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COVID-19 reshaping cities:

From past pandemics toward future healthier urban planning

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Abstract:

Health diseases throughout history have brought cities' design and infrastructures the challenge to improve and control the spread of the infectious virus. In the 19th century, the concern regarding promoting hygiene and healthy environments led to developing several urban design models and innovations. Urban planners such as Cerdà, Ebenezer Howard, Clarence Perry, and Le Corbusier were fundamental to the evolution of new urban approaches. In the 20th century, the World Health Organization started the movement known as Health Cities, which had as the main goal of promoting a healthy approach to environmental design. The debate on how to build a better urban environment is constantly under discussion, as the world's circumstance keeps changing and has now been impacted by the COVID-19 pandemic. Since it was declared a pandemic in March 2020, city governments, together with architects, urban planners, and health professionals, discussed how this pandemic will reshape future urban design. This thesis analyzes how pandemics have affected urban design in the past and how the current COVID-19 emergency affected cities and their inhabitants through the measures adopted to control the spread of the virus. Nations worldwide developed strategies to recover and build better-adapted cities in the future, which were analyzed and applied in the Study Case in the city of Gothenburg, Sweden.

Keywords: Urban Planning; urban design; pandemics; COVID-19; public space.

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1. INTRODUCTION

Over centuries changes in human life implied different consequences for the urban structure: mass migration to cities resulted in overcrowding, poor living conditions, and uncontrolled urban sprawl, leading to the spread of infectious disease, for instance, the Black Death, also known as the bubonic plague. The Black Death was a devastating global epidemic of bubonic plague that struck Europe and Asia in the mid-1300s. The plague arrived in Europe in October 1347, when 12 ships from the Black Sea docked at the Sicilian port of Messina. To slow the spread of the disease, officials in the port city of Ragusa kept arriving sailors in isolation until it was clear they were not infected.[1] The Cholera disease had numerous outbreaks and seven pandemics.[2] In Britain's capital in 1850, the deadly outbreaks that killed ten thousand people – long associated with the stench of untreated human waste and industrial fumes choking the city – demanded direct urban intervention.[3] This eventually led to a sanitary reform movement, creating sewer and sanitation systems.

In the late 1800s and early 1900s, the concern about hygiene and health of cities and their respective populations increased, which led to the development of public health policies, the provision of services and infrastructures, the redesign of particularly unhealthy urban neighborhoods, and new urban planning model, such as the Garden City. In 1898 Ebenezer Howard developed the concept of setting a minimum distance between houses to avoid person-to-person contact and secure adequate light and fresh air for health, adequate un-built-on ground for convenience, and proper parks and gardens.[4] Furthermore, the modernist movement from the 1920s to the 1970s was based on similar concerns and marked by Le Corbusier's innovative architecture and urban planning. At the time, lack of sunlight, ventilation, and personal space was seen to be directly linked to tuberculosis's spread. For this reason, Le Corbusiers's in his book City of Tomorrow (1929), hypothesized the exact cubic meters of air, sunlight, and open space needed per resident and used these measures as a formula for town planning. By the end of the 20th century, a series of multidisciplinary studies made it possible to effectively link environmental, social, psychological, and economic aspects with the spread and impact of the disease.

In the 1970s, the psychologist Robert Ader presented the first opportunity to connect environmental influence, individual perception, and disease manifestation. In the early

1 History.com Editors (2010). "Black Death". A&E Television Networks. https://www.history.com/topics/middle-ages/black-death

2 History.com Editors (2017). "Cholera". A&E Television Networks. https://www.history.com/topics/inventions/history-of-cholera

3 Wintle, T. (2020). "COVID-19 and the city: How past pandemics have shaped urban landscapes". CGTN. https://newseu.cgtn.com/news/2020-07-08/COVID-19-and-the-city-How-past-pandemics-have-shaped-urban-landscapes-QCFjZLBIxG/index.html

4 Unwin, R. (1912). "Nothing gained by overcrowding!: How garden city type of development may benefit both owner and occupier". P. S. King & Son. https://www.hgstrust.org/documents/nothing-gained.pdf

1980s, cross-disciplinary research by social epidemiologists, most notably the work done by Roslyn Lindheim, an architect, and Leonard Syme, a psychologist, further connected social and spatial conditions of neighborhoods to disease resistance.[5] This highlights the importance of the urban planning to ensure the well-being and health of the population and contain the spread of infectious diseases and avoid them becoming a bigger problem such as an epidemic.

From the perspective of urban history, any epidemic or disaster is an alleged fox "small probability" event, and it rarely occurs in the long term of urban development. But if cities do not have effective preventive measures, once such "small probability" incidents occur, they will have a more significant negative impact and even become urban disasters.[6] Therefore, cities should be prepared to respond when such epidemics happen, even if it is just a small probability. The lack of previous planning can be risky and make the whole situation even worst, as we could see lately with the COVID-19 pandemic.

In December 2019, Chinese authorities informed WHO's China office of pneumonia cases in Wuhan City, Hubei province, China, with unknown cause. By the end of January 2020, the 2019-nCov had already reached more countries. Japan and U.S. each confirmed the second case on the 24th of January, while on the 25th, Australia confirmed the first case in the continent, and France confirmed three cases, the first in Europe. By 11th February, WHO assigned the disease caused by the novel coronavirus its official name: COVID-19, which by 11th march 2020, was declared a pandemic.[7]

1.1. Research Imperatives

A widely accepted definition of health comes from the 1948 constitution of the World Health Organization: Health is a state of complete physical, mental and social well-being and not only the absence of disease or infirmity. Being able to enjoy the highest possible standard of health is one of the fundamental rights of every human being, regardless of race, religion, political belief, or economic and social conditions.[8] According to this, COVID-19, a disease with physical effects, is just one part of the concept of achieving a complete state of health, but still, we can notice that it was actually more than that.

For decades, the prevalence of mental health conditions has been broadly unchanged; this trend changed in 2020 with the outbreak of the COVID-19 pandemic. From March

[5] Carr, S. J. (2014). "The Topography of Wellness: Mechanism, metrics, and models of health in urban landscape". https://escholarship.org/uc/item/8cg2t860

[6] Wei, D. (2020) "Urban Function – Social Response Strategy for the Pandemic – A concise Manual on Urban Emergency Management."

[7] Lei Ravelo, J., Jerving, S. (2020). "COVID-19 in 2020 – a timeline of the coronavirus outbreak". Devex. https://www.devex.com/news/covid-19-a-timeline-of-the-coronavirus-outbreak-96396

[8] Bartons, H., Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants". S2D-International Association for the Promotion of Health and Sustainable Development. https://www.euro.who.int/__data/assets/pdf_file/0010/102106/E93982.pdf

2020 onwards, the prevalence of anxiety and depression increased. For example, in Belgium, France, Italy, Mexico, New Zealand, the United Kingdom, and the United States, the prevalence of anxiety in early 2020 was double or more than double the level observed in previous years; in Australia, Belgium, Canada, France, the Czech Republic, Mexico, Sweden, the United Kingdom and the United States, the prevalence of depression in early 2020 was also double or more than double that observed in previous years.[9] This provided evidence that even if COVID-19 is not a mental disease, it affects the population's mental health and the general health according to the WHO definition.

One of the main strategies used to avoid the spread of the COVID-19 virus was quarantine, which separates and restricts the movement of people exposed to a contagious disease to see if they become sick.[10] Major stressors during quarantine included its more prolonged duration, fears of infection, frustration and boredom, inadequate supplies, and inadequate information. Stressors after quarantine included financial loss and stigma from others.[11] Which leads to poor mental health and explains the increase in the number of people that presented depression or anxiety since the pandemic started.

Restrictions regarding public spaces and social distance were also used to contain the spread of the COVID-19 virus and protect public health. With the absence of leisure facilities such as shopping malls, restaurants, and recreational places, the cancellation of social activities, and the requirements of self-quarantine and social distancing, parks and green spaces have become increasingly popular and essential for public health and social benefits.[12] This highlights the importance of urban planning to build well-adapted urban areas to be used under normal life circumstances and when small probability events, such as epidemics, happen.

Architecture and urbanism as academic disciplines and professions that influence, in many different ways, individuals, communities, and societies, can support efforts through developing new insights into the impact of a pandemic on cities and urban environments now and in the future.[13] Seeking to achieve the balance between urban planning and environmental health and be prepared for an emergency again, different institutions, such as the World Health Organization (WHO) and the National Association of City Transportation Officials (NACTO), proposed manuals regarding how

[9] OEDC Policy Responses to Coronavirus (COVID-19) (2021). "Tackling the mental health impact of the COVID-19 crisis: An integrated, whole-of-society response"

[10] Centers for Disease Control and Prevention (2017) "Quarantine and Isolation". https://www.cdc.gov/quarantine/index.html

[11] Brookes, S. K. et al (2020). "The psychological impact of quarantine and how to reduce it: Rapid review of the evidence." Lancet. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30460-8/fulltext

[12] Gend, D. et al (2021). "Impacts of COVID-19 pandemic on urban park visitation: a global analysis". Journal of Forestry Research (Harbin). 10.1007/s11676-020-01249-w

[13] Salama, A. M. (2020). "Coronavirus questions that will not go away: Interrogating urban and socio-spatial implications of COVID-19 measures". Emerald Open Research. https://emeraldopenresearch.com/articles/2-14

to plan the cities in the post-COVID-19 future. Also, cities have designed their own future measures, including the smart city concept and more green and inclusive recovery neighborhoods. Guidelines supporting local business, employment, tourism, culture, and creative industries are also included in the proposed measures.

1.2. Research Questions

- Health concerns drove what historical context of past urban designs?
- What was the role of the urban planners and city authorities in the measures adopted to control the spread of the virus?
- Which were the changes that the COVID-19 pandemic brought to the urban organization and functionalities of cities that will remain after the emergency?
- Which measures proposed by the future design could efficiently avoid spreading infectious disease and promote public health?

1.3. Research Contribution

The main contribution of this thesis is the analysis and understanding of the guidelines proposed for urban planning after COVID-19 and if they could be practical to build healthier environments sustainably, guaranteeing life quality for city inhabitants and protection from significant impacts in the occurrence of a new pandemic in the future.

1.4. Methods

This thesis reflects historical, theoretical, and practical frameworks of health, urban form, and landscape. The study of these fields is the key to understanding how the past pandemics and urban design movements and policies were conducted to create healthier environments and how to develop cities to be healthier and prepared for future emergencies to arrive at the understanding, I employ the following methods:

- ***historical and theoretical research:*** A review of historical literature to understand the connection between urban planning, the previous pandemics, the environment, and its impacts on people's health. This approach is a fundamental step to figuring out how these elements interfered with the city's planning qualities and strategies as we know them today. It is also essential to understand which of the measures taken to control previous pandemics worked, which ineffective, and the reasons behind them to avoid the same mistakes or reuse old strategies.
- ***metanalysis/review:*** review and analyze proposals regarding city planning after the COVID-19 pandemic, drawn from both public health and urban planners. Some of the recommendations consist of manuals with guidelines for future city development in general. At the same time, also most of the countries and cities around the world have planned their own future projects. An overview of these responses and also the analysis of how people's lives change during the

pandemic emergency and the impact of the measures taken to avoid the spread of the virus aims to show overlaps and gaps in considering future urban planning.

- ***case study:*** Gothenburg is the second largest city in Sweden, the country that called a lot of attention during the COVID-19 pandemic due to its lack of mandatory restrictions to control the spread of the virus. After the proposals for post-pandemic urban planning and the impacts of COVID-19 in the city, a masterplan project was elaborated, aiming to make the urban environment more well-adapted to the new reality.

1.5. Structure of Dissertation

In response to the research questions, this thesis is structured in 4 parts:

The first part surveys the history and theory behind the built environment and health outcomes. Chapter one provides a narrative of historical convergences of public health and public real, specifically how epidemics have shaped the urbanization process, from Bubonic Plague to the most recent pre-COVID-19 pandemics.

The second part is dedicated to healthy urban planning concepts and recommendations. Theoretical guidelines will be investigated, and built projects analyze according to their different aims regarding urban health planning. The main purpose is to understand if the recommendations and parameters efficiently bring people a healthier and better life quality, preventing and addressing future pandemics.

The third part explores the COVID-19 timeline, and how it expanded and affected people's lives, highlighting the urban planning measures taken to avoid the spread of the virus, and their respective efficiency and consequences. Further we will analyze and compare the proposals from the different cities and institutions regarding cities after COVID-19 pandemics.

The last part focus on the city of Gothenburg and how it was affected by the health emergency. The analyses of the city together with the concepts discussed on the chapter before, a project proposal was developed for the city aiming to create a better and healthier urban environment.

