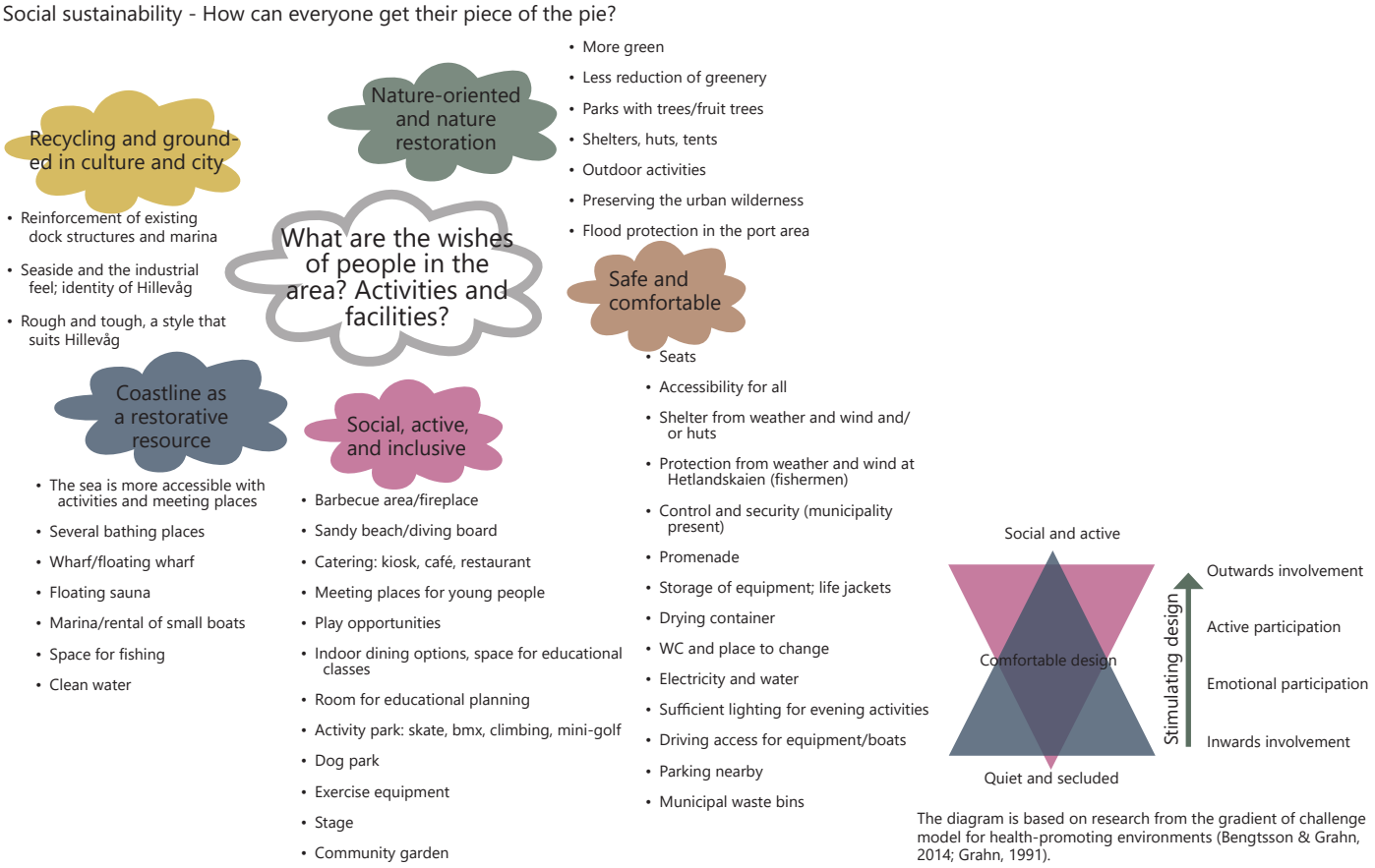


Figure 15. The five design themes developed as a result of the dialogue process, which relate to different user needs and correspond with the evidene-based models. Illustrations: Martina Andersson, Stavanger Municipality.

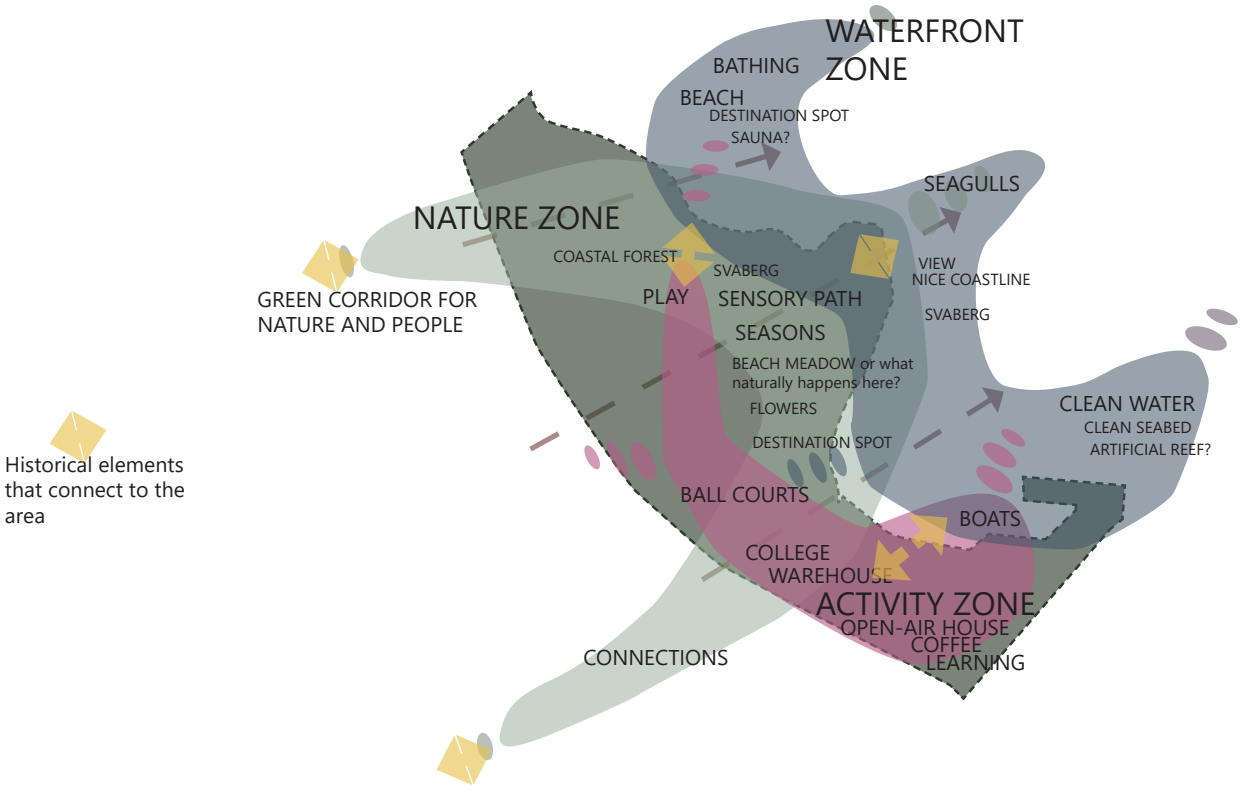


Figure 16. Design concept for Hamnevika, formed based on inventories made for environmental qualities (Phase 1) and the identification of users' perspectives of the site (Phase 2). Illustration: Martina Andersson, Stavanger Municipality.

identified in Phase 2 (Figure 15). From this, the landscape architect developed a design concept (Figure 16) visualizing the overarching design ideas, followed by a recommendation map aiming to guide future development of the site. Here, the landscape architect presented a detailed suggestion for how to distribute different environmental qualities across the development site (Figure 17) using the colour-coded design categories to visualise identified user needs in relation to physical site conditions.

The landscape architect also presented a more detailed design proposal (Figure 18) that can inspire and guide future development of the site, with specific suggestions for how green space can support human health and well-being.

Phase 4: Using evidence-based models in a post-occupancy evaluation

As previously mentioned, the researchers and practitioners did not begin Phase 4 during the NORDGREEN project period. However, based on the work that has been done thus far, we see great value in conducting a follow-up on the survey used in the Hillevåg in the future to understand if the design implementation has been successful, and how the planned development of the recreational area in Hamnevika has influenced the health and well-being of residents in the neighbourhood.