2. HISTORICAL EVOLUTION OF HEALTH URBAN PLANNING

The emergence of urban planning as a profession and academic discipline had a basis in nineteenth-century public health initiatives.[14] Not only urban planners were seeking to make places healthier but also many other professionals in different ways and levels. Some focus on providing individuals health care and preventive services, including medicines, physical therapy, nursing, and occupational therapy. Others operate at the community level, focusing on populations more than on individuals. These professions collectively make up the public health field, which is dedicated to fulling society's interest in assuring conditions in which people can be healthy, from adequate health care systems to healthy environments. Public health professionals pursue this mission by assessing and monitoring community health to identify problems, developing public policies to solve these problems, and working to ensure access to appropriate and cost-effective care.[15]

Environmental health is the subfield of public health that focuses on the relationships between people and their environment. It aims to promote healthy environments and human health and well-being; and fosters healthy and safe communities.[16] The main focus of this subfield was initially on sanitation: providing clean water and sewage. It has recently started to care about chemical hazards, climate change impacts, and sustainability. It is essential to understand that "environment" does not refer only to nature but also to the indoor environment, where people can be exposed to radon, chemicals, and noise.[17] Exposure to unhealthy environments results in many diseases and injuries, including heart disease and chronic respiratory problems. In 2016, 24% of the global deaths were linked to poor environmental conditions.[18]

Architecture is a word that can lead to many meanings, but in the context of public health, architecture is the art and technique of designing that operates at the scale of buildings. One characteristic that distinguishes an architecture work from other built structures is the suitability of the project to be used by human beings and how it is adaptable to particular human activities. Architecture is created only to fulfill the

[14] Corburn, J. (2007). "Reconnecting with Our Roors: American Urban Planning and Public Health in the Twenty-first Century." SAGE Publictions. https://journals.sagepub.com/doi/10.1177/1078087406296390
[15] Dannenberg, A. L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.
[16] ALPHA - American Public Health Association. "Environmental Health". https://www.apha.org/topics-and-issues/environmental-health
[17] Folkhälsomyndigheten (2018). "Environmental health". https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/living-conditions-and-lifestyle/environmental-health/
[18] World Health Organization (WHO). "Environmental Health". https://www.who.int/health-topics/environmental-health#tab=tab_2

specifications of an individual or group, and therefore architects can be specialized in different classes of buildings: residential, commercial, or health structures.[19]

"Architecture is the scientific art of making structure express ideas. Architecture is the triumph of human imagination over materials, methods, and men to put man into possession of his own earth. Architecture is man's great sense of himself embodied in a world of his own making. It may rise as high in quality only as its source because great art is great life."[20]

Landscape architecture studies designing environments that create and enable life between the buildings. The involvement of landscape architects can be seen in shared paths, housing states, shopping malls, squares, regional and national parks, gardens, waterways, and across towns, cities, and countries. Landscape architects often go beyond design creating frameworks and policies for place and city shaping that enable citizens and government to create better places for all.[21] Landscape design may vary according to different styles, formality, and use. For instance, the ancient Egyptians, Greeks, and Romans designed green spaces, such as parks and gardens, to serve as private pleasure.[22] Over the years, this perspective changed, and the presence of open public spaces in the city became more common and essential to creating a healthy environment.

Finally, urban planning, also known as urban design, regional, and sectorial planning, is focused on the design of the city and the physical elements within it, including their arrangement and appearance. It is concerned with the function and appeal of the public spaces.[23] Urban planners can ensure accessibility for inhabitants by connecting neighborhoods through a rich provision of mobility options, highlighting the importance of high-quality public transportation and non-motorized options, like bike paths, sidewalks.[24]

As mentioned before, urban planning significantly influenced the 19th century. Still, public health has been a concern long before that, even if this terminology was not known by then. The greatest of ancient civilizations were built according to careful and complex plans, from the scale of the buildings to the scale of vast cities. In old city remains across the world, there is evidence of hierarchical street arrangements, monuments, public spaces, and terraces carefully built to manage water flows. Many

[19] Ackrman, James S. (2000). "architecture". Britannica. https://www.britannica.com/topic/architecture
[20] Craven, J. (2019). "Defining Architecture and Design - Exploring Construction of the Built Environment". ThoughtCO. https://www.thoughtco.com/what-is-architecture-178087
[21] Holmes, D. (2021). "What is landscape architecture?". World Landscape Architecture.
[22] The Editors of Encyclopaedia Britannica. "landscape architecture". Britannica. https://www.britannica.com/art/landscape-architecture
[23] Handy, Susan L. et at. (2002) "How the Built Environment Affects Physical Activity – Views from Urban Planning". Am J Prev Med. 10.1016/s0749-3797(02)00475-0
[24] Harvey, H. (2017). "Getting Around: How Urban Transportation and Planning Unlock the future of Accessibility". Forbes.

of these achievements reflected efforts to protect the health.[25] During the 19th century instead, some of the achievements were tenement housing reforms, the construction of water supply and sewerage systems.[26] The reason behind these innovative solutions was the healthy problems encountered by the current problems in the 19th century in combination with the previous ones. This provides further evidence that our generation needs a similar approach to combat the problems issued by the COVID-19 emergency and innovative solutions according to the specific situation.

2.1. The pandemics through the 14th to 18th century

The Bubonic Plague, also known as the Black Death, is considered Europe's most daunting tragedy to this day. Sweeping one-third of the continent's population, the plague killed 50 million people in the 14th century or 60 percent of Europe's entire population. The reason behind these innovative solutions was the healthy problems encountered by the current problems in the 19th century in combination with the previous ones. This provides further evidence that our generation needs a similar approach to combat the problems issued by the COVID-19 emergency and innovative solutions according to the specific situation.[27] Originated from the east, the pandemic reached Medieval Europe via the Silk Road in October 1347. Its first encounters were the people of Caffa, the merchant port city, and modern-day Feodosia, from which the pandemic widely spread inland, soon covering the whole continent. Doctors and physicians of 14th century Europe were incapable of defining the origins of the plague, therefor divine punishment became the only explanation possible for medieval people; God's retribution for humanity's sins. [28] The acceptance of this explanation by the population highlight the lack of knowledge regarding infectious disease and urban health at that time.

The quarantine measures

Even though the nature of the Black Death was unknown, people still managed to find solutions to reduce the spread of the diseases. When the increase of sea trade coincided, in the 14th century, with successive outbreaks of bubonic plague, isolation measures started to be taken: In 1374, a proclamation was issued in Venice that stated all ships and passengers had to be stationed on the nearby island until the special

[25] Dannenberg, A. L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.
[26] Corburn, J. (2007). "Reconnecting with Our Roors: American Urban Planning and Public Health in the Twenty-first Century." SAGE Publictions. https://journals.sagepub.com/doi/10.1177/1078087406296390
[27] Benedictow, O. (2005). "The Black Death: The Greatest Catastrophe Ever". History Today. https://www.historytoday.com/archive/black-death-greatest-catastrophe-ever
[28] Mrad, J. A. (2020). "Architectural changes in Europe after Bubonic Plague". Rethinking the Future. https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1436-architectural-changes-in-europe-after-bubonic-plague/

health council permitted them to enter the city.[29] Ships, designed for unrestricted movement and transport of goods, were transformed into a static system of containment and, in some tragic cases, a floating mass-coffin. The architectural characteristics of a trading ship, its autonomous and self-sufficient nature, and the inaccessibility which a body of water offers resulted in a robust physical barrier against disease.[30]

Across the Adriatic Sea in Ragusa (present-day Dubrovnik, Croatia), however, the city's Great Council passed a ground-breaking law in 1377 to prevent the spread of the pandemic requiring all incoming ships and trade caravans arriving from infected areas to submit to 30 days of isolation. The legislation stipulated that anyone coming from pernicious places must spend a month in the nearby town of Cavtat or the island of Mrkan for the purpose of disinfection before entering the medieval walled city. The Ragusan Republic imposed stringent punishments and fines for offenders who did not follow the 30-day quarantine law (trentine, as the term was written in a document found in the Archives of Dubrovnik, dated 27 July 1377). In the beginning, quarantine was 30 days, but it was eventually prolonged to 40 days, as in Venice.[31]

No one knows precisely why the isolation period was changed from 30 to 40 days: some suggest 30 days were deemed insufficient to prevent disease spread, as the exact incubation period was unknown; others believe the 40-day quarantine was related to the Christian observance of Lent; and still, others believe the 40 days is based on biblical events like the great flood, Moses' stay on Mt Sinai, or Jesus' stay in the wilderness. But we know that the term quarantine is derived from 40 days in Italian: *Quaranta Giorni*, *quarantino*.[32]

The construction of the *Lazzarretti*

Together with the increase in the number of days in isolation, containment islands, or *lazarreti*, were built in the Venetian lagoon to house the infected until deemed healthy or buried when dead. Designed to be self-contained, the *lazaretti* borrowed from defensive solutions of the time to create a barrier system for controlled access and isolation. The edge condition between water and the island was defined by high walls with a single entrance and rotating shelves at windows to avoid contamination when exchanging goods. Within the walls, hospitals, cell accommodation, chapels, gardens for food production, and cemeteries were distributed following guidelines of minimum

[29] Vuković, K. (2020). "The Lazarettos of Dubrovnik are a reminder of the city's foresight in combating infectious disease centuries ago". BBC. https://www.bbc.com/travel/article/20200421-dubrovnik-the-medieval-city-designed-around-quarantine

[30] Garcia, D. (2020). "Distant space: the architecture of quarantine". The Architectural Review. https://www.architectural-review.com/buildings/health/distant-space-the-architecture-of-quarantine

[31] Vuković, Kristin op. cit

[32] Ibid. 2020

contact between residents, with halls and paths that allowed for servicing cells while respecting barriers and distancing, solutions found in isolation units well into the 1900s.[33]

Figure 1: Francesco Guardi depicts the Lazzaretto Vecchio.
(https://www.pubhist.com/w57162)

Isolation and human distancing proved to be an efficient strategy against the bubonic plague, which explains why it was used when similar situations arose. Medieval cities expanded their borders to create less cluttered spaces for their population.[34] During the plague of 1630-31, a lockdown was enforced in the city of Florence, communicating with other cities to help contain the spread of the disease. Systematized efforts to discover patient zero were also recognized as efficient containment methods. In 1701, legislation was passed in Massachusetts forcing those infected with smallpox to self-isolate. More radically yet, American authorities incarcerated over 300,000 prostitutes during the First World War to stop the spread of venereal diseases.[35] L*azzaretti*

[33] Garcia, D. (2020). "Distant space: the architecture of quarantine". The Architectural Review. https://www.architectural-review.com/buildings/health/distant-space-the-architecture-of-quarantine
[34] Mrad, J. A. (2020). "Architectural changes in Europe after Bubonic Plague". Rethinking the Future. https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1436-architectural-changes-in-europe-after-bubonic-plague/
[35] Garcia, D. (2020). "Distant space: the architecture of quarantine". The Architectural Review. https://www.architectural-review.com/buildings/health/distant-space-the-architecture-of-quarantine

continued to be an isolation space when an emergency disease occurred. During the 17th century, the so-called Plague of the Maids broke into the city of Dubrovnik, and anything thought to be a disease transmitter (including wool and cotton) spent 45 to 60 days in a *lazzaretto*. Soon they became overcrowded, so monasteries, palaces, and family homes were also transformed into quarantine centers.[36]

2.2. The pandemics in the 19th century

Although cholera has existed for many centuries, the disease became prominent in the 19th century. It is unclear when exactly cholera first affected people. Still, it is known that its first pandemic emerged out of the Ganges Delta with an outbreak in Jessore, India, in 1817, stemming from contaminated rice. By 1820, cholera had spread to Thailand, Indonesia, the Philippines, and China. In 1821, British troops traveling from India to Oman brought cholera to the Persian Gulf. The disease eventually made its way to European territory, reaching modern-day Turkey, Syria, and Southern Russia. It came to Japan in 1822 by way of infected people on ships. There have since been numerous outbreaks and seven global pandemics of cholera.[37]

Until a severe cholera outbreak in London in the 1850s, it was typical for row sewage to flow out of buildings and directly onto city streets. At the beginning of the epidemic, it was believed that cholera was "miasma," the medieval understanding that disease was spread through contact with bad air, like vapors emanating from rotting organic matter. [38] But the physician William Farr was willing to do something about the pandemic, so he systematically recorded who was dying and where. The most important things he discovered were negative. Wealth didn't protect you from cholera. Neither did occupation or residing close to the sea. What mattered was how high above the Thames people lived. Farr concluded that the river's horrendous stench caused the disease. Another English doctor, John Snow, made the proper connection: London's sewers emptied into the water. A year later, Snow saved countless lives by persuading parish authorities to remove the handle from the Broad Street pump in Soho. By pinning down the waterborne pathway of contagion, Farr and Snow had transformed a devasting public disease into a routine exercise in civil engineering. In 1858, Parliament passed legislation, proposed by then-chancellor of the exchequer Benjamin Disraeli, to finance new drains. London suffered its last cholera epidemic in 1866. [39] Although isolation was proven to be an efficient way to contain the spread of infectious

[36] Raisin, L. (2020). "The history of quarantines in the city that invented them". Time Out. https://www.timeout.com/croatia/news/the-history-of-quarantines-in-the-city-that-invented-them-033120

[37] History.com Editors (2017). "Cholera". A&E Television Networks. https://www.history.com/topics/inventions/history-of-cholera

[38] Budds, D. (2020). "Design in the age of pandemics". Curbed. https://archive.curbed.com/2020/3/17/21178962/design-pandemics-coronavirus-quarantine

[39] Huber, P. W. (2007). "Germs and the City: Two centuries of success against infectious disease have left us complacent – and vulnerable". City Journal.

disease, Farr and Snow's actions highlight the importance of controlling and managing it by focusing on discovering and eliminating its source.

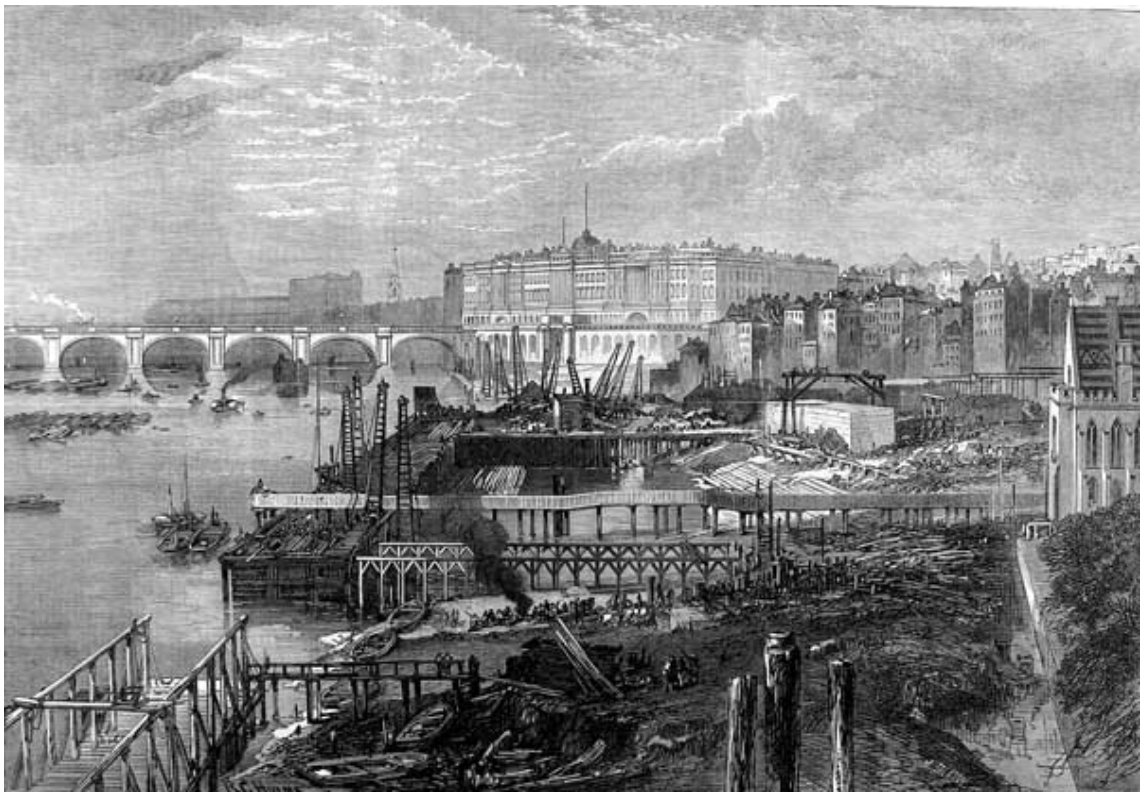

Figure 2: A representation from 1865 of the construction of Victoria Embankment. (Wintle, T. 2020)

In 1864, the construction of The Victoria Embankment started to provide the city of London with a modern sewerage system and to help relieve traffic congestion of traffic on The Strand and Fleet Street.[40] Joseph Bazalgette was charged with overseeing the conversion of vast areas of the Thames's marshland into paved walkways, covering pipelines that could take wastewater safely downstream and away from drinking supplies. The two-kilometer stretch of lush gardens and spacious boulevards that runs along the River Thames was officially opened to the public in 1870. The dam, mirrored by similar sewerage modernization projects in Paris and Berlin in the late 100s, allowed for the expansions of vast self-described imperial promenades and grand public parks that have come to define many modern-day European capitals.[41] Limiting the spread of waterborne diseases through urban design led us to the European cities of today.

[40] Hill, D. "The Embankment"

[41] Wintle, T. (2020). "COVID-19 and the city: How past pandemics have shaped urban landscapes". CGTN. https://newseu.cgtn.com/news/2020-07-08/COVID-19-and-the-city-How-past-pandemics-have-shaped-urban-landscapes-QCFjZLBIxG/index.html

In 1872, Disraeli rallied his Tory Party around what his Liberal opponents derided as a "policy of sewage" – reforms involving housing, sanitation, factory conditions, food, and the water supply – and while he served as prime minister, these policies became law. For the next 50 years or so, in the United States, as in Britain, public health depended on the city bureaucrats above all. They wasted little time with sick patients, other than sometimes ordering them to lock their doors and die alone. Instead, they focused on eradicating germs before reaching the patient, which meant attending to the water, sewage, trash, and rats.[42]

The 19th century is when the city becomes the real focus of infectious disease. For many people living in any industrial center, whether it be London, Bradford, or Glasgow, the risk of your home making you ill was very significant. Poor sanitation, overcrowding, and ventilation all contributed, and inevitably the most severe cases were among the working poor of these newly industrialized centers, which helped lower the average age of death in areas such as Manchester and Liverpool. These conditions inspired architects, city planners, and the 19th-century philanthropic factory owners to design new utopian communities that prioritized health through open space and green settlements. Good examples of these ideal settlements are Saltaire in northern England and Cadbury's Bournville just outside Birmingham. There, factories and their workers were relocated to new leafy suburbia where laborers were thought to be better protected from the respiratory diseases spreading in the city.[43]

During the Civil War, Fredrik Law Olmsted, a sanitary officer, used public health to convince New York City to build Central Park, arguing that its open space would become "the lungs of the city." His belief in the medicinal qualities of green space also influenced his 1868 master plan for Riverside, Illinois, a "garden suburb" that was viewed as a healthier alternative to city life due to widespread access to recreational space.[44] All these examples of new city projects in the 19th-century evidence how important avoiding the spread of infectious disease became and how the living environment can affect people's health. In the 20th century, more ideal cities and settlements were proposed.

The cholera epidemic also spread throughout the whole of Europe, including Italy. Naples, known as an overcrowded city with precarious sewage, lost more the 8.000 inhabitants to this disease. The huge cholera outbreak impact led to an urban reform guided by the law of "*Risanamento"* of January 1885. Old unhealthy buildings were pulled down and given space for newer constructions; so-called slums locate below the natural water level; new roads were built connecting the Central station with the

[42] Huber, P. W. (2007). "Germs and the City: Two centuries of success against infectious disease have left us complacent – and vulnerable". City Journal. https://www.city-journal.org/html/germs-and-city-13005.html
[43] Ibid 2020.
[44] Budds, D. (2020). "Design in the age of pandemics". Curbed. https://archive.curbed.com/2020/3/17/21178962/design-pandemics-coronavirus-quarantine

squares of the city, and in May of 1885, the new Serino aqueduct was inaugurated, providing the town with quality water.[45]

2.3. The pandemic in the 20th century

2.3.1. Spanish Flu

During the 20th century, more precisely in 1918, during World War I, the Spanish Flu pandemic infected an estimated 500 million people worldwide – about one-third of the planet's population – and killed an estimated 20 million to 50 million victims, in which 675 thousand Americans.[46] Spain was one of only a few major European countries to remain neutral during World War I. Unlike in the Allied and Central Powers nations, where wartime censors suppressed news of the flu to avoid affecting morale, the Spanish media was free to report on it in gory detail. News of the sickness first made headlines in Madrid in late-May 1918, and coverage only increased after the Spanish King Alfonso XIII came down with a nasty case a week later. Since nations undergoing a media blackout could only read in-depth accounts from Spanish news sources, they naturally assumed that the country was the pandemic's ground zero. Meanwhile, the Spanish believed the virus had spread to them from France, so they called it the "French Flu".[47]

Symptoms of the Spanish Flu were similar to the symptoms we all watch out for during flu season. However, Spanish flu symptoms were more severe and included: a sudden, and sometimes very high, fever, dry caught, headache and body aches, sore throat, chills, runny nose, loss of appetite, and extreme tiredness.[48] The pandemic occurred in three waves, though not simultaneously, around the globe. In the Northern Hemisphere, the first wave originated in the spring of 1918. Although it remains uncertain where the virus first emerged, the earliest cases in the United States were detected in March among military personnel stationed at Camp Funston in Fort Riley, Kansas. By summer, the virus had reached parts of Russia, Africa, Asia, and New Zealand. This first wave was comparatively mild and had begun to die down in some areas, but a second, more lethal wave began about August or September 1918. During this wave, pneumonia often developed quickly, with patients usually dying just two days after experiencing the first symptoms of the flu. As social distancing measures were enforced, the second wave began to die down toward the end of November.[49]

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[45] Napolitano, S. "Naples, demolitions and urban rehabilitation". HistoryPage – Storia e Altre Storie. https://www.historypage.it/naples-demolitions-and-urban-rehabilitation/

[46] History.com Editors (2010). "Spanish Flu". A&E Television Networks. https://www.history.com/topics/world-war-i/1918-flu-pandemic

[47] Andrews, E. (2016). "Why was it called the 'Spanish Flu?'". History.com. https://www.history.com/news/why-was-it-called-the-spanish-flu

[48] Cleveland Clinic (2021). "Spanish Flu" https://my.clevelandclinic.org/health/diseases/21777-spanish-flu

[49] Zelazko, A. (2020). "How long did the Flu Pandemic of 1918 last?". Britannica. https://www.britannica.com/story/how-long-did-the-flu-pandemic-of-1918-last#:~:text=Courtesy%20of%20the%20National%20Museum,not%20simultaneously%20around%20the%20globe

An essential output regarding the social distancing measures is that relaxing them too early could cause an otherwise stabilized city to relapse. A good example of this is St. Louis; emboldened by its low death rate, the city lifted restrictions on public gatherings less than two months after the outbreak began. A rash of new cases soon followed. Of the cities that kept interventions in place, none experienced a wave of high death rates.[50] A third wave around the world began in the winter and early spring of 1919. Though not as deadly as the second wave, the third wave still claimed a large number of lives. By summer, the virus had run its course in many parts of the world, but some historians suggest that there was a fourth wave in the winter of 1920, though it was far less virulent.[51]

As mentioned before, the social distance was a strategy used to control the spread of the virus, as in previous pandemics. Still, the first official preventive measures were the obligatory notification of suspected cases and the surveillance of communities such as day schools, boarding schools, and barracks implemented in August 1918. In October 1918, local authorities in several European countries strengthened these general provisions by adding further measures, for instance, the closure of public meeting places, such as theaters, and the suspension of public meetings. In addition, long church sermons were prohibited, and Sunday instruction was to last no more than five minutes. Street cleaning and the disinfection of public spaces, such as churches, cinemas, theaters, and workshops, were considered to be cornerstones in controlling the spread of Spanish flu, in addition to banning crowds outside shops and limiting the number of passengers on public transport. However, they did not prove very effective.[52]

Among public health interventions, local health departments distributed free soap and provided clean water for the less wealthy; services for the removal of human waste, the regulation of toilets, and the inspection of milk and other food products were organized; spitting in the street was forbidden, which determined the spread of pocket spittoons, and announcements in newspapers and leaflets advertised the therapeutic virtues of water. To simplify mortuary police services, many administrations in the worst affected centers in Italy set up collection points for corpses and abolished all the rituals that accompanied death. In addition, identifying cases of illness through surveillance and voluntary and mandatory quarantine or isolation also helped to curb the spread of the Spanish flu.[53] By that time, there were no effective vaccines or antivirals available, and for this reason, social distancing was necessary.