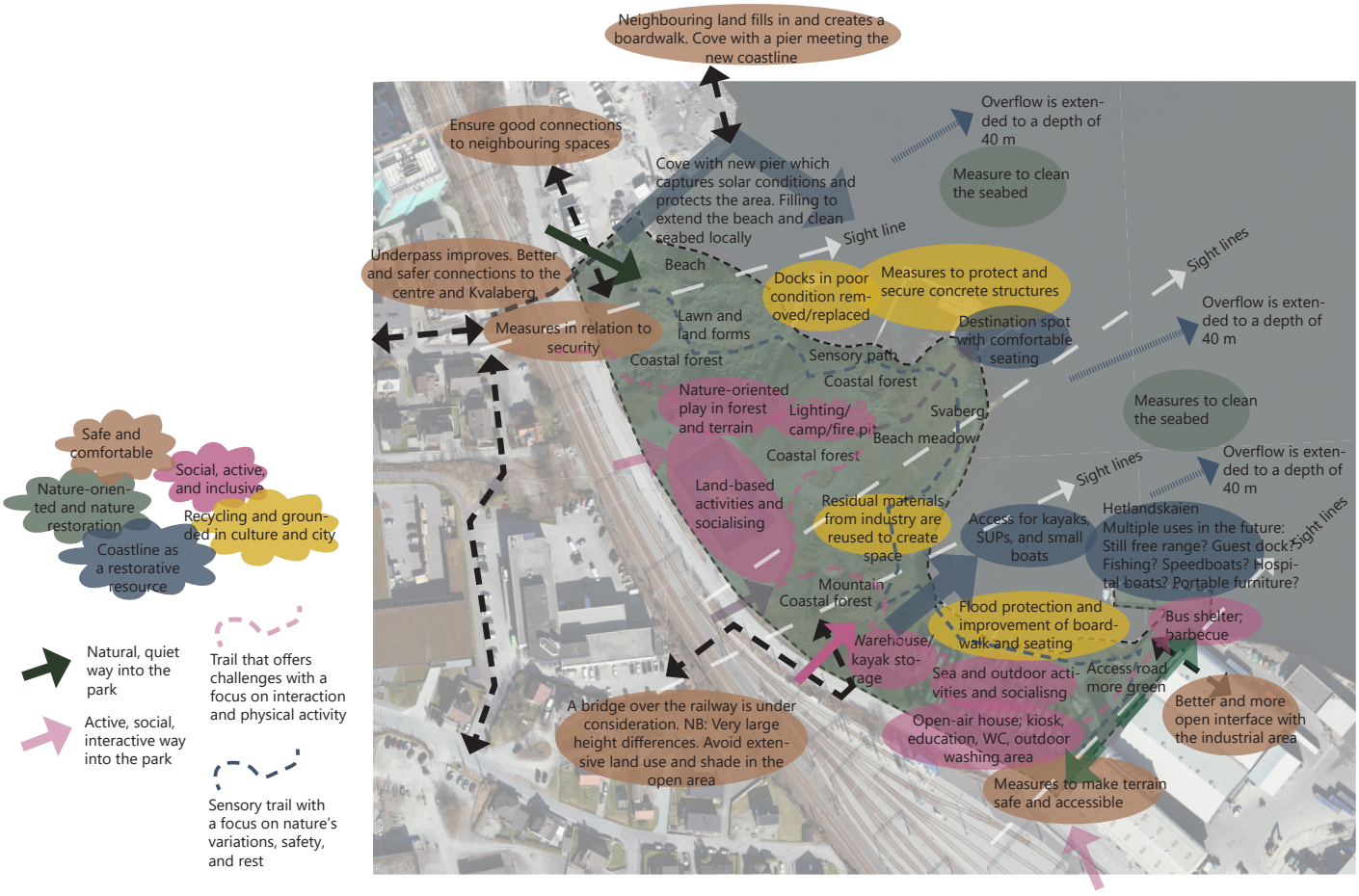


Figure 17. Recommendation map presenting the landscape architects' suggestion for the future development of the project site. Illustration: Martina Andersson, Stavanger Municipality.

Figure 18. A design proposal to illustrate possible design solutions for developing the area to support residents' health and well-being. Illustration of design proposal: Martina Andersson, Stavanger Municipality.

CONCLUSION AND KEY MESSAGES

This chapter describes how evidence-based models are useful to develop green areas that have a positive impact on people's everyday lives. The models provide a way to understand how green space design may influence people based on their zone of contact with the outdoor environment (e.g., in the home, in the workplace, and during recreation in the city's parks), as well as how specific environmental qualities within a green space can promote comfortable outdoor living, physical activity, social interaction, and recovery.

The chapter aimed to describe one method for how to implement evidence-based models in the kind of complex problem solving that green area development implies. Each design project is unique when it comes to the physical, social, and organisational conditions of the site. Thus, it is essential for practitioners to use critical thinking in the process (Hamilton, 2003). The evidence-based working process does not replace established practices but is intended to be combined with the practice conducted at each municipality or office that works with green space development. There is no one right way to go about it. Even if the same models are used, the result of each phase is unique to each site and context.

Based on the work within the NORDGREEN project, we have found that the models are useful for projects of varying scales and contexts, projects with assorted target groups, and projects related to different overarching political goals. Further, green space designers, planners, and managers were able to find their own creative ways of working with the models as well as presenting and visualising their results, as shown in the Hamnevika example. Figure 19 shows how the practitioners for Hamnevika understood the design process integrating the initial project request with the evidence-based models approach.

Within the NORDGREEN project, green space design-

ers, planners, and managers have used the models in Phases 1-3 of the evidence-based working process. Based on this experience, we suggest that planners and designers consider the following take-aways when integrating evidence-based models into their own work:

- The method and the models take time to absorb, and training is needed to be able to use them in practice. Prior knowledge in environmental psychology with a focus on outdoor environment, outdoor activities, and health is an advantage.
- The models can be used to justify and argue for the need of green spaces in people's everyday environments for health and well-being.
- The models are useful to consider the health potential of green areas, not only at development sites (Zone 3), but also in the spaces surrounding the site (Zones 1, 2, and 4).
- The models are useful to understand and describe the range of activities and level of social interaction that is needed at a site, in relation to its context.
- The models are useful to base design decisions on existing environmental qualities (instead of adding new programs), and thus design more sustainably.
- The models should be combined with other tools and knowledge to ensure long-term sustainability of a project. For example, for the environmental quality "species richness and variation," invasive species can provide positive experiences even though they pose a threat to the environment, and thus, in the long-term, to human health.

Overall, the practitioners perceived the evidence-based models and the working processes as valuable additions to established practices in green space development; they specifically helped to highlight people's needs of green space and understand the city's green spaces as health-promoting resources.

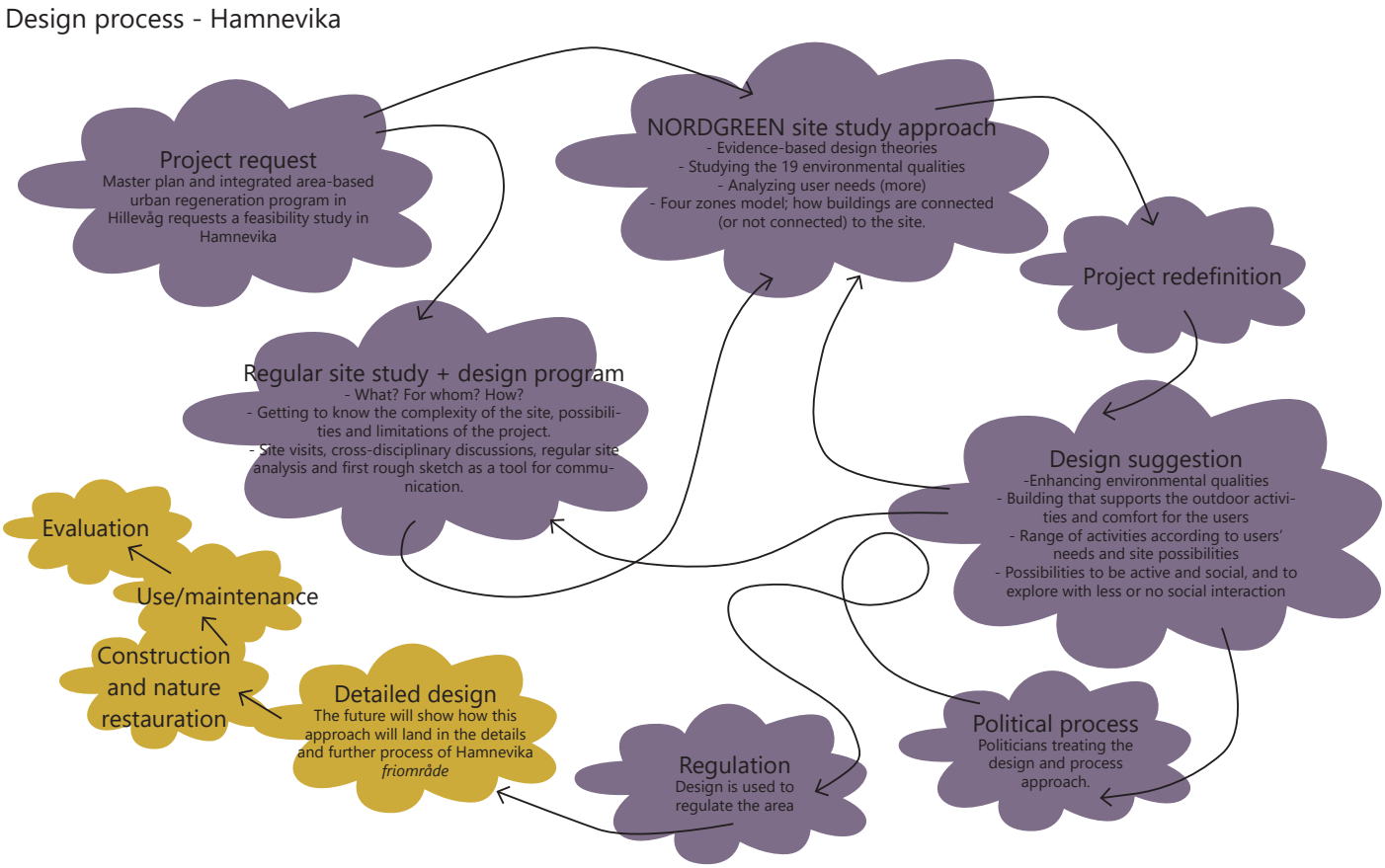


Figure 19. Illustration of design process using the evidence-based models. Martina Andersson, Stavanger Municipality.

PART 3

TOOLBOX

METHODS, MODELS, AND GUIDELINES FOR PRACTITIONERS TO DELIVER HEALTH-PROMOTING GREEN SPACE

LUCIANE AGUIAR BORGES, LISA ROHRER, GEIR AAMODT, MARTINA ANDERSSON, ANNA BENGTSSON, ELSE DYBKJÆR, PATRIK GRAHN, ANNA KAJOSAARI, MARKETTA KYTTÄ, KJELL NILSSON, EMMA CHARLOTT A. NORDBØ, HELENA NORDH, THOMAS B. RANDRUP, SAANA ROSSI, ANNA SUNDING, & ANNA ÅSHAGE

ABSTRACT

This chapter summarises the main methods, models, and guidelines—hereafter named as NORD tools—included in each component of the NORD framework (NUMBERING, OBSERVING, REGULATING, DESIGNING). The chapter provides further details on how to use these tools as well as how practitioners can combine them to deliver health-promoting green spaces.

DELIVERING HEALTH-PROMOTING GREEN SPACE

One goal for civil servants working with city making is to plan, design, and manage spaces that enable all people and communities to live happy, healthy lives. Practitioners working with green space and health are likely to have several needs for achieving this goal. These needs typically include understanding: (1) the linkages between people and spaces, and (2) how these linkages can be mediated through governance. For example, when *planning green spaces for people*, practitioners need to know who visits green spaces, what are their motivations for doing so, and how their experiences in green spaces relate to health and well-being. When *designing green spaces*, practitioners need to know where green spaces people visit are located, what are the characteristics of these spaces, and how do these characteristics influence health and well-being. When *managing green spaces*, practitioners need to know how to coordinate working processes for integrating health into planning, and what type of commitments and capacities are required to do so. Table 1 outlines several general questions pertaining to the design and management of health-promoting green space from the perspective of practitioners and categorises specific needs they may have related to people, spaces, and governance.

This toolbox responds to each of these needs by describing how to implement a method, model, or guideline that has been applied or has emerged from the NORDGREEN project. For example, practitioners who need to understand people's potential access to green space are supported with a method from NUMBERING for analysing objective indicators. Similarly, practitioners who need to provide public green spaces that are designed to respond to various people's needs and preferences are supplied with an evidence-based design model from DESIGNING.

This toolbox chapter summarises how the ideas from this handbook can be applied in practical ways. We also show how multiple tools can be applied alongside each other within a broader working process. Box 1 provides a disclaimer regarding how these tools should be considered by handbook readers.

OVERVIEW OF NORD TOOLS

The summary of the NORD tools is structured along the different components of the NORD framework—NUMBERING, OBSERVING, REGULATING, and DESIGNING.

Box 1. Disclaimer for working with the NORD tools.

The NORD tools (methods, models, and guidelines) presented in this chapter have been elaborated based on the context of a few cities and rural communities from the Nordic Region. They should be seen as tools that can assist in getting a better understanding of some relevant aspects for planning, designing, and managing urban green spaces (e.g., the use of indicators, public participation, governance, and design) to improve public health. However, practitioners should carefully consider how these tools must be tailored to other contexts. These tools are not one-size-fits-all. The adoption of any method, model, or guideline should always be contextualised and reimagined to suit the unique purposes of the practitioners who use them.

When using the NORD tools in practice, keep in mind that the tools serve different purposes and could be employed in different stages of green space planning. While NUMBERING methods are useful to map green space distribution and accessibility in relation to people's health, OBSERVING methods and guidelines allow for including people's experiential place-based knowledge in planning. REGULATING guidelines highlight the political and institutional commitment and new capabilities necessary to integrate health into urban planning, and DESIGNING models and guidelines can be employed in the design of green spaces, making them responsive to people's different needs. Despite their particularities, the NORD tools rest on principles that are mutually reinforcing (i.e., people, space, and governance).

The authors are fully aware of the shortcomings of providing tools and recommendations, as this can lead to simplification and generalisation. Therefore, we advise reading this chapter through the lens of your own context and considering how to integrate these tools into existing planning, design, and management processes.

Table 1. Three interrelated categories, overarching questions, and research needs of practitioners.

PEOPLE	SPACES	GOVERNANCE
Which social groups visit green spaces? Why? What is their experience as it relates to health/ well-being?	Where are the spaces people visit? What are the characteristics of the space? How does it affect health?	How to coordinate working processes for integrating health into planning? What types of commitment and capacities are required?
• Understand people's potential access to green space (e.g., the closest green area people may potentially visit) and/ or monitor changes to green space access. • Understand people's actual access to green space (e.g., the green areas people actually visit) and/or monitor changes to green space access. • Understand people's health and/or monitor changes in population health. • Understand who benefits from health-promoting green space projects based on people's physical contact with, and proximity to, green space. • Include people's experiential, place-based environmental perceptions, values, and concerns in urban planning. • Extrapolate place-based, experiential knowledge to predict the effects of potential planning scenarios.	• Identify public spaces with specific perceived characteristics, values, or uses. • Understand which public spaces are most significant to people. • Understand how green space and health is spatially (and socially) distributed within the municipality. • Understand existing and potential elements within a physical environment that benefit people's health and well-being, meet a variety of needs, and make green space accessible and useful. • Provide public green spaces that are designed to respond to various people's distinct needs and preferences, particularly regarding their sensitivity to stimulation and need for mental health restoration.	• Develop clear goals for connecting green space and human health and well-being. • Coordinate across sector-oriented departments. • Secure strong vertical alignment between policymaking, planning, management, and operational implementation to ensure cost efficiency and documentation for political backup. • Identify and explain how the feedback from residents (perceptions, value of public spaces) have impacted planning solutions and vice versa. • Include people's experiential knowledge into planning processes. • Integrate evidence-based solutions into design processes.

Each section begins with a short description of the main message conveyed by that component. This is followed by matching practitioners' needs to the tools delivered within NORDGREEN. Three types of tools are offered to practitioners:

- *Methods*, which are understood as approaches or ways of working to identify, collect, or analyse data.
- *Models*, which provide representational categories that can be adapted and applied in different settings.
- *Guidelines*, which provide stepwise descriptions of how to design and/or implement processes.

Table 2 lists which types of tools are delivered by the components of the NORD framework.

Table 2. Inventory of NORDGREEN tools for planning, design, and management of health-promoting green space.

	METHODS	MODELS	GUIDELINES
NUMBERING	• Method—Working with objective/perceived indicators for access to green space (N1). • Method—Working with objective/perceived indicators for health (N2). • Method—Working with objective/perceived indicators of green space and health together (N3).		
OBSERVING		• Method—Exploratory analysis using the outcomes of PPGIS surveys (O2). • Method—Explanatory analysis using the outcomes of PPGIS surveys (O3). • Method—Predictive analysis using the outcomes of PPGIS surveys (O4).	• Guidelines—Designing a PPGIS survey (O1). • Guidelines—Integrating the results of a PPGIS survey into planning practice (O5).
REGULATING			• Guidelines—Producing a plan (R1).
DESIGNING		• Model—Using the four zones of contact model as a framework for identifying interfaces of people and nature (D1). • Model—Using the quality evaluation tool to make an inventory of existing, and considering future, design qualities of a space, and adapting the triangle of supportive environment model to design restorative environments (D2).	• Four step evidence-based design working process (D3).

NUMBERING

NUMBERING concludes that objective and perceived indicators for both access to green space and for health are not equivalent to one another. However, together, both can be used by planners to gain a more holistic understanding of the spatial distribution of green spaces in cities, how this distribution relates to the health and well-being of people, and how people perceive their access to green space. NUMBERING responds to practitioners' needs with three methods (Table 3).

Table 3. NUMBERING needs and tools.

IDENTIFIED NEEDS OF PRACTITIONERS →	TOOLS THAT EMERGE FROM 'NUMBERING'
Understand people's potential and actual access to green space and/or monitor changes to green space access. (*People*)	**N1**: Method—Working with objective/perceived indicators for access to green space
Understand people's health and/or monitor changes in population health. (*People*)	**N2**: Method—Working with objective/perceived indicators for health
Understand how green space and health is spatially (and socially) distributed within the municipality. (*Space*)	**N3**: Method—Working with green space and health indicators together

N1 METHOD—WORKING WITH OBJECTIVE/PERCEIVED INDICATORS FOR ACCESS TO GREEN SPACE

OBJECTIVE

To explain how to identify/collect/analyse objective/perceived indicators for access to green space.

USAGE

- Enable planners to target neighbourhoods or specific areas where a change in the physical environment is most urgently needed (when information from both types of indicators are layered together)
- Map the distribution of access to green space within the municipalities
- Map the distribution of access to green space according to sociodemographic characteristics of inhabitants
- Identify neighbourhoods with low access to green space

BY USING THIS TOOL, PRACTITIONERS GAIN

- Better understanding about the differences between real and perceived access to green space
- Knowledge of physical barriers that hinder access to green spaces
- Understanding the perceptions of access to green space
- Knowledge of areas where potential green space planning interventions are needed.
- Knowledge of differences in access to green space between groups

MAIN CHALLENGES

- Data at the relevant scale and spatial resolution is not

RESOURCES NEEDED

- List of relevant indicators

always available.

- Conducting surveys for perceived access to green space can be time-consuming and expensive.
- Inhabitants may experience survey exhaustion.
- Layering objective and perceived indicators does not provide a direct answer as to why mismatches between objective and perceived green space access occurs—only that there is a mismatch and in which areas. Further evaluation on-site must be conducted to determine why.