[50] Strochlic, N., Champine, R. D. (2020). "How some cities 'flattened the curve' during the 1918 flu pandemic". National Geographic. https://www.nationalgeographic.com/history/article/how-cities-flattened-curve-1918-spanish-flu-pandemic-coronavirus

[51] Zelazko, A. (2020). "How long did the Flu Pandemic of 1918 last?". Britannica.

[52] Martini, M. et al. (2019). "The Spanish Influenza Pandemic: a lesson from history 100 years after 1918". Journal of Preventive Medicine and Hygiene. 10.15167/2421-4248/jpmh2019.60.1.1205

[53] Martini, M. et al. (2019). "The Spanish Influenza Pandemic: a lesson from history 100 years after 1918". Journal of Preventive Medicine and Hygiene. 10.15167/2421-4248/jpmh2019.60.1.1205

To summarize, figure 3 shows the main measures utilized in the past centuries to control and contain the spread of the various infectious diseases that caused the previous pandemics.

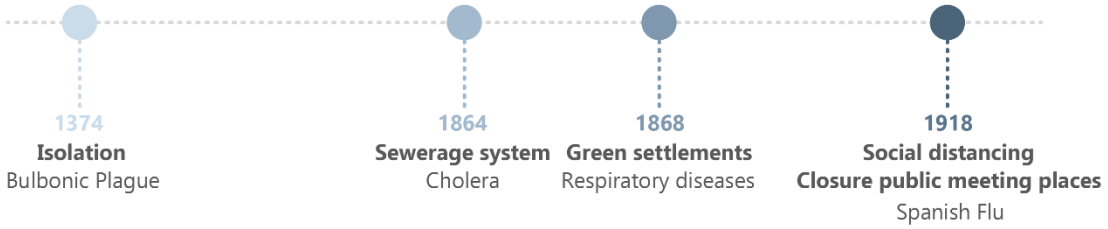


Figure 3: Timeline of measures used on to control infectious diseases.

2.3.2. Utopic urban planning

In 1850, Cerdà based his expansion proposal on an in-depth socio-statistical study of old Barcelona's population conditions. His diagnosis began by studying the population's living conditions in the social structure of old Barcelona. His proposal for urban expansion was based on improving the population's living conditions. Therefore, he planned a rational distribution of essential services to the population. Schools, markets, and hospitals were proposed in order to meet the educational, shopping, and health needs of this population. The nineteenth-century Barcelona was an industrial society and was active in trade through the port, historically connected to all other Mediterranean ports with goods and passenger traffic. The industrial revolution involved massive densification of the urban fabric in which the bourgeois society, working class, and factories were brought together in a walled medieval city. Then the quality of living conditions in the city decreased, with a high population density, high-density housing for the working class (10 square meters per person), a poor drinking-water supply, and a poor sewerage system. Furthermore, with the epidemics broke out, 3% of the population died each time.[54]

The plan proposed incorporating an additional 1,969 hectares to a medieval core of only 192 hectares by implementing a grid of streets between the Old City and the peripheral villages. The grid consisted of 1,000 blocks, 113.3 meters by 113.3 meters in length and width, with streets measuring 20 to 30 meters wide and two parallel buildings on each block, from 10 meters to 20 meters deep (building occupation: 40% of the total block), with yards and green spaces in between each block, intertwined with pedestrian paths in the middle that linked the inner open spaces together independent of the street network. Furthermore, the corners of each block were cut at

[54] Pallares-Barbera, M., Badia, A., Duch, J. (2011). "Cerdà and Barcelona: The need for a new city and service provision". Urbani Izziv.
https://www.researchgate.net/publication/263230559_Cerda_and_Barcelona_The_need_for_a_new_city_and_service_provision

45° angles, 20 meters long, to create small squares between the octagonal blocks.[55] Cerdà had created a neighborhood without class divisions where, both for ideological and public health reasons, the population would be spread out equally, and there wouldn't be exclusive areas for the rich or poor.[56] Nowadays, Barcelona is considered not a utopic planning but instead an urban success. To improve and adapt the city accordingly to its growth in the past years, in 2016, the "superblock" model was successfully implemented. This will be further discussed in the following chapters.

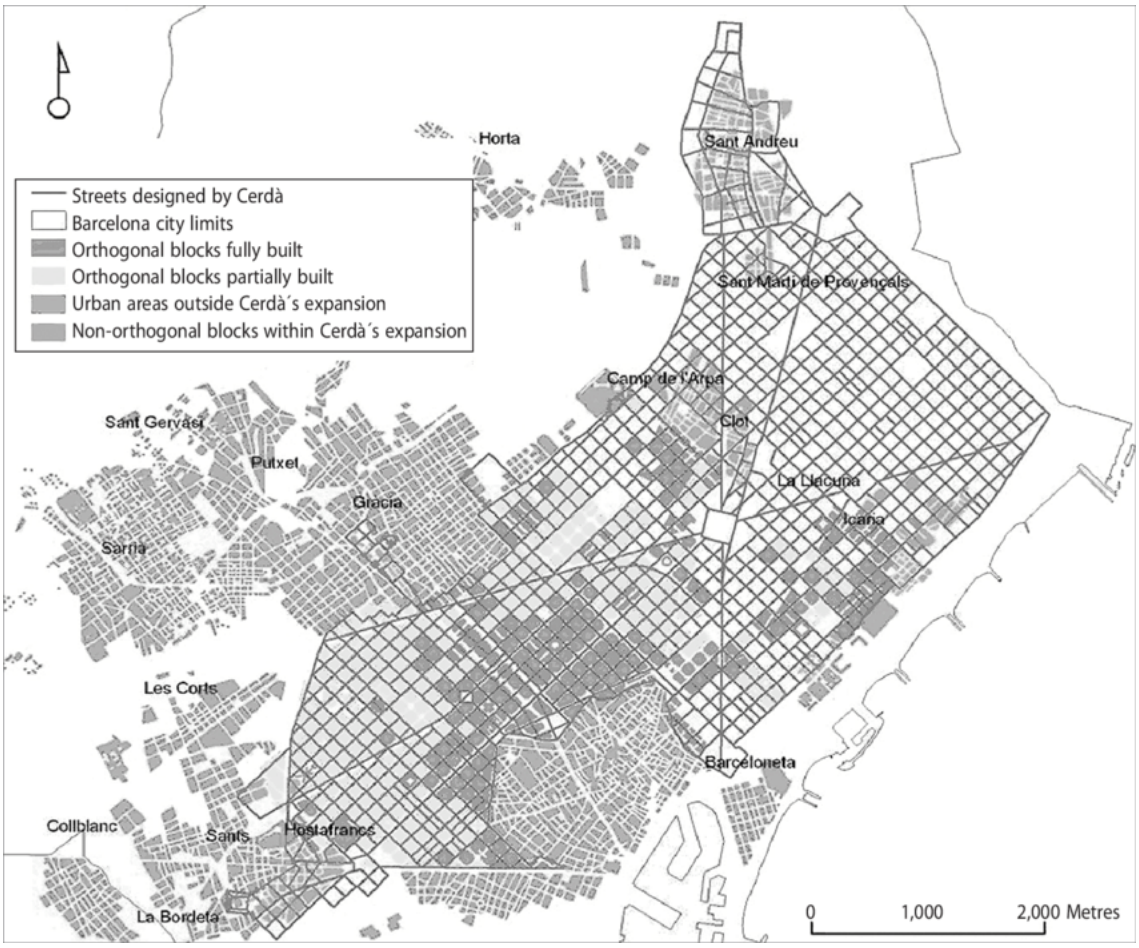


Figure 4: Barcelona's built environment in 1926.
(https://www.researchgate.net/figure/Barcelonas-built-environment-in-1926-source-National-Geographic-Institute-1926_fig4_263230559)

Conceptualized by urban planner Ebenezer Howard at the turn of the 20th century, garden cities were a response to the absence of sunlight caused by narrow streets and high houses, which were recognized as a cause of the prevalence of the disease. The overall goal for Howard is to combine the traditional countryside with the traditional

[55] Pallares-Barbera, M., Badia, A., Duch, J. (2011). "Cerdà and Barcelona: The need for a new city and service provision". Urbani Izziv.
[56] Bausells, M. (2016). "Story of cities #13: Barcelona's unloved planner invents science of 'urbanization'". The Guardian. https://www.theguardian.com/cities/2016/apr/01/story-cities-13-eixample-barcelona-ildefons-cerda-planner-urbanisation

town. A 32,000-person population cap is set, and the roads are incredibly wide, ranging from 36 to 128 meters for the Grand Avenue, and they are radial rather than linear. The whole design aims to make it as little like the overcrowded London of his day as possible, so public parks and private lawns are everywhere. Howard gives precise prescriptions for the new city, down to acreage and expenses. Six thousand acres of cheap rural land are to be purchased, 1000 of which are reserved for the city.[57] Unlike many Utopian planning schemes, Howard was actually keenly obsessed with sustainably and incrementally financing the Garden City through a system of payments to a general welfare fund after mortgages were paid off and funneling increasing land values back into community amenities, including pensions for the town's elderly. The Garden City realization could only be achieved by expanding development into previously undeveloped land. Howard was also directly influenced by Benjamin Ward Richardson's Hygeia (Richardson, 1876) — specifying low population density, suitable housing, wide roads, underground railway and open space.[58] With that said, Howard intended to make a city that was socially and physically controlled.

Howard's ideas were considerably popular, and 28 Garden Cities were produced in England. New settlements of the time, such as New Delhi in India, the Australian capital of Canberra, and the leafy suburbia of Kowloon Tong in Hong Kong, are all indebted to the garden city concept.[59] Many of Howard's ideas were translated to the United States via Raymond Unwin, a British engineer, architect, and planner. Unwin's plans for Letchworth, England, considered the first built Garden City, and England's Ministry of Health swiftly adopted Hampstead Garden Suburb as model housing.[60] His design specified a minimum distance of 20 meters between houses, or 12 houses per acre, to let miasmic airs dissipate, guard against the contagion of person-to-person contact, and guarantee a degree of sunshine and fresh air. Unwin also had to grapple with the increasing use of the automobile. Fearing pedestrian safety, he sought to reduce auto land use by cutting down the amount of road area from 40 to 17 percent and subsequently raising garden and open space land from 17 to 55 percent.[61]

[57] Nairn, D. (2007). "Ebenezer Howard's Garden City concept". Smart Cities Dive. https://www.smartcitiesdive.com/ex/sustainablecitiescollective/ebenezer-howards-garden-city-concept/9045/

[58] Carr, S. J. (2014). "The Topography of Wellness: Mechanism, metrics, and models of health in urban landscape". https://escholarship.org/uc/item/8cg2t860

[59] Wintle, T. (2020). "COVID-19 and the city: How past pandemics have shaped urban landscapes". CGTN. https://newseu.cgtn.com/news/2020-07-08/COVID-19-and-the-city-How-past-pandemics-have-shaped-urban-landscapes-QCFjZLBIxG/index.html

[60] Carr, S. J. (2014). "The Topography of Wellness: Mechanism, metrics, and models of health in urban landscape". https://escholarship.org/uc/item/8cg2t860

[61] Unwin, R. (1912). "Nothing gained by overcrowding!: How garden city type of development may benefit both owner and occupier". P. S. King & Son. https://www.hgstrust.org/documents/nothing-gained.pdf