- Access to databases
- Competency in how to obtain and treat already existing population survey data if that is available
- Competency in conducting population surveys
- Competency in GIS and spatial analysis
- Competency in statistical analysis

COLLECTING AND ANALYSING DATA

INFORMATION	COLLECTION SOURCE	ANALYSIS
Scale: Demographic statistical area (DeSO), postal code areas, districts *Data of objective indicators for green space* (via national authority sources and worldwide open sources for GIS): • Total area of green space • Total area of different green space types • Vegetation cover • Green areas • Distance from dwellings to green spaces *Data of perceived indicators for green space* (via national surveys): • Perceived access to green space, scale of 1 (poor) – 10 (very good) *Resolution:* Spatial resolution: • About 20 m for national and local maps. • About 50 m for Urban Atlas • About 250 m for vegetation cover. Temporal resolution is a continuous updating of local and national maps, about every second year for Urban Atlas, and about three times each month for	*Objective indicators for green space:* • Sweden: Lantmäteriet • Norway: GeoNorge • Denmark: Kortforsyningen • Finland: National Land Survey of Finland • Worldwide: Urban Atlas; OpenStreetMap *Perceived indicators for green space:* Sweden: Statistics Sweden (Citizen Survey, *Medborgarundersökningen*) • Perceived access to green space survey question: On a scale of 1 (poor) to 10 (very good), how do you perceive your access to parks, green spaces, and nature in your city? Norway: County Public Health Survey • Perceived access to green space survey questions: Do you feel that parks and other green areas are easily accessible? Do you feel that it is easy for you to reach nature and outdoor areas?	• Map data using GIS so as to reflect all indicators geographically. • Layer maps so as to visually analyse the indicators together. • Identify areas where objective indicators do not correlate with perceived indicators so as to select places for further analysis of the area.

N2 METHOD—WORKING WITH OBJECTIVE/PERCEIVED INDICATORS FOR HEALTH

OBJECTIVE

To explain how to identify/collect/analyse objective/perceived indicators for health

USAGE

- Identify areas with high/low burden of disease
- Identify areas with high/low well-being
- Understand the differences between hard measures (objective health status) vs. soft measures (perceived health and well-being).

BY USING THIS TOOL, PRACTITIONERS GAIN

- Spatial understanding of vulnerable areas on the perspective of health and well-being of residents

MAIN CHALLENGES

- Health statistics are not always available or presented at a spatial scale relevant for planners to, e.g., depict health differences within districts or neighbourhoods.
- Data is not always readily available.
- Conducting surveys for perceived health and well-being can be time-consuming and expensive.
- Inhabitants may experience survey exhaustion.
- A plausible understanding of health requires aggregated data consisting of different indicators, which can be difficult to monitor or obtain data on.

RESOURCES NEEDED

- Access to data due to GDPR (approval from relevant national agencies)
- List of relevant indicators
- Access to relevant databases
- Competency in conducting population surveys
- Competency in GIS and spatial analysis
- Competency in statistical analysis

COLLECTING AND ANALYSING DATA

INFORMATION	COLLECTION SOURCE	ANALYSIS
Scale: Demographic statistical area (DeSO), postal code areas, districts (dependent on available data and what geographical or statistical units that are used when collecting/presenting the data) *Data of objective indicators for health* (via national statistics databases): • Life expectancy (years) • Obesity (% of total population) • Incidence of heart attack (per 100,000 inhabitants) • Incidence of stroke (per 100,000 inhabitants) *Data of perceived indicators for health* • Perceived well-being	*Objective indicators for health:* • Statistics Sweden • Statistics Norway • Statistics Denmark • Statistics Finland *Perceived indicators for health:* Sweden: Statistics Sweden (Citizen Survey, *Medborgarundersökningen*) • Perceived well-being question: Do you think you can be who you are and live your life the way you want in your municipality? • Perceived health survey question: Because of your health, do you find it difficult to participate in activities or cope with tasks that most other people can cope with? Norway: County Public Health Survey:	• Map data using GIS so as to reflect all indicators geographically. • Layer maps so as to visually analyse the indicators together. • Identify areas where objective indicators do not correlate with perceived indicators so as to select places for further analysis of the area. • Descriptive statistics of health survey data (e.g., using mean values).

• Physical activity • Perceived health *Resolution:* National and local objective health indicators are updated annually (registries) or each second or third year (health surveys).	• Overall, how satisfied are you with your life at the moment? Responses are given on a scale from 0 (not satisfied) to 10 (very satisfied). These questions capture life satisfaction, which is considered an indicator for subjective wellbeing.	

N3 METHOD—WORKING WITH GREEN SPACAE AND HEALTH INDICATORS TOGETHER

OBJECTIVE

To describe how to identify/collect/analyse health and access to green space indicators together

USAGE

- Understand how access to green space and health correlate within a geographical area
- Identify potential areas to intervene with health-promoting green space planning
- Prepare evidence-based arguments (e.g., to politicians) on the need for green space interventions

BY USING THIS TOOL, PRACTITIONERS GAIN

- Knowledge of which areas have both high/low burden of disease and high/low well-being and access to green space
- Knowledge of trends such as access to green space and health indicators such as vegetation cover and life expectancy

MAIN CHALLENGES

- Making an appropriate contextual interpretation of results is difficult as other health determinants (e.g., smoking, physical activity, and diet) are likely to play a role on health outcomes.

RESOURCES NEEDED

- Access to data due to GDPR (approval from relevant national agencies)
- List of relevant indicators
- Access to databases
- Competency in how to obtain and treat already existing population survey data if that is available
- Competency in conducting population surveys
- Competency in GIS and spatial analysis
- Competency in statistical analysis

COLLECTING AND ANALYSING DATA

INFORMATION	COLLECTION SOURCE	ANALYSIS
Use data from Tools N1 and N2	Use collection sources from Tools N1 and N2	• Map data for both health and access to green space using GIS so as to reflect all indicators geographically • Layer maps so as to visually analyse the indicators together • Identify areas where objective indicators do/do not correlate with perceived indicators so as to select places for further analysis of the area • Identify areas where objective and perceived green space indicators correlate/do not correlate with objective and perceived health indicators.

OBSERVING

OBSERVING asserts that spatial knowledge about people's behaviour and perceptions of local environments is valuable for informing planning decisions, including the planning of attractive environments that promote healthy lifestyles and improve the well-being of people. The OBSERVING chapter provides an overview of how such knowledge can be acquired through the implementation of Public Participation GIS (PPGIS) surveys. Several methods and guidelines emerge from this work (Table 4).

Table 4. OBSERVING needs and tools.

IDENTIFIED NEEDS OF PRACTITIONERS →	TOOLS THAT EMERGE FROM 'OBSERVING'
Include people's experiential, place-based environmental perceptions, values, and concerns in urban planning. *(People)*	**O1**: Guidelines—Designing a PPGIS survey
Identify public spaces with specific perceived characteristics, values, or uses; understand which public spaces are most significant to people. *(Space)*	**O2**: Method—Exploratory analysis using the outcomes of PPGIS surveys
Identify and explain how the feedback from residents (e.g., perceptions, value of public spaces) have impacted planning solutions and vice versa. *(Governance)*	**O3**: Method—Explanatory analysis using the outcomes of PPGIS surveys
Extrapolate people's place-based, experiential knowledge to predict the effects of potential planning scenarios. *(People)*	**O4**: Method—Predictive analysis using the outcomes of PPGIS surveys
Include people's experiential knowledge into planning processes. *(Governance)*	**O5**: Guidelines——Integrating the results of a PPGIS survey into planning practice

O1 GUIDELINES—DESIGNING A PPGIS SURVEY

OBJECTIVE

To guide the design of a public participation process using a PPGIS survey

USAGE

- Gather people's spatial and experiential knowledge
- Learn directly from residents about their experiences and engagement in public spaces

BY USING THIS TOOL, PRACTITIONERS GAIN

- Understanding of how, why, where, and when people use green areas
- Understanding of people's wishes, visions, and preferences for future
- Opportunities to diversify and scale-up public participation

MAIN CHALLENGES

- Inhabitants may experience survey exhaustion.
- Reaching particular social groups can be difficult (e.g., elderly and vulnerable groups without access to online surveys).
- Survey design requires cross-departmental collaboration, which can be challenging depending on the municipal organisation.

RESOURCES NEEDED

- Access to software (e.g., Maptionnaire) for conducting the survey and collecting results
- Competency in conducting population surveys
- Competency in data analysis
- Competency in communicating the results back to the participants
- Competency in developing the planning culture that is ready to use the knowledge from people

STEPS

Step 1: Determine the survey's scope	This includes determining the survey goals, objectives, the geographical coverage of the survey (entire city or a particular neighbourhood), and the target group (overall population, specific groups, such as children). This step is likely to entail the involvement of planners and civil servants from different departments of the municipality to fully cover all the information to be harvested.
Step 2: Formulate the questions	PPGIS surveys allow for retrieving two kinds of information from people: (1) non-spatial and (2) spatial knowledge. *Non-spatial knowledge* can be gathered using: • Multiple choice questions, useful for collecting, e.g., demographic data. • Rating scales questions (e.g., Likert-scale), which help to measure respondents' opinions, behaviours and attitudes. • Open-ended questions, which are suitable for eliciting responses about attitudes and opinions in a respondent's own words. *Spatial knowledge* can be: • Collected by asking respondents to map points, lines (e.g., routes), or areas in various categories on a base map and to specify their important characteristics. • Concerned with gathering respondents' preferences of the existing environment (e.g., individual preferences, everyday practices, or identified environmental problems) to inform planning proposals and future developments.
Step 3: Engage and inform the respondent	Invite respondents to participate in the survey with a strategy that can reach the target groups. This could be through: • Random sampling and mail/email invitation • Targeting prospective respondents through an institution or appropriate network • Open invitation on social and traditional media Components to include in the invitation: • Introduction clarifying the survey purpose • Statement regarding how the data will be used • Explanation of how a respondent can follow up on the research results • Clarification of what the respondent's rights are regarding privacy and withdrawal of their participation

Step 4: Use Maptionnaire (or another PPGIS software)	Inputting and testing survey questions is quite simple in Maptionnaire's visual interface. Once the survey is completed, replies may be analysed in descriptive graphs and map visualizations within the online system or exported for deeper analysis on a GIS software. Before the analysis, some cleaning and formatting of the responses in a Microsoft Excel table format is needed. The software allows for easy engagement with respondents as the survey can be advertised in newspapers, posters, flyers, QR codes, and/or social media channels.