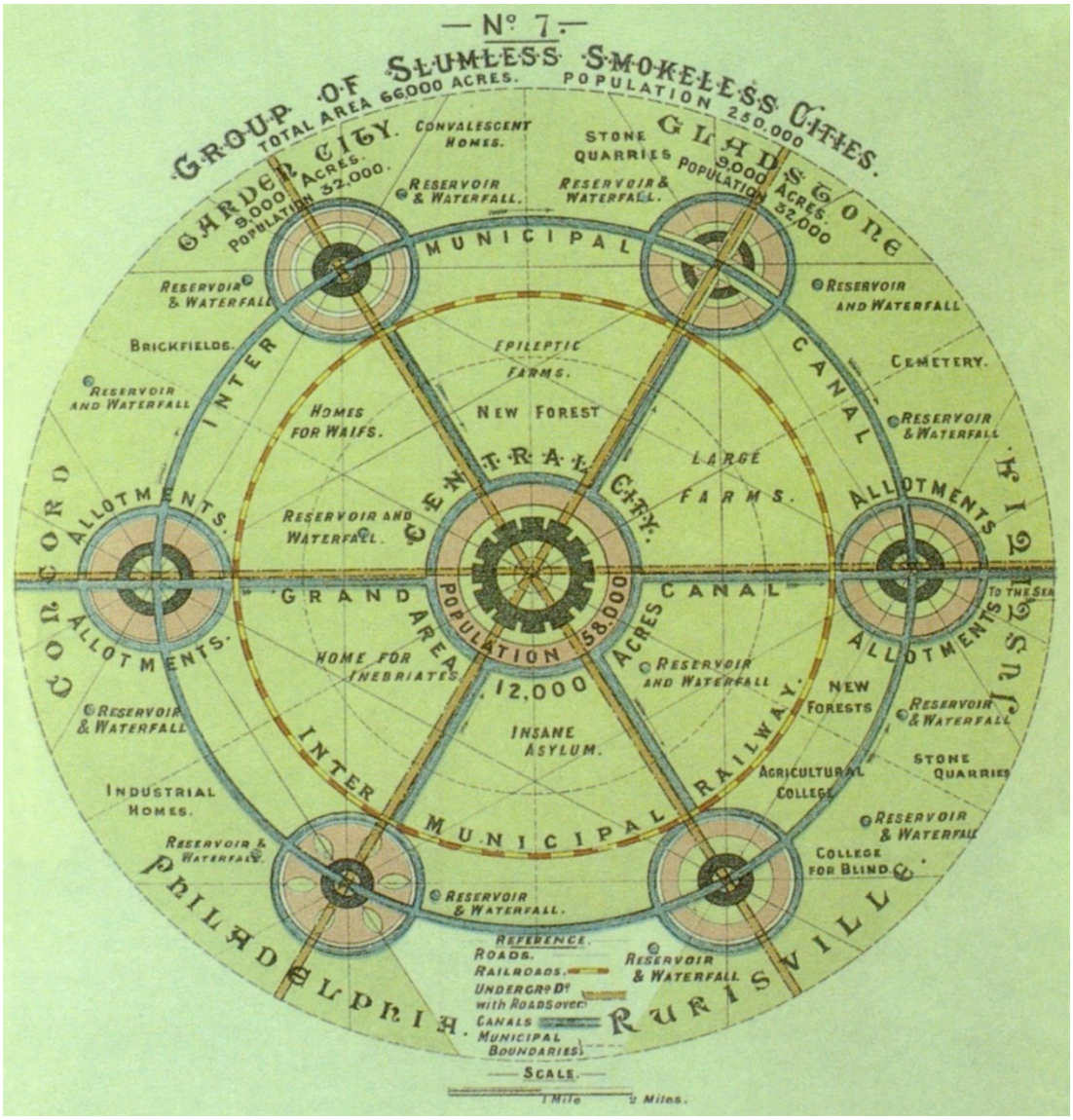


Figure 5: The Garden City Concept by Ebenezer Howard, 1902. (https://newseu.cgtn.com/news/2020-07-08/COVID-19-and-the-city-How-past-pandemics-have-shaped-urban-landscapes-QCFjZLBIxG/index.html)

Howard's and Unwin's models were translated into their most pure form in Radburn, New Jersey, planned by Clarence Stein and Henry Wright in 1928 and built by 1929. However, Stein and Wright were also influenced by the work of sociologist and planner Clarence Perry.[62] In 1929, Perry introduced the concept of the Neighborhood Unit, which he described as an area with a population between 5.000 and 6.000 people that would occupy about 65 hectares and have a shape that would render it unnecessary for any child to walk a distance of more than half mile radius to school. The unit would be served by shopping facilities, churches, a library, and a community center.[63] Like Unwin, Perry also had a great deal of distaste for the automobile. While keeping too

[62] Carr, S. J. (2014). "The Topography of Wellness: Mechanism, metrics, and models of health in urban landscape".
[63] Meenakshi (2011). "Neighborhood Unit and Its Conceptualization in the Contemporary Urban Context". Institute of Town Planners, India Journal.

much of Howard's and Unwin's tenets, particularly regarding density and a country home aesthetic, Stein and Wright chose to accommodate the automobile but would separate pedestrian pathways from vehicle roads, allowing developers to sell Radburn as "A Town for the Motor Age".[64]

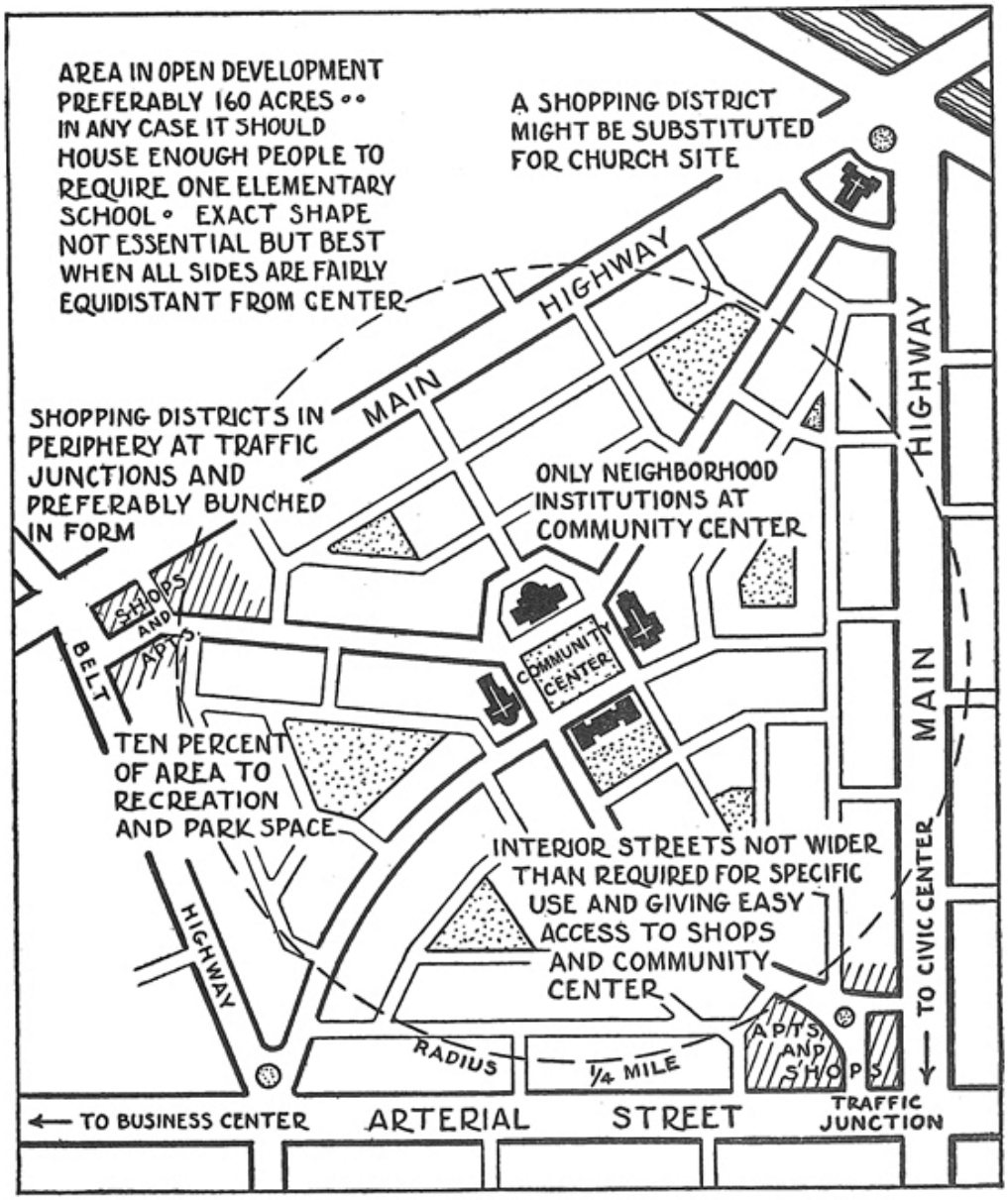


Figure 6: Clarence Perry illustrating The Neighborhood Concept.
((https://www.researchgate.net/figure/The-basic-components-of-Clarence-Perrys-Neighborhood-Unit-Perry-1929_fig7_282075470)

Meanwhile, new building technologies and materials were being explored, such as reinforced concrete and steel-frame construction, suiting the fulfillment of a more hygienic lifestyle. The Swiss-French modernist architect and radical design thinker

[64] Hall, P. (2014). "Cities of Tomorrow: An Intellectual History of Urban Planning and Design Since 1880". Wiley-Blackwell.

Charles Edouard Jeanneret, known as Le Corbusier (1887–1965), supported the idea that social deterioration was the result of a too rapid process of urbanization. In Urbanisme (1924), he expounded his radical views on town planning and house building to promote good health and sound morality.[65] *Ville Radieuse* (Radiant City) was an unbuilt urban plan by Le Corbusier designed to contain efficient means of transportation as well as an abundance of green spaces and sunlight. Le Corbusier's city of the future not only aimed to offer residents a better life but to help create a better society. Although radical, rigorous, and almost totalitarian in its order, symmetry, and standardization, the principles proposed by Le Corbusier had extensive influence on modern urban planning, leading to the development of new high-density housing typologies, such as residential buildings with more than 12 floors and skyscrapers constructed in steel, concrete and glass and residential. [66]

In accordance with modernist ideals of progress, the Radiant City would contain identical, high-density prefabricated skyscrapers distributed over vast green areas and arranged in a Cartesian grid, allowing the city to function as a "living machine." At the heart of Le Corbusier's plan was the notion of zoning: the strict division of the city into segregated commercial, business, leisure, and residential areas. The business area was located in the center and featured monolithic mega-skyscrapers, each reaching a height of 200 meters and seating between five and eight thousand people. Situated in the center of this civic district was the central transportation hub, from which a vast underground train system would transport citizens to the surrounding housing districts, which would feature prefabricated apartment buildings, known as "U*nités*". Reaching a height of fifty meters, a single *Unité* could accommodate 2,700 inhabitants and function as a vertical village. Restaurant and laundry facilities would be on the first floor, and a kindergarten and swimming pool on the roof. Between the blocks would be parks, providing residents with maximum natural light, minimum noise, and recreational facilities right outside the door.[67] It must be considered that Le Corbusier's famous model is characterized by the non-acceptance of the complexity of the historic city and by the substantially rigid application of the concept of zoning.

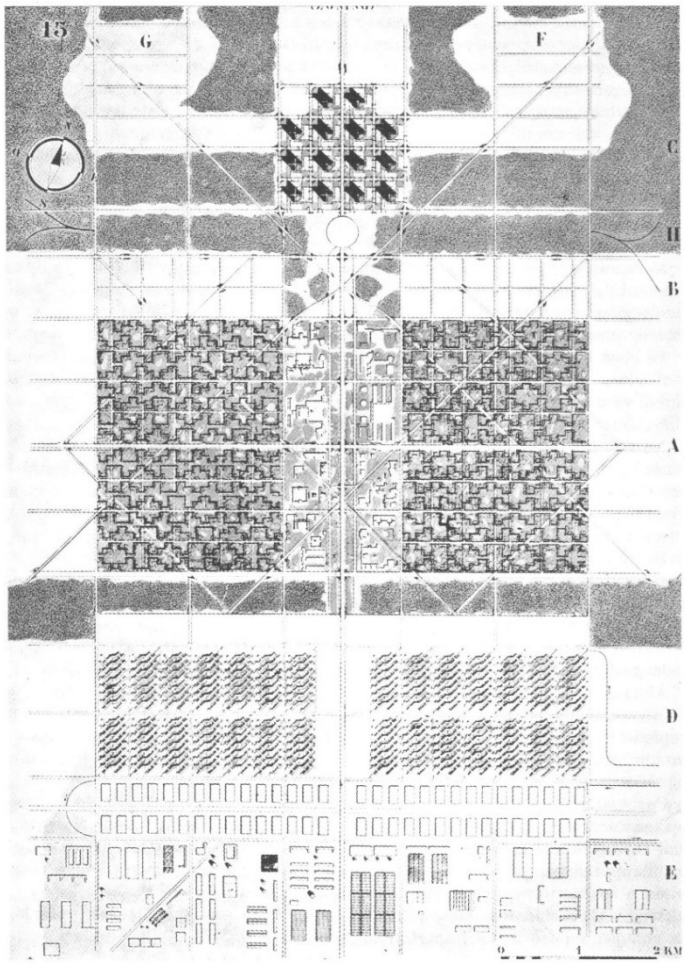
In his book City of Tomorrow (1929), Le Corbusier hypothesizes exact cubic meters of air, sunlight, and open space needed per resident and uses these measures as a formula for town planning. One specific goal for his town planning was segregating people from the street congestion and reducing the danger of pedestrian and automobile accidents, which explains his vision of having all interactions as vertical and internal to the building itself. Along with the street, Le Corbusier's ideal city further improved on the present-day city by eliminating the dank spaces of the underground. The

[65] Campbell, M. (2005). "What Tuberculosis did for Modernism: The Influence of a Curative Environment on Modernist Design and Architecture". Med Hist. 10.1017/s0025727300009169

[66] Souza, E. (2016). "Clássicos da Arquitetura: Ville Radieuse / Le Corbusier". Arch Daily. https://www.archdaily.com.br/br/787030/classicos-da-arquitetura-ville-radieuse-le-corbusier

[67] Ibid. 2016

underground is no longer occupiable; it only serves to bury piped infrastructure. Like Ebenezer Howard, who essentially planned the Garden City around the relationship of local jobs to housing needs, Le Corbusier similarly designed an entire city around the binary relationship of what he saw as basic human functioning to housing units.[68] Besides this similarity between Howard's and Le Corbusier's plans, they had quite different aspects. While Garden Cities intended to have residential houses near parks and green areas with low density, Radiant cities would house tall residential buildings spread from each other and the other cities' functions, such as work and leisure.