02 METHOD—EXPLORATORY ANALYSIS USING THE OUTCOMES OF PPGIS SURVEYS

OBJECTIVE

To show how PPGIS survey outcomes can be used to provide a thematic or descriptive overview of peoples' use of public space or their wishes related to a planning process

USAGE

- Identify preferable type of places (indoors, outdoors, public spaces, green areas, shore areas) by age group
- Set the foundation for the explanatory and predictive analysis
- Visualize data for planning and communication

BY USING THIS TOOL, PRACTITIONERS GAIN

- Better understanding of how people perceive and value the local environments
- Insights on the desirable quality of public spaces

MAIN CHALLENGES

- Exploratory analysis does not tell us much about the links between place experiences and the characteristics of the environment.
- The sample size and the geographic representativeness and coverage of the data should be broad enough to provide reliable parameters for predictions.

RESOURCES NEEDED

- Access to PPGIS survey results

COLLECTING AND ANALYSING DATA

INFORMATION AND COLLECTION SOURCE	ANALYSIS
The data is collected through online surveys. Two types of data can be combined in a PPGIS survey: spatial and non-spatial survey data: *Non-spatial PPGIS:* • Respondent background information (e.g., age, gender, education, income, tenure) • General knowledge about the individual (preferences, lifestyle, attitudes, values) • The outcome variable (satisfaction, quality of life, perceived health, happiness, etc.) *Spatial PPGIS*: • Existing environment (preferences, attitudes, behaviour, everyday practices, environmental phenomenon, and problems)	• The data retrieved from the survey needs to be prepared for analysis (e.g., removing inaccuracies on spatial records or misleading mappings, converting open responses into codes, or text inputs into numbers, re-ordering, data queries, and exclusion of outliers). • Descriptive and visual analysis of survey data • Some spatial and numerical analysis can be done in Maptionnaire platform.

03 METHOD—EXPLANATORY ANALYSIS USING THE OUTCOMES OF PPGIS SURVEYS

OBJECTIVE

To show how PPGIS survey outcomes can be used to explain relationships within the collected PPGIS data and between the data and secondary sources of data

USAGE

- Identify areas where potential green space planning interventions are needed
- Identify green structure elements that are valued by people and that have the strongest health outcomes
- Identify areas with high concentrations of values given to green spaces by people (e.g., perceived green space quality)
- Compare the intensity of usage of green areas with management and development needs (see OBSERVING, Figure 5)
- Inform ecosystem-based management, climate resilience and adaptation planning, and protected area management etc.

BY USING THIS TOOL, PRACTITIONERS GAIN

- Better understanding of residents' behaviour (e.g., mobility patterns, usage of public spaces)
- Support to prioritize investments for improving local environments (development and management)

MAIN CHALLENGES

- Finding or training people for the competencies/expertise required can be difficult.
- The sample size and the geographic representativeness and coverage of the data should be broad enough to provide reliable parameters for predictions.

RESOURCES NEEDED

- Access to PPGIS survey results
- Expertise on spatial analysis
- Advanced competency in GIS

COLLECTING AND ANALYSING DATA

INFORMATION AND COLLECTION SOURCE	ANALYSIS
• Spatial and/or non-spatial PPGIS data • Traditional GIS data (e.g., basic maps, land cover, land use, roads, housing density, conservation areas)	• The data retrieved from the survey needs to be prepared for analysis (e.g., removing inaccuracies on spatial records or misleading mappings, converting open responses into codes, or text inputs into numbers, re-ordering, data queries, and exclusion of outliers). • The data retrieved from the survey is combined with traditional GIS data • This level of analysis typically demands the use of both GIS programmes and statistical programmes

04 METHOD—PREDICTIVE ANALYSIS USING THE OUTCOMES OF PPGIS SURVEYS

OBJECTIVE

To show how PPGIS survey outcomes can be used to predict the impact of changes to green spaces on people

USAGE

- Predict potential impacts on the environment based on people's perceptions and behaviours
- Predict changes in use of green space if a new plan is realised
- Gain insights on urban environments by generalising mapped knowledge from PPGIS surveys
- Predict perceived green space qualities even in areas where there is no PPGIS data
- Predict planning outcomes for people and their well-being (e.g., whether the environmental health promotion processes are strengthened or weakened through the realisation of a plan).

BY USING THIS TOOL, PRACTITIONERS GAIN

- Better understanding of potential impacts of changes in the environment

MAIN CHALLENGES

- Finding or training people for the competencies/expertise required can be difficult.
- The sample size and the geographic representativeness and coverage of the data should be broad enough to provide reliable parameters for predictions.

RESOURCES NEEDED

- Access to Maptionnaire PPGIS survey results
- Advanced competency in GIS
- Additional training to combine PPGIS to GIS traditional data
- Advanced expertise in performing analysis that integrates multiple data sources to predict and model PPGIS data

COLLECTING AND ANALYSING DATA

INFORMATION AND COLLECTION SOURCE	ANALYSIS
• Data collected through online surveys; data used from exploratory analysis • Type of data: GIS data about the characteristics of settings that can potentially explain the phenomenon at hand (e.g., the size of urban green area, forest biodiversity, proximity to water, noise exposure). • Data is spatially explicit as it predicts how the urban environment may look like based on the outcomes of the PPGIS survey the spatial analysis covers a wider geographical area than the PPGIS survey.	• The data retrieved from the survey needs to be prepared for analysis (e.g., removing inaccuracies on spatial records or misleading mappings, converting open responses into codes, or text inputs into numbers, re-ordering, data queries, and exclusion of outliers). • Apply the place-based knowledge from the PPGIS survey (e.g., environmental qualities) to estimate impacts of an area of interest/study area/planning area (e.g., an entire city or municipality). • Develop a statistical model that include the weights with which the environmental characteristics explain e.g. perceived quality of green areas.

O5 GUIDELINES—INTEGRATING THE RESULTS OF A PPGIS SURVEY INTO PLANNING PRACTICE

OBJECTIVE

To suggest how to integrate experiential/participatory knowledge layers with other municipal (GIS) data

USAGE

- Share existing survey knowledge effectively across various sectors of a planning organisation
- Enable practitioners to independently access and analyse survey results even if they were not involved in collecting the data

BY USING THIS TOOL, PRACTITIONERS GAIN

- Participatory layer of background knowledge
- Understanding of how to effectively utilise collected participatory knowledge
- Basis for deepening participation by building on previously collected knowledge
- Potential to use longitudinal experiential data for evaluating progress if the data is updated/if surveys are repeated

MAIN CHALLENGES

- Processing survey knowledge to be shared on municipal GIS platforms is resource intensive.
- Municipal GIS platforms might be subject to reacquisition, threatening the continuity of availability or usability of uploaded data.
- Significant effort is required to communicate the availability of the survey data , and to test and develop the usability of the data.
- The process requires cross-departmental collaboration, which can be challenging depending on the municipal organisation.

RESOURCES NEEDED

- Map-based municipal information system
- Knowledge-sharing practices and networks
- Competency in understanding the everyday practices of potential users (such as planners, managers, communication officers, any other municipal officials), their development needs, and their available resources

STEPS

Step 1: Plan data collection	While planning surveys (described in O1), knowledge needs should be considered in relation to existing data. What is the scope of a new survey? Does it include repeated questions to collect follow-up data for evaluating people's experiences of areas that have recently been developed?
Step 2: Upload the data	• Identify the survey results that can be distributed via a municipal GIS platform (ideally, this would include all map-based data excluding personal information such as home locations). • Simplify and combine survey categories as needed. • Make survey metadata (such as information about the data collection, number of participants, representativeness) is accessible to users. Consider and clarify responsibilities: • How and by whom will the data be kept up to date? • Is technical support available to users? • Is support in creating more detailed analyses available to users? • Do potential users in varied departments or sectors have access to the municipal GIS platform?

Step 3: Test and develop the usability of PPGIS data	Invite practitioners who will use the data to inform their work from various departments to test the usability and clarity of the data. • Is the data easy to find? • Are the categories clear? • Is colour-coding legible? • Is required metadata easily available? • Is it clear where or how the full data set can be acquired? Plan how knowledge can be integrated into existing processes, and provide examples, templates, and structures for this when possible. For example, in a planning document template, provide data visualization templates, or for a public participation event, provide slide templates for showing survey results on chosen themes.
Step 4: Communicate the available knowledge	• Organise presentations of available data sets and analyses for primary and other potential users • Distribute knowledge of available data sets and visualisation templates among potential users via digital and physical internal communication channels. • If possible, recruit members of the organisation to pioneer the use of data and to report their experiences to their colleagues and to the public.