La planimetria della Ville Radieuse (Le Corbusier).
A, abitazioni; *B*, alberghi e ambasciate; *C*, città degli affari; *D*, industrie; *E*, industrie pesanti (fra le due i depositi generali e i docks); *F*, *G*, nuclei satelliti con caratteri speciali (per es., città degli studi, centro del governo, ecc.); *H*, stazione ferroviaria e aeroporto.

Figure 7: Le Corbusier's Radiant City Plan.
(https://www.archdaily.com.br/br/787030/classicos-da-arquitetura-ville-radieuse-le-corbusier/51fae684e8e44e82ac00000b-ad-classics-ville-radieuse-le-corbusier-image)

In Le Corbusier's Radiant City, the mere presence of green is enough to provide therapeutic benefits, and it is quantified in units with equal value, like light and air, but not articulated in terms of composition, placement, and arrangement. While air and light are parceled out to each living unit, the appropriate units of green space are

[68] Carr, S. J. (2014). "The Topography of Wellness: Mechanism, metrics, and models of health in urban landscape".

aggregated on the ground rather than distributed out to each individual, as in the Garden City plans. It is not that landscape isn't elevated to the same level of importance as light and air. There are several guidelines for its use and design in the Radiant City, and the fact that buildings and roads were designed for maximum density and efficiency left a copious amount of green on the ground floor. However, like the plans for the units themselves, the green space is anonymous and flat to encourage flexibility of use. Although the sun and fresh air could access the uppermost reaches of the building, the aggregated units of green space remain far away from the residential unit itself and actually further isolate each tower.[69]

While Le Corbusier explicitly discussed how his designs would liberate residents from the filth and disease of the city and reconnect them with nature, it is also interesting to note that his publications also coincided with the rise of tuberculosis in Europe and the United States. Tuberculosis was related to the growing industrialization and mainly affected younger men and women of working age. Before a cure for tuberculosis was found, it was thought essential to cure it and for rickets, and for general wellbeing, deliberate exposure to the sun, or heliotherapy, which was encouraged by the medical profession. It is likely that, in the garden at Pen Pits, a revolving summer house would also have been strategically placed to catch the sun's rays throughout the whole year. Le Corbusier's flat roofs, deep patios, and white floors and walls would reflect sunlight into the far reaches of their units, reflecting the medical thinking of this era.[70] On the other hand, as we know, Le Corbusier embraced high density in his city proposals, which ironically creates specific opportunities for the transmission of tuberculosis.[71]

Le Corbusier ideas are of great importance to the history of architecture and urban planning. One of his most important legacies is the 1943 publication *Le Charte d'Athènes*, written after the fourth *Congrès Internationaux d'Architecture Moderne* (CIAM IV). The publication describes his own renderings of the Congress's idea of the Functional City. Although *La Charte* was heavily criticised over Le Corbusier's year-long insistence on zoning practices and a strict spatial division of urban activities (dwelling, work, leisure, circulation), it led to compartmentalised large-scale planning as evidenced in the city-projects of Brasilia and Chandigarh.[72]

The new utopic capital city of Chandigarh was designed in the 1950th. It is divided into the monumental Capitol Complex, and 97 hectares of the city itself, as a place to live

[69] Scott, J. C. (1998). "Seeing Like a State. How certain schemes to improve the Human condition have failed". Yale University Press. https://www.jstor.org/stable/j.ctt1nq3vk

[70] Campbell, M. (2005). "What Tuberculosis did for Modernism: The Influence of a Curative Environment on Modernist Design and Architecture". Med Hist.

[71] Van Hest, N. A. et al. (2014). "Tuberculosis control in big cities and urban risk groups in the European Union: a consensus statement". Euro Surveill. 10.2807/1560-7917.es2014.19.9.20728

[72] Gkintidis, D. (2019). "The Fourth CIAM Congress of 1933 in Athens and the foundations of Western urbanism". Greek News Agenda. https://www.greeknewsagenda.gr/topics/culture-society/7026-the-fourth-ciam-congress-of-1933-in-athens-and-the-foundations-of-western-urbanism

and work. The northern zone serves the function of the civic administration, while the northern zone houses the activities of the district administration. It is connected to the Capitol Complex, the university, and the industrial area by fast traffic roads. At the heart of the City Center is a central chowk or "piazza", marking the crossing of two broad pedestrian ways in the form of a cross. Around the Hall, the Central Library, the Post and Telegraph offices, cinemas, shops, etc. A slow-traffic read encircles the chowk with large areas set aside for car parking. The Chowk is free from any vehicular traffic, ideally suited for religious and other festive congregations that are important to the Indian way of life. The chowk is connected to other spaces of the City Center by a network of pedestrian ways. The sector, which makes up the residential section, is marked by a sameness that leaves a visitor lost, without landmarks. Each sector is self-contained, providing essential services within walking distance of every dwelling.[73]

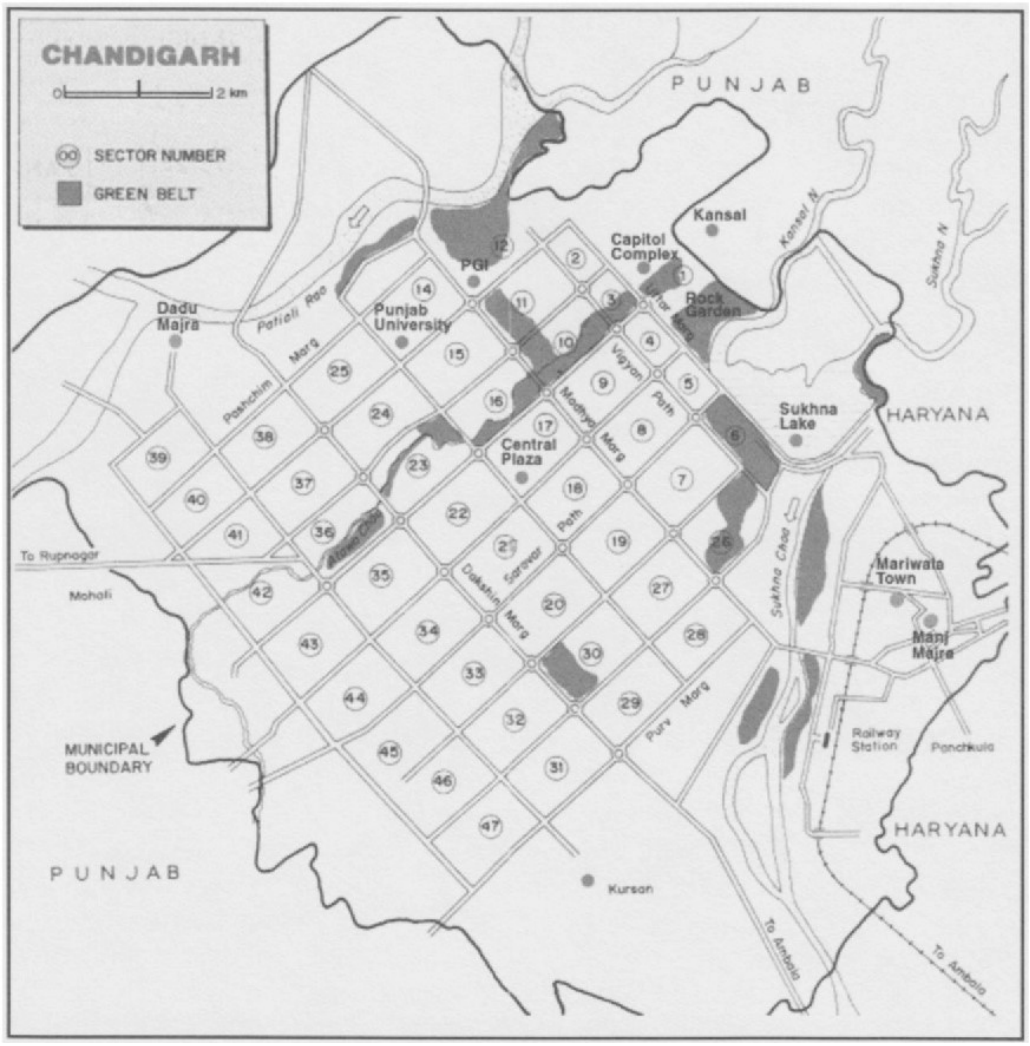


Figure 8: Map of Chandigarh.
(Fitting, P. Urban Planning/Utopian Dreaming: Le Corbusier's Chandigarh Today. Utopian Studies, Penn State University Press, 2002)

[73] Fitting, P. (2002). "Urban Planning/Utopian Dreaming: Le Corbusier's Chandigarh Today". Utopian Studies, Penn State University Press. https://www.jstor.org/stable/20718410?origin=JSTOR-pdf

The criticism of Le Corbusier and his work alternate between describing the alienating effects of high rises and planned cities and the practical consequences of some of the principles of Modern Architecture, which – in its ideal purity – have led to the construction of overly expensive, highly impractical buildings which cannot withstand the "real world of ice and snow and hail and rain and broiling sun and soot and otherwise polluted air"[74]. At the level of daily life, these critics argue that such "sacred" planning concepts as zoning and single-use neighborhoods (e.g., residential separate from workspace or business, etc.) produce buildings and living spaces which are profoundly alienating, particularly because of the absence of street life.[75] These criticisms reveal how Chandigarh's design was believed to be boring but at the same time safe and still an inspiration for urban planning.

Another most significant realization of Le Corbusier's ideas and the CIAM IV principles can be witnessed in the design of the capital of Brazil, Brasilia, built on a vast vacant lot provided by the Brazilian government. Lúcio Costa and Oscar Niemeyer designed a geometrically perfect city segregating the monumental administration zones and the identical state-owned housing districts, hoping to create a city that materialized equality and justice.[76] Brasília was designed to eliminate the street and the square as places for public life, which used to be full of people since the colonial days in Brazil. Although the plan was indeed rational, healthy, and relatively egalitarian, it made not the slightest concession to the desire, history, and practices of its residents.[77]

The constraints imposed by the physical configuration of Brasilia on the people who inhabit it cannot be denied. Brasilia has been conceived and built based on a clear-cut separation of tasks: residential facilities work best if they are distant from the workplaces.[78] The idea of a housing model based on strings of *superblocks* was dictated by a desire to create residential premises that could offer a higher-quality environment (in terms of exposure, air, light, etc.) and ensure a high degree of socialization. This intention found tangible expression in the design of collective space: totally permeable at ground level, with no barriers to the passage of people, and "vague" enough to admit multiple uses on the part of the inhabitants, its configuration guaranteed by the public ownership of the land. [79] The goal was to have spaces in the big courtyards for children to play. With no roads cutting across them, traffic is

[74] Blake, P. (1978 apud Fitting, 2002, p.74). "Form Follow Fiasco: Why modern Architecture Hasn't Worked". Little Brown & Co.

[75] Fitting, P. (2002). "Urban Planning/Utopian Dreaming: Le Corbusier's Chandigarh Today". Utopian Studies, Penn State University Press. https://www.jstor.org/stable/20718410?origin=JSTOR-pdf

[76] Souza, E. (2016). "Clássicos da Arquitetura: Ville Radieuse / Le Corbusier". ArchDaily. https://www.archdaily.com.br/br/787030/classicos-da-arquitetura-ville-radieuse-le-corbusier

[77] Scott, J. C. (1998). "Seeing Like a State. How certain schemes to improve the Human condition have failed". Yale University Press. https://www.jstor.org/stable/j.ctt1nq3vk

[78] Balducci, A. (2012). "Brasilia and its contradictions". Urbanistica, INU Edizioni Srl.