REGULATING

REGULATING introduces the programmatic alignment framework, which provides a pathway to examine the performance of municipalities to plan and manage health-promoting green spaces. The framework distinguishes three planning and management levels within the municipal organisational structure: policy, tactical, and operational. Each level accounts for different activity phases ranging from policymaking, planning, and management, to implementation. Observing the links (or missing links) between green spaces and health issues across the three levels from visioning (policymaking) to operational implementation (vertical alignment), as well as across departments (horizontal alignment), provides valuable lessons for health-promoting planning and management of green spaces. REGULATING emphasizes one overarching tool to respond to several governance-related needs (Table 5).

Table 5. REGULATING needs and tools.

IDENTIFIED NEEDS OF PRACTITIONERS	→ TOOLS THAT EMERGE FROM 'REGULATING'
Develop clear goals for connecting green spaces and human health and well-being. (*Governance*)	**R1**: Guidelines—producing a plan
Secure strong vertical alignment between policymaking, planning, management, and operational implementation to ensure cost efficiency and documentation for political backup. (*Governance*)	
Coordinate across sector-oriented departments. (*Governance*)	

The objective and content of a plan or project will vary depending on a range of factors, and the process of producing the plan will often be as beneficial for the organisation as the plan itself. Therefore, these guidelines intend to support the process of setting up a plan. This includes identification of who should be involved in informing and producing the plan. The guidelines below suggest three steps to be carried out at the beginning—when formulating a new plan. These steps, however, are not necessarily chronological but may be performed simultaneously or individually.

R1 GUIDELINES—PRODUCING A PLAN

OBJECTIVE

To provide potential steps for initiating a plan, policy, or design process that encourages programmatic alignment

USAGE

- Assists the initiation of a green spaces and health/well-being relationship in municipal planning, by 1) addressing the relation between green areas and health/well-being, while 2) providing guidance on how to plan and manage health-promoting green areas

BY USING THIS TOOL, PRACTITIONERS GAIN

- Greater awareness about the relationship between green space and health and well-being
- Knowledge of which stakeholders have key interests, powers, and potential to be involved in the planning process

- Supports the preservation of existing, and justifies the implementation of new green spaces
- Supports cross-sectoral collaborations
- Supports sustainable and long-term planning and management relating to implementation capacity

- Clarification of which stakeholders should be engaged in the planning process, and with which means
- Understanding of the resources required for implementing the plan (time, financial resources, and knowledge)

MAIN CHALLENGES

- Identifying and sorting the different types of existing plans and strategies is time-consuming and complex due to uncertainties regarding their purpose and accountability.
- Identifying and addressing relevant stakeholders may be difficult.
- There may be a potential risk of excluding relevant themes due to lack of coordination.
- It may be difficult to interpret ambiguous arguments/ statements from existing plans/policy documents may be difficult.

RESOURCES NEEDED

- Knowledge and expertise to identify skills needed in initiating and creating the plan
- Time to identify and analyse relevant documents and stakeholders

STEPS

Step 1: Set the plan and policy context	Aim: to become aware of existing plans and policy documents, and to identify the most relevant for the elaboration of a new plan.

Regardless of the type of plan or strategy, the plan will be allocated in the hierarchy of existing steering and/or guiding documents in the municipality. To ensure the plan is developed to address the right purpose and audience, it is important to identify which other documents the plan must relate to. This applies to both vertical and horizontal alignment.

For *vertical alignment,* three main types of materials need consideration:

- The wider policy context: Both overarching policies, conventions, and rules at the national or international level, and relevant policies at the local policy level (e.g., park policy or a health strategy).
- Supporting documents: These can be reports or inventories (playgrounds, trees, etc.) or analysis of use or user groups (e.g., PPGIS inventories, see OBSERVING) which provide an overview of the current situation and inform decision-making.
- Affected documents: Other documents might benefit from the elaboration of the plan by using its recommendations and strategies as a basis. This can be, e.g., a thematic green plan, an action plan, a maintenance plan, or a prioritisation of planned investments.

For *horizontal alignment*, it is important to identify all relevant sectors or knowledge fields for the elaboration of the plan. Regarding green space utilisation, different departments have specific responsibilities depending on the different types of green spaces. For example, the technical department may be responsible for public parks and public trees, the social department for green spaces related to institutions (e.g., schools, elderly homes, kindergartens) and the cultural department for the sports grounds and related facilities. Each department or area may have existing plans or documents that are relevant to the new plan. In addition, policies and strategies from other fields (e.g., public health strategies or action plans formulated for specific user groups) should inform the plan.

Step 2: Mapping stakeholders	Aim: to engage suitable capacities in developing the plan, and to create stakeholder ownership for the plan
	Reed et al. (2009) suggest three approaches for mapping stakeholders: (1) identify stakeholders, (2) differentiate and categorise stakeholders, and (3) investigating relationships between stakeholders. 1: Identify stakeholders (individuals, organisations) who could be affected by the plan's purpose and scope, or who can have an impact on it. This includes the identification of all relevant departments, units, and even individuals within the knowledge fields of green spaces and health and well-being within and outside the organisation. These stakeholders can also play a supporting role in further identifying existing plans and policies, as mentioned under Step 1. 2 and 3: Categorise and investigate the relationships between the stakeholders. Four categories are used to differentiate the stakeholders regarding their interests and power to affect the planning process and outcomes (Ackermann & Eden, 2011). Stakeholders who: • Inform the plan: They initiate the planning process (i.e., politicians who set the long-term visions and political agendas, for example, that green spaces and human health and well-being should be further developed within the municipality). However, they may not be directly involved in developing the plan. These stakeholders have high power to influence but have no direct interest in the outcomes or are not affected by the plan. They should be "kept informed" in terms of progress, not at least to facilitate the final approval of the plan. • Affect the plan: They are directly involved in elaborating the plan (e.g., planners and managers from different departments, key external stakeholders such as users or interest groups). These stakeholders both affect and are affected by the plan. They have high power and interests in the outcomes of the plan; therefore, they should be "managed closely." • Are affected by the plan: They are directly affected by the plan (e.g., green space maintenance unit, civil servants responsible for implementing the plan, or planners who will create other documents that must adhere to the plan, and user groups). These stakeholders have low power to influence the plan but high interest in the outcomes; therefore, they should be "kept satisfied, empowered." • Are informed by the plan: They are planners and managers from other departments. These stakeholders have low power over the plan and low interest in the outcomes of the plan; therefore, they should be "monitored, engaged strategically." Stakeholders representing all four categories should be involved in the planning process. The knowledge about their power and interest in the plan, and whether they inform or affect the plan, is important to define their engagement and commitment. Even though representatives from the different stakeholders do not need to be engaged during all planning stages (e.g., preparatory, and implementation phases), it is important to provide everyone with regular feedback and updates on the planning process.
Step 3: Surveying available resources	Aim: to identify the resources available for implementing the plan and opportunities for increasing resources.
	At the policy level, one of the key factors for the success of the new plan is ensuring that the new recommendations are supported by management initiatives. Estimating the costs and benefits of the implementation and long-term management of the new plan is useful for informing decision-making. Nevertheless, it is important to manage the expectations of the different stakeholders who are involved and can be affected by the plan. To this end, the inventory of the available resources (e.g., financial, personnel, time, expertise) that the unit(s) or department(s) responsible for implementing the plan have, as well as opportunities to increase the resources for the long-term management, should be assessed. This is paramount as the implementation

	of the plan is likely to add new tasks and routines demanding further resources. As the plan is cross-sectorial, joint financing between departments with a clear division of responsibilities and costs could be an alternative to capitalising funds for implementing the plan. This may also entail the prioritisation or re-prioritisation of responsibilities between the departments. For defining priorities and monitoring the implementation of the plan, the visions, goals, and specific aims should be clearly related to health outcomes. They should also clearly relate to how specific green spaces can contribute to improving human health and well-being. This will allow determining when targets or goals have been achieved, which is fundamental to ensure the alignment of activities across departments.

DESIGNING

DESIGNING highlights that planners need evidence concerning which kinds of outdoor environments can have a positive impact on people's everyday life, particularly on their health and well-being. Planners can conduct landscape analysis using one or several evidence-based models within an evidence-based working process to strategically design health-promoting green spaces. Here, practitioners gain models and guidelines from DESIGNING (Table 6).

Table 6. DESIGNING needs and tools.

IDENTIFIED NEEDS OF PRACTITIONERS →	TOOLS THAT EMERGE FROM 'DESIGNING'
Understand who benefits from health-promoting green space projects based on people's physical contact with, and proximity to, green space. *(People)*	**D1**: Model—Using the *four zones of contact* model as a framework for identifying interfaces of people and nature
Understand existing and potential elements within a physical environment that benefit people's health and well-being, meet a variety of needs, and make green space accessible and useful; provide public green spaces that are designed to respond to various people's distinct needs and preferences, particularly regarding their sensitivity to stimulation and need for mental health restoration. *(Space)*	**D2**: Model—Using the *quality evaluation tool* to make an inventory of existing, and considering future, design qualities, and adapting/applying the *triangle of supportive environment* framework to design restorative environments
Integrate evidence-based solutions into design processes. *(Governance)*	**D3**: Guidelines—Four step, evidence-based design working process

D1 MODEL—USING FOUR ZONES OF CONTACT FOR IDENTIFYING INTERFACES OF PEOPLE AND NATURE

OBJECTIVE

To provide categories that expand the understanding of who is affected by green spaces

USAGE

- Increase added value of the green space for people beyond using or stepping foot within the green space itself (e.g., people walking past the green space, or people who can see the green space from their building)

BY USING THIS TOOL, PRACTITIONERS GAIN

- Perspectives for designing green space that positively contributes to the well-being of people who experience the site from different proximities (inside and outside the site itself).

MAIN CHALLENGES

- Identifying how different types of contact with nature affect people's health can be difficult.
- The model is one part of the design process which

RESOURCES NEEDED

- Maps (various scales and marking various features)
- Visualisation software

requires complex problem solving. For example, it is important to understand that the models focus on the health and well-being of people and should be combined with other knowledge focusing on other perspectives of sustainability. Evidence-based working processes do not replace established practices; rather, they are intended to complement existing practices of municipalities or offices working with green space development.

- Time and training are needed to enable the use of the model in practice.

- Professional education and experience, especially landscape architecture and skills in identifying and analysing environmental/landscape characteristics.
- Prior knowledge in environmental psychology with a focus on outdoor environment, outdoor activities, and health is an advantage.

COLLECTING AND ANALYSING DATA (to identify and describe relevant zones in a development, see Table 1, p. 83)

INFORMATION	COLLECTION SOURCE	ANALYSIS
Practitioners use already existing data/information as well as produce new understanding of information; qualitative assessment	• Observation/site visits • Pictures • Mapping of existing green structure • Questionnaire • Dialogue with, e.g., potential users/relevant stakeholders	Spatial analysis (e.g., connectivity between different zones, assessment of environmental qualities, qualitative interpretations and synthesizing) creative processing

D2 MODEL—USING THE QET TO MAKE AN INVENTORY; ADAPTING TRIANGLE OF SUPPORTIVE ENVIRONMENT

OBJECTIVE

To provide categories for making an inventory of existing landscape qualities, the results of which influence the design of green space environments for human health and well-being.

USAGE

- Design green spaces according to diverse needs and preferences
- Clarify the connection between people's mental state and their need for different types of environments.
- Identify which kinds of spaces might best respond to people's need for stress relief or stimulation.

BY USING THIS TOOL, PRACTITIONERS GAIN

- Perspectives for designing and planning green space that specifically considers stimulation, restoration, and comfort for specific target groups and for people in general

MAIN CHALLENGES

- It can be difficult to identify how different environmental qualities affect people's health and well-being
- The model is one part of the design process which requires complex problem solving. For example, it

RESOURCES NEEDED

- Maps (various scales and marking various features)
- Professional education and experience, especially landscape architecture and skills in identifying and analysing environmental/landscape characteristics.

is important to understand that the models focus on health and well-being of people and should be combined with other knowledge focusing other perspectives of sustainability. Evidence-based working processes do not replace established practices; rather, they are intended to complement existing practices of municipalities or offices working with green space development.

- Time and training are needed to enable the use of the model in practice.

- Prior knowledge in environmental psychology with a focus on outdoor environment, outdoor activities, and health is an advantage.

COLLECTING AND ANALYSING DATA (to identify relevant environmental qualities, see Table 4 on p. 86; to understand the relationship between the QET and the triangle of supportive environment, see Figure 3 on p. 87)

INFORMATION	COLLECTION SOURCE	ANALYSIS
Practitioners use existing data/information as well as produce new understanding of information; qualitative assessment.	Landscape inventory through: • Observation/site visits • Pictures from existing green structure Mapping • Questionnaire • Dialogue with, e.g., potential users/relevant stakeholders	Spatial analysis (e.g., assessment of environmental qualities, qualitative interpretations, and synthesizing) creative processing

D3 GUIDELINES—FOUR-STEP EVIDENCE-BASED DESIGN WORKING PROCESS

OBJECTIVE

To provide a roadmap for working with evidence-based models

USAGE

- Clarify how evidence can be used to develop and evaluate health-promoting green spaces
- Clarify how evidence-based models can be combined in practice

BY USING THIS TOOL, PRACTITIONERS GAIN

- Perspectives for designing green space that positively contributes to the well-being of people who experience the site from different proximities
- Perspectives for designing and planning green space that specifically considers stimulation, restoration, and comfort for specific target groups and for people in general

MAIN CHALLENGES

- Conducting the four phases can be challenging because it demands long-term commitment (especially to include Phase 4).
- Folding the phases into pre-existing design processes and ways of working can be difficult.
- Including people's perspectives or determine which needs or interests to prioritise is not always possible to.

RESOURCES NEEDED

- Understanding of evidence-based models (D1 and D2)
- Surveys to collect qualitative data

PHASES	
Phase 1: Identifying existing zones and health-promoting environmental qualities	In this phase, green space developers can use the principal model of four zones of contact (D1) and the environmental qualities from the QET (D2) to make an inventory of zones and qualities in and around the project site. Descriptions could be made through: • Text • Illustrations • Photos Overview of environmental qualities could be made through: • Numerical rating system • Colour indications of zones
Phase 2: Identifying user perspectives	Zones and qualities are used in dialogues and/or questionnaires to study users' perspectives of the green area in question. Surveys can include questions about people's needs and preferences in relation to environmental qualities. These can be recorded through descriptions or by asking respondents to give qualities a numerical value.
Phase 3: Designing green spaces	Based on the results of Phase 1 and Phase 2, green space designers can propose measures for environmental qualities and zones. In this phase, management experts can be included to provide their perspectives.
Phase 4: Conducting a post-occupancy evaluation	The focus of this phase is to follow up on the intentions of the proposal, in relation to all environmental qualities and zones and describe, for each quality and zone, if the intentions have been fulfilled. In this phase, ratings for the appearance of each environmental quality could be compared to the intention ratings from Phase 3. The post-occupancy evaluation typically occurs approximately 5 years after the design intervention.

A PATHWAY FOR COMBINING THE NORD TOOLS

The components of the NORD framework reinforce each other in the endeavour of planning, designing, and managing green supportive environments for health and well-being.

- NUMBERING provides methods that enable practitioners to assess the status of a municipality with regards to green area accessibility and health and well-being indicators. This information can be retrieved at the city level and is helpful in providing a baseline for the elaboration of comprehensive and thematic plans (political and tactical levels).
- OBSERVING focuses on peoples' perspectives and needs in the urban environment. The outcomes of the PPGIS surveys provide place-based experiential knowledge that is fundamental for decision-making. Making people visible and part of planning cities is a strategy that can influence planning at all organisational levels.
- REGULATING lies at the heart of the framework as all other components deliver relevant information for planning, management, and policymaking of health-promoting green space.
- DESIGNING offers models that guide landscape architects to create supportive environments for health and well-being. This methodology provides rich insights on how to intervene in public green spaces using evidence-based methods so that interventions are not random or misguided when it comes to providing genuine outcomes for health.

Besides having REGULATING as the common denominator, the other NORD components have the potential to reinforce each other by delivering additional knowledge while validating the outcomes. The methodological triangulation of research findings is an essential strategy as it mitigates bias and increases the trustworthiness of the work. As shown in Figure 1, NUMBERING and OBSERVING can reinforce each other through the sharing of indicators. OBSERVING and DESIGNING can be linked through participatory practices, and NUMBERING and DESIGNING can strengthen one another when it comes to identifying environmental enablers and barriers. Table 7 expands this reasoning and maps how the different NORD components provide input for the different planning levels (REGULATING).

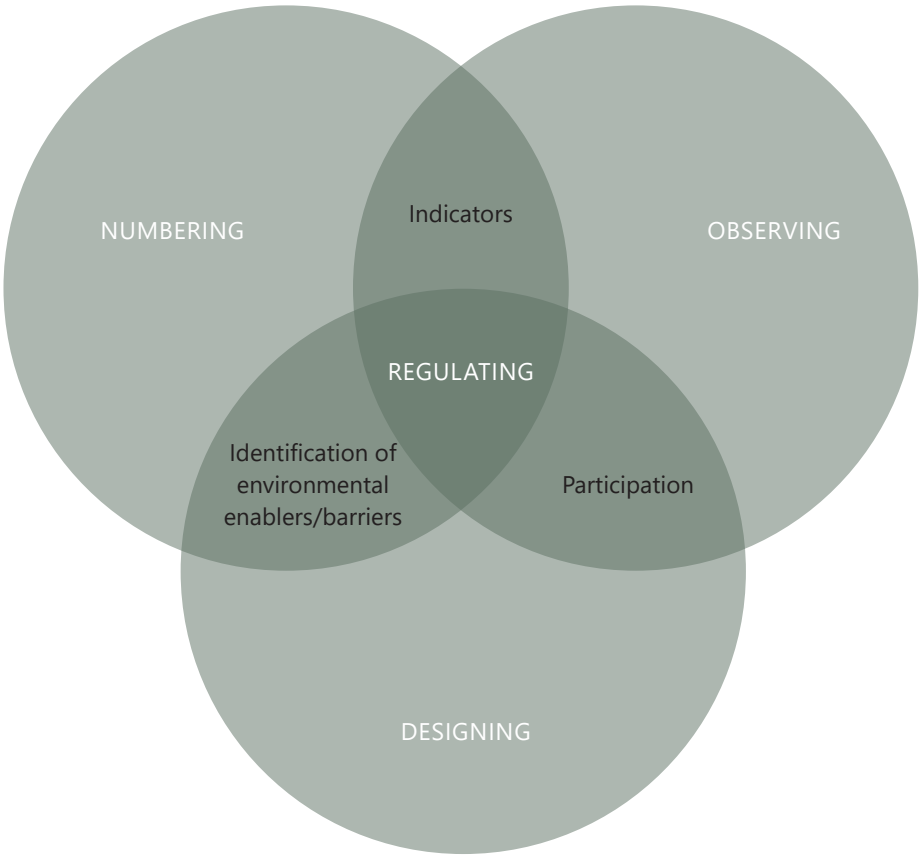


Figure 1. Diagram of the NORD components and their interlinkages.