[79] Bruzzese, A. (2012). "Brasilia: changes and contradictions in residential collective space". Urbanistica, INU Edizioni Srl.

smoother, especially because the vehicle streams are separated by pedestrian paths. At the same time, the city presents a radical transformation compared to the rest of the country, and with the elimination of pedestrian jams, residents feel isolated and bored by the equals apartments blocks. From an aerial perspective the city looks beautiful and organized, but it is hard to navigate on the ground.

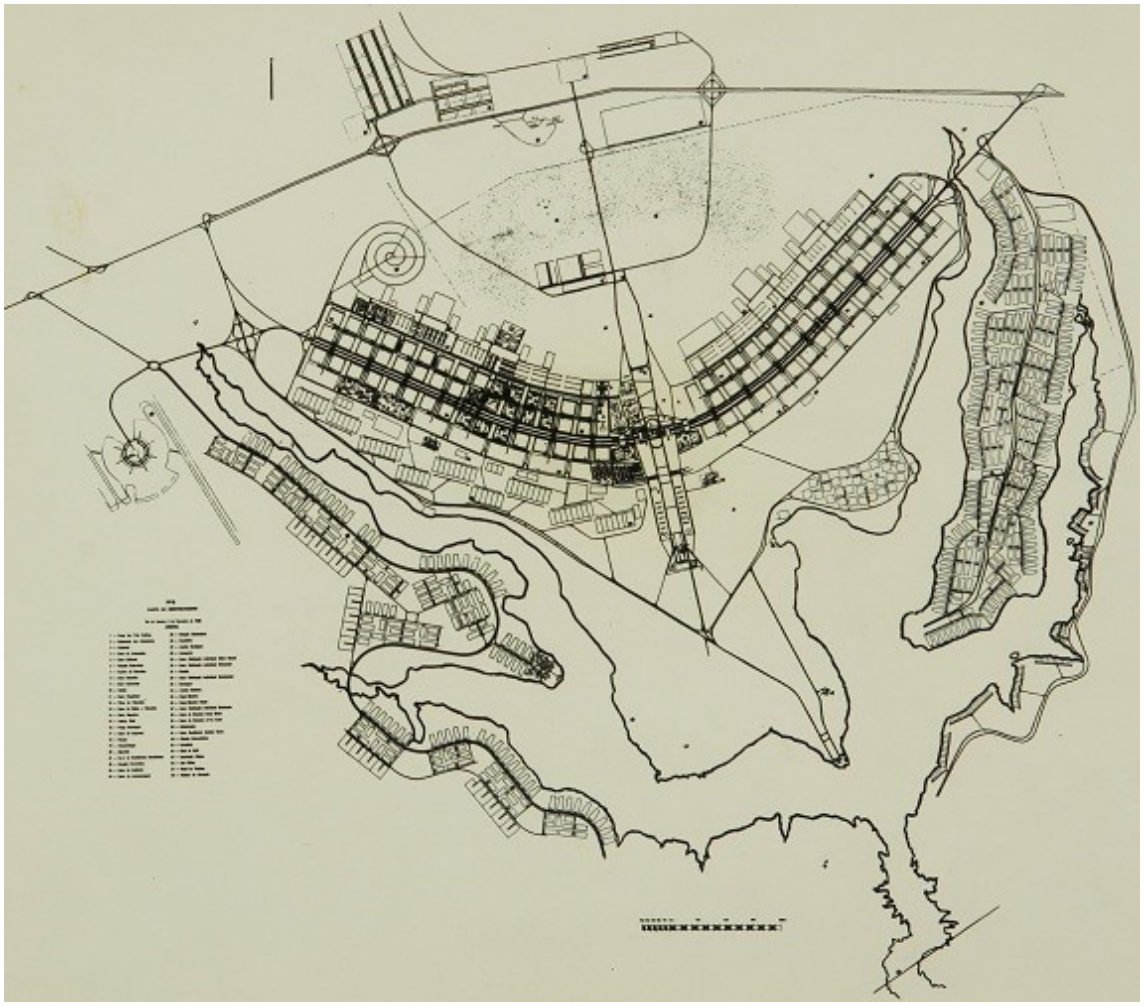


Figure 9: Plano Piloto of Brasília.
(http://www.ipatrimonio.org/wp-content/uploads/2017/04/Plano-Piloto-Imagem-Acervo-Digital-do-Iphan.jpg)

The earliest blocks to be constructed with the buildings designed by Niemeyer should have been a veritable prototype, but the superblocks that followed display many departures from the original models. The plan for a residential district reveals that the original model is denied in its essential characteristics. The number of stories of the buildings has been raised (from six to eight), and the number of commercial facilities has also increased, indicating a different interior layout of the housing units and a reduction in their overall dimensions. In this case, the most notable discrepancy is in the proportion of parking and asphalted space, which changes the nature of open space in relation to the buildings. Communal open space loses its role as a permeable to become a sequence of “filter zones” designed to maintain a safety distance between

the environment of the infrastructure and that of the household.[80] The reduction of free space characterized how the original plan was left aside, and the sense of open space has been distorted.

The Plano Piloto significantly concentrates the jobs opportunities but has houses for only 12% of the city's population, which created a territorial configuration that resulted in significant mobility constraints as the express free-ways that connect the satellite cities with the center face daily congestion problems, and the public transportation system is very inefficient and low productive. Although it is extensive and has good coverage, there are too many routes, low rates of passenger/kilometer, long travel times, and one of the most expensive fares in Brazil. Besides that, the single-family house typology dominates the landscape in most satellite cities, increasing land consumption and increasing the distances among different areas of the city.[81] This results in an even more significant number of cars in order for people to be able to move between the satellite cities and the capital, which consequently creates a worse traffic situation and environmental damage.

In 2016, the French-Colombian scientist Carlos Moreno revealed his vision for the 15-Minute City model. The model can be compared with The Neighborhood concept by Clarence Perry, as both are willing to promote movement and social interactions through a small walking distance.[82] The 15-minute city is a flexible concept that neighborhoods can adapt to their culture and circumstances based on four key characteristics: proximity, diversity, density, and ubiquity.[83] The combination of these principles offers:

- A boost to the local economy: with everything available within a short walk distance, local businesses experience higher opportunities and create a better streetscape.
- A more equitable, inclusive, and robust sense of community: the 15-minute city model creates more public spaces to socialize and support a more inclusive neighborhood.
- Lower transport emissions and better air quality: the proximity makes the usage of motorized cars unnecessary and, consequently, lowers the emission of GHG (greenhouse gases).
- Better health and wellbeing: in the 15-minute city, travels are made by walking or bicycle, which increases physical activity and reduces air pollution. The

[80] Bruzzese, A. (2012). "Brasilia: changes and contradictions in residential collective space". Urbanistica, INU Edizioni Srl.

[81] Sánches, J., Pescatori, C. (2012). "Mobility and public transportation in Brasilia". Urbanistica, INU Edizioni Srl.

[82] Antunes, M., Barroca, J., Oliveira, D. (2021). "Urban Future With a Purpose - 12 trends shaping the future of cities by 2030". Deloitte. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/deloitte-urban-future-with-a-purpose-study-set2021.pdf

[83] Luscher, D. (2021). "Introducing the 15-Minute City Project – Putting People in the center of urban transformation". 15-minute city blog. https://www.15minutecity.com/blog/hello

presence of green areas reduces the urban heat-island effects and impacts people's wellbeing and mental health.[84]

2.4. Summary

During a pandemic, busy and overcrowded urban centers are a significant opportunity for the fast spread of the disease, especially if there is no quick response to avoid this. As we saw, at least since the 14th-century, diseases can easily travel between cities and countries, and the more well-connected these places are, the more they contribute to that. A lot has changed in urban planning, especially during the 19th and 20th, when pursuing health and hygiene became a key factor for cities' development. Responding to an epidemic requires close coordination and cooperation between different levels of the city sections and different departments, which requires the instant deployment of medical sources, including the medical, social services, assistance sectors, and also urban planners. The utopic urban planning, even with its flaws, taught us a lot about how to focus on the well-being of the population: the importance of green spaces, natural lighting and ventilation, the importance of sewage and water system, and also how living in a well-planned area that provides services as schools, local health care units, commercial and leisure in a nearby distant can increase life quality. These are the innovations that still nowadays are part of our lives and had their importance even more highlighted when the COVID-19 outbreak started.

[84] C40 Cities Climate Leadership Group, C40 Knowledge Hub (2020). "Why every city can benefit from a '15-minute city' vision". C40 Knowledge Hub. https://www.c40knowledgehub.org/s/article/Why-every-city-can-benefit-from-a-15-minute-city-vision?language=en_US&gclid=CjwKCAjw9NeXBhAMEiwAbaY4lrFMPOuXSEpPcTvykLAjX5h8N6EBxhQUc9SSkkXLFeFPD1g-3PqgKRoC-3wQAvD_BwE

3. HEALTH CITY DEVELOPMENT

During the 1920s, the widespread market penetration of automobiles that was even more accelerated after World War II, urban populations began to disperse from cities in a pattern known as Urban Sprawl or suburban Sprawl, according to the model of the North American cities, which is the rapid expansion of the geographic expansion of cities and towns, is often characterized by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation.[85] For the many reasons influencing the urban sprawl, we can highlight inner-city poverty and crime and suburbs with better schools and access to green space. However, urban sprawl has been correlated with an increase in energy consumption, pollution, and traffic congestion, which negatively affect health. Besides that, the increase in the physical and environmental metropolitan areas implicates a reduction of existing natural areas and a more significant demand for resources.

In 1700, only 2 percent of the world's population lived in cities, and since 2008, more than 50 percent have been living in cities (figure 10), marking a key point of transition in human history. According to the Department of Economic and Social Affairs of the United Nations, the proportion of the population living in cities and towns is expected to rise from 54 percent in 2015 to 60 percent by 2030 and to 66 percent by 2050. [86]

Although cities only occupy 2% of the earth's land surface, 75% of all natural resources are consumed within cities.[87] With the future perspective of the increasing urban population, the demand for materials for new buildings, roads, and landscape constructions will be greater, and a higher response speed will be required. As well as the demand for technology and resources such as energy, water, and food. According to Swilling et al., in 2013, the average per capita resource consumption around the world was around 8 tons per annum, which means about 22 kg per person per day; extraction increases to about 40 kg of resources per day if that which is extracted but goes unused is included.[88] Considering that the world population has grown half a million from 2013 to 2020 and it is estimated to increase by approximately 2 million until 2050, we can assume that the demand for materials and resources will increase equally, as well as its impacts on the earths environment.