Table 7. The combination of the different NORD tools and components provides inputs for planning and policymaking at different levels.

	ASSOCIATION BETWEEN NORD COMPONENTS	REGULATING		
		POLITICAL LEVEL	TACTICAL LEVEL	OPERATIONAL LEVEL
NUMBERING + OBSERVING	• These NORD components are complementary and use similar data and analytical frameworks (statistics and GIS analysis). • PPGIS surveys (OBSERVING) can provide experiential indicators that can be combined with objective indicators (NUMBERING). • OBSERVING can be used to identify places and areas of interest that can be further analysed with NUMBERING (statistical analysis).	NUMBERING and OBSERVING provide baseline information about green space accessibility and health that can inform the elaboration of com-	NUMBERING and OBSERVING reinforce the need to promote the joint work between planners and health strategists as cross-departmental data sharing and collaboration is necessary for the planning and management of health-promoting green spaces.	
NUMBERING + DESIGNING	• The combination of these NORD components bridges statistical data and design. • NUMBERING identifies environmental enablers and barriers that can be addressed through DESIGNING. • DESIGNING, specifically the QET (D2), can suggest the integration of other environmental qualities in national surveys.			NUMBERING and DESIGNING inform spatial interventions in the urban environment that are necessary to promote health.
OBSERVING + DESIGNING	• OBSERVING provides experiential place-based knowledge. DESIGNING uses this knowledge to identify sites for green space and health transformations. • OBSERVING provides inputs to DESIGNING in two steps of the design process: (1) to investigate different user groups in relation to the environment, and (2) to follow up on the outcomes of the development project.		OBSERVING and DESIGNING provide a process for data sharing (e.g., through an interdepartmental database) so that survey content is usable in multiple departments by a range of potentially relevant actors.	OBSERVING and DESIGNING inform spatial interventions in the urban environment that are necessary to promote health.

As highlighted in Table 7, there are several associations across the NORD tools and various ways in which the tools can be combined to support the overall aims of practitioners. While the combination of two components may have immediate implications at specific levels (political, tactical, and/or operational), programmatic alignment as a framework emphasises the need to synthesize all NORD components. Figure 2 provides an overview of some potential ways in which the various methods, models, and guidelines can feed into one another when aiming to plan, design, and manage a public space—either by combining multiple methods to enhance a study, or by sharing results from one process to influence or support the work of another process.

In this example, we present how the various methods for identifying, collecting, and analysing perceived and objective indicators for access to green space (N1) and for health (N2) combine to influence the method of identifying, collecting, and analysing these health and green space indicators together (N3). Meanwhile, the PPGIS survey guidelines (O1) can guide the process of completing exploratory/explanatory/predictive analysis of PPGIS survey results (O2, O3, O4) and enable the integration of this knowledge with other data layers used in planning (O5). If such an analysis of place-based survey results is combined with the work of N3, this could result in additional layers of information that take into account both national citizen surveys (used in NUMBERING) as well as participatory GIS responses (used in OBSERVING).

This new place-based information, made up of multiple layers of objective and perceived data regarding both green space access and health, could be utilised to develop clear goals at the political level. Data can also be shared across departments (tactical level) in order to enhance elements of both horizontal and vertical alignment. In doing so, practitioners at the operational level can use the mapping work to identify more effectively the potential districts, neighbourhoods, and specific sites in which landscape changes should be considered. This information can form the foundation for developing a programmatically aligned plan for green space and health (R1).

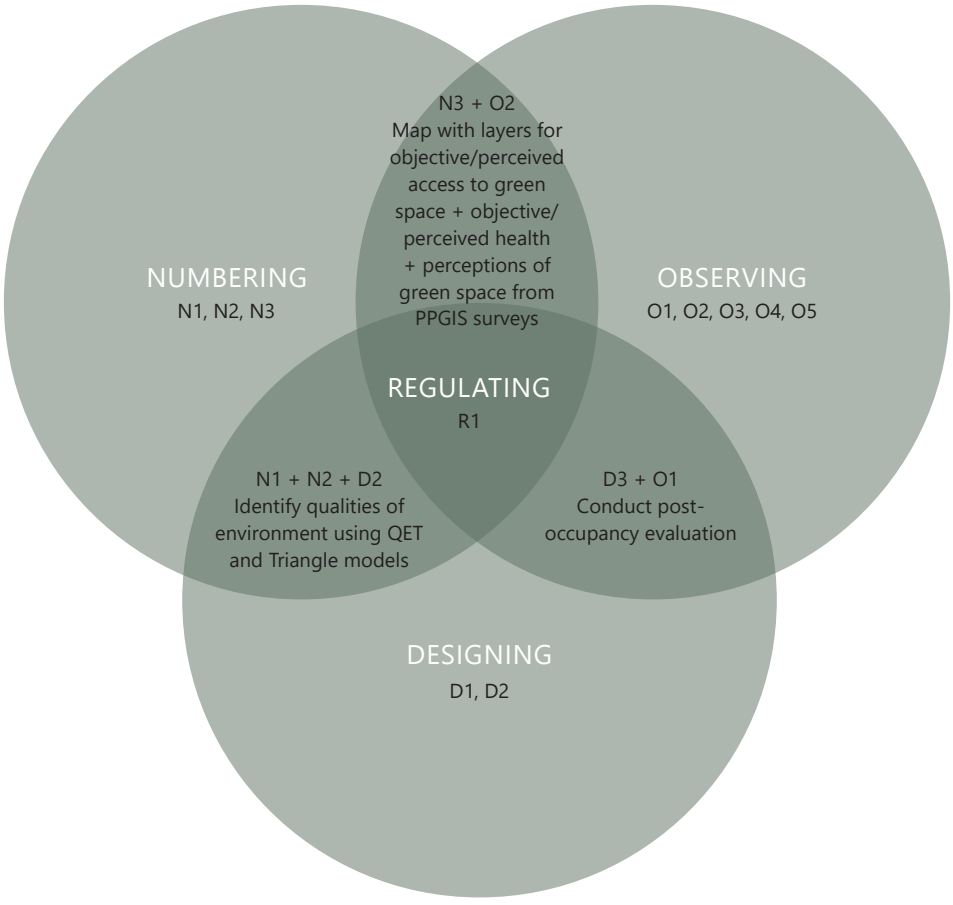


Figure 2. Example of how the NORD tools can be combined for planning, designing, and managing green space.

Here, the evidence-based models from DESIGNING can be integrated into the working process. After evaluating the data provided from NUMBERING and OBSERVING, the four zones of contact model (D1) can be employed to identify the site location and its zones to mark where the interfaces between people and their natural environment are found. An additional, site-specific PPGIS survey could also be conducted to determine these zones. Models such as the QET and the triangle of supportive environment (D2) can also be taken up once the zones are identified to analyse the existing health-promoting qualities of the site. It is also possible that the QET (D2) could be considered in advance of the NUMBERING methods, specifically with regards to the perceived indicator surveys. For example, the survey questions might be informed by the qualities presented in the QET so that residents are asked to reflect on their perceived health or perceived access to green space as it relates to the 19 environmental qualities.

After the transformation of the site, D3 provides guidelines of an evidence-based design process in which a post-occupancy evaluation takes place. The OBSERVING tools can boost this type of evaluation by lending its methods within PPGIS survey guidelines (O1) to conduct a follow-up survey in which people can identify how changes to the environment have influenced people's behaviours and perceptions.

By combining the NORD tools in various ways, practitioners can find inspiration and support in delivering health-promoting green space in their cities.

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GEIR AAMODT

Geir is a professor in epidemiology at the Norwegian University of Life Sciences (NMBU). He has worked with projects focusing on environmental factors such as air-pollution, noise, and drinking water in addition to green space and different health outcomes such as mental health and well-being, heart disease, and hip fractures.

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Martina is a landscape architect and project manager in Stavanger Municipality working with both strategic city planning as well as more detailed landscape design. She is especially interested in implementing natural processes, research, and art into the design process.

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Anna is a landscape architect and senior lecturer at the Swedish University of Agricultural Sciences (SLU). She researches and teaches in health-promoting outdoor environments, evidence-based design, and environmental psychology.

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Luciane is a senior research fellow at Nordregio with a PhD in planning and decision analysis from the Royal Institute of Technology (KTH) in Stockholm. Her professional experience includes research and teaching in the fields of urban design, urban planning, regional mobility, heritage management, futures studies, sustainable cities, green space planning, urban agriculture, and circular economy.

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Patrik is a professor in landscape architecture at the Swedish University of Agricultural Sciences (SLU). His research lies at the interface of landscape architecture and environmental psychology, and how these can be applied in health-promoting landscape architecture and nature-based therapy. Together with colleagues, he has developed several key theories related to landscape architecture, environmental psychology, and health.

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Anna is an urban geographer working in the field of urban health. In her research, she uses digital participatory mapping methods to understand how urban environments support population health and well-being and how these effects may differ based on who you are and where you live. Anna received her PhD from Aalto University, and she now works as a postdoctoral research at the Austrian Academy of Sciences (ÖAW).

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Anna is a doctoral student in the Landscape Governance and Management group at the Swedish University of Agricultural Sciences (SLU). She has a background as a landscape architect in Swedish municipal practice. Her interest lies in creating sustainable management of public green spaces.

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Anna is a research assistant in environmental psychology at the Department of People and Society at the Swedish University of Agricultural Sciences (SLU). She has experience from several research projects working in dialogue processes and participatory design processes together with landscape architects and city planners.