[85] Rafferty, J. P. "urban sprawl". Britannica. https://www.britannica.com/topic/urban-sprawl

[86] Department of Economic and Social Affair. "Probabilistic projection". United Nations. https://population.un.org/wpp/

[87] Swilling M., Robinson B., Marvin S., and Hodson M. (2013). "City Level Decoupling: urban resources flows and the governance od infrastructure transitions." United Nations Environment Programme (UNEP). https://wedocs.unep.org/handle/20.500.11822/8488

[88] Ibidem

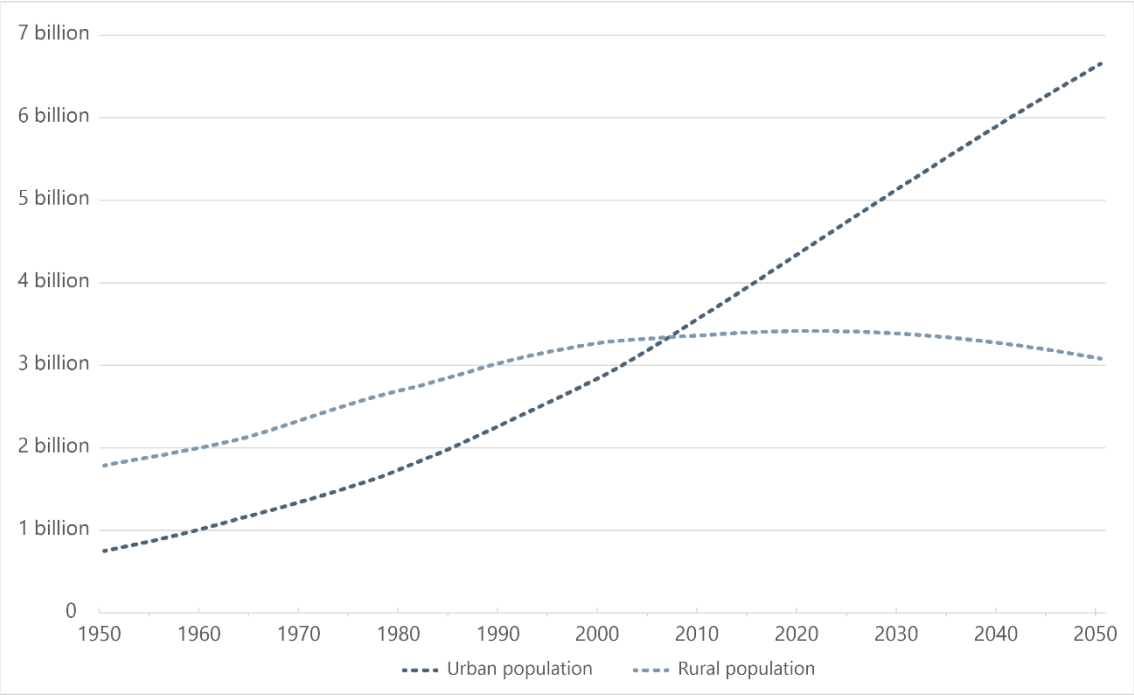


Figure 10: Number of people living in urban and rural areas, World. (https://ourworldindata.org/urbanization#:~:text=As%20of%202018%20we%20see,3.4%20billion%20in%20rural%20areas)

The dataset for total population was incomplete regarding the frequency of the data. From 2020, the prediction about future total population was obtained in increments of 5 years, i.e. 2020, 2025, 2030, and so on. Thus, to obtain data for the missing years, a linear interpolation technique was used. That is, of the total increase in-between the 5-year intervals, a fifth was added to each year (or for simplicity, a straight line was fitted with constant slope). This approach might naively suggest a constant growth during latter parts of the dataset, but does not impact the result as the originally obtained 5-year increment data was not estimated using such technique.

The average resource consumption hides significant variation in the quantities and types of resources extracted and consumed across continents and countries and between individuals within nations. This variation is also an issue when for population health. During the 1990s, the average life expectancy of the 870 million people in the European Region grew less for the first time since the Second World War, largely owing to a deterioration in health status in the newly independent states and some countries of central and eastern Europe. In almost all countries, there has been an increase in the health gap between more and less advantaged socioeconomic groups due to diseases, accidents, and mental health.[89] During the 2000s, life expectancy across Europe continued to increase, and by 2018 its average was 1.7 years more than in 2008.[90] The impact of the urbanization process implies the growth of life informal settlements, such

[89] European Health for all. (1999) "Health 21. The health for all policy framework for the WHO European Region". https://www.euro.who.int/__data/assets/pdf_file/0010/98398/wa540ga199heeng.pdf

[90] Eurostat – Statistics Explained (2020). " Being young in Europe today – health". https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Being_young_in_Europe_today_-_health

as slums, often defined as unsafe places with overcrowded homes, and leads to a higher demand for health services to guarantee the continued increase in life expectancy and health status, besides its importance when uncommon situations, such as epidemics, puts these parameters at risk.

With that said, we conclude that the urbanization process is inevitable, and it has kept growing faster over the years. The increase of the world's population implies not only the creation of new urban spaces but also the use of natural resources and the choice of appropriate systems for houses and transportation. In order to make this process less impactful to the world's natural environment at the same time as good life quality and health is provided to people, it is essential to understand the concept and parameters to be considered during the urban planning process.

3.1. Concept

The definition of a Healthy City is comprehensive and incorporates not only ideas regarding urban planning but also involves sociology, economics, philosophy, human scale and need, geography, and morphology. It can also vary from person to person, depending on their culture, values, city, and background.

In any case, a healthy city is more than the health of its population. To an economist such as Jane Jacobs, for example, a healthy city might be one that replaces imports in a positive frenzy of creativity and innovation[91], while to an urban planner, a healthy city may be one that has good physical characteristics such as housing, transportations, and green space; to a sociologist, a healthy city may be one that promotes social cohesion, while to an educator it may be one that enables people to grow and develop; for an epidemiologist a healthy city may be one with high health status, for a health care planner it may be one that has high quality, accessible hospitals, and medical services, while for WHO it may be one that promotes health for all, enabling the attainment by all citizens of a level of health that permit them to lead a socially and economically productive life. And for the person in the street, a healthy city may be one that enables them to make a living, keep a roof over their heads and food in their stomach, provide for their family, meet their friends, move around safely and, in general, to freely carry out all the functions in life.[92] Each person understands a healthy city in a different way, according to our perspectives and needs.

For this reason, according to Hugh Barton and Catherine Tsourou, the health of a city cannot be described only by a series of tables integrating automatic data printouts from a computer. The health of a city must be "lived", and its evolution must be possible through any intuitive or global measures that can complement and improve it. Data

[91] Jacobs, J. (1984). "Cities and the wealth of nations. Principles of Economic Life". New York, Random House.
[92] Duhl, L. J., Hancock, T. (1988). "Promoting Health in the Urban Context" Who Healthy Cities Project Office. https://www.euro.who.int/__data/assets/pdf_file/0013/101650/E87743.pdf

and documents generated by a computer are not effective in defining the quality of a city when not combined with the life experience of a city's inhabitants.[93]

In 1986 a movement known as Health Cities was originated by the World Health organization. The main goal was to promote a healthy approach to urban governance, environmental design, and service delivery.[94] During the development of the project, the first functional definition of a Healthy City was formulated by Hancock and Duhl:

A healthy city is one that is continually creating and improvising those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and in developing to their maximus potential. [95]

In the first phase of the WHO Healthy Cities project (1987-1992), this original definition was supplemented by the following definition:

A Healthy City is defined in terms of a process and not simply in terms of results. A Healthy City is not a city that has achieved a particular level of health status, but a city that cares about health and strives to improve it. Thus any city can claim to be a Healthy City regardless of its current health status its current health status; what is required is a commitment to health with the establishment of What is required is a commitment to health with the establishment of an organization and an approach to achieve it. [96]

The Healthy City project was developed in three distinct phases. In each phase, the WHO has designated several cities as members of its European network. These cities have to meet certain requirements and respond to the challenges of the Health for All policy. The very structure of the project offers cities the space, time, and legitimacy to experiment with the process of their transformation into a Healthy City.

The Criteria for a Healthy City are:

1. *A high quality physical environment (including housing) that is both clean and safe.*
2. *An ecosystem that is stable in the present and sustainable in the long term.*
3. *A strong, supportive community that does not exploit people.*
4. *A high degree of public participation and control over decisions affecting their lives, health and well-being.*

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[93] Barton, H., Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants". S2D-International Association for the Promotion of Health and Sustainable Development. https://www.euro.who.int/__data/assets/pdf_file/0010/102106/E93982.pdf

[94] Dannenberg, A. L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

[95] Duhl, L. J., Hancock, T. (1988). "Promoting Health in the Urban Context" Who Healthy Cities Project Office. https://www.euro.who.int/__data/assets/pdf_file/0013/101650/E87743.pdf

[96] Barton, H., Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants". S2D-International Association for the Promotion of Health and Sustainable Development. https://www.euro.who.int/__data/assets/pdf_file/0010/102106/E93982.pdf

5. *The satisfaction of basic needs (food, water, housing, sufficient income, job security) for all the city's inhabitants.*
6. *Access to a large number of experiences and resources; the possibility of a wide variety of contacts, exchanges and communication.*
7. *A diversified, vibrant and innovative urban economy.*
8. *An emphasis on the links with the past, the cultural and biological heritage of the city's inhabitants and other groups and individuals.*
9. *A configuration of the city that is compatible with and enhances the previous characteristics.*
10. *An optimum level of public health and care services, adapted and accessible to all.*
11. *A high level of health (high degree of good health and low morbidity).*[97]

3.2. Parameters of a Healthy City

As noticed, the process of building a healthy city may vary from different locations. However, it is important to identify general parameters that can define essential elements to help in its development. For this reason, in this chapter, literature in the healthy city field will be reviewed, and the parameters commonly referred to in literature will be discussed in detail.

The perceptual science of human settlements by Doxiadis

To begin, the visionary urban planner Constantinos Apostolos Doxiadis, who gained international prominence as one of the architects of Greece's postwar reconstruction, developed a science of human settlements. Know as Ekistics, a term derived from the Greek word for house, this science was developed because of his preoccupation with urban sprawl, generated everywhere by population growth.[98] It considers the principles man uses when building his settlements, as well as the evolution of human settlements through history in terms of size and quality. The target is to build a city of optimum size, that is, a city that respects human dimensions. Since there is no point in resisting development, we should try to accommodate technological evolution and the needs of man within the same settlement.[99]

With that said, Doxiadis individuate five different principles. The first is the maximization of man's potential contact with the elements of nature, with other people, and with the works of man, such as buildings and roads. This, after all, amounts to an operational definition of personal human freedom. The second principle is the

[97] Barton, H., Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants". S2D-International Association for the Promotion of Health and Sustainable Development. https://www.euro.who.int/__data/assets/pdf_file/0010/102106/E93982.pdf

[98] Saxon, W.(1975). "Constatinos Doxiadis City Planner, Is Dead at 62". The New York Times. https://www.nytimes.com/1975/06/29/archives/constantinos-doxiadis-city-planner-is-dead-at-62.html

[99] Doxiadis, C. A. (1970). "Ekistics, the science of human settlements". Science. https://www.doxiadis.org/Downloads/ecistics_the_science_of_human_settlements.pdf

minimization of the effort required to achieve man's actual and potential contacts. Doxiadis always gives his structures the shape, or selects the route, that requires the minimum effort, no matter whether he is dealing with the floor of a room, which he tends to make horizontal, or with the creation of a highway.

The third principle is the optimization of man's protective space, which means the selection of such a distance from other persons, animals, or objects that he can keep his contact with them (first principle) without any kind of sensory or psychological discomfort. This must be true at every moment and in every locality, whether it is temporary or permanent and whether man is alone or part of a group. The fourth principle is the optimization of the quality of man's relationship with his environment, which consists of nature, society, shells (buildings and houses of all sorts), and networks (ranging from roads to telecommunications), as can be noticed in figure 11. This is the principle that leads to order, physiological and aesthetic, and that influences architecture.

Finally, the fifth principle consists of man organizing his settlements in an attempt to achieve an optimum synthesis of the other four principles, and this optimization is dependent on time and space, on actual conditions, and on man's ability to create a synthesis. A "successful human settlement" means that the settlement has achieved a balance between man and his man-made environment by complying with all five principles.

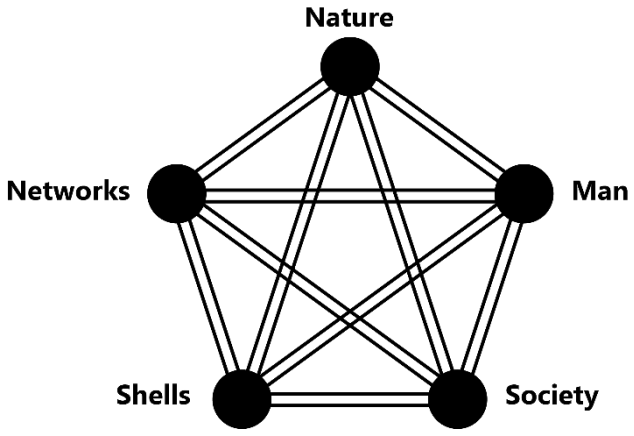

Figure 11: Ekistics forth principle: optimization of the quality of man’s relationship with his environment.
(Doxiadis, C. A. Ekistics, the science of human settlements. Science, 1970)

Kevin Lynch and the theory of good city form

Further on, the noted urban designer and theorist Kevin Lynch wrote on 1981 ‘A the theory of good city form”. In his book, he claims that an environment is a good habitat if it supports the health and biological well-functioning of the individual and the species’ survival. Even though health is challenging to define, he describes three

different aspects of health that are relatively clear, three principal features of the environment which are conducive to health, good biological function, and survival in this sense, that is, which make it a vital place, an adequate life ground:

1. *Sustenance*: Which means that should be an adequate supply of food, energy, water, and air, and proper disposal of wastes according to the location of the settlements and density. Soil and vegetation are conserved and are adapted to produce the required supplies. Croplands, greenhouses, soil conservation, managed forests, sewer systems, wells, coal mines, stream control, interior ventilation, food markets, aqueducts, latrines, and site dispositions are some spatial devices used to achieve this.
2. *Safety*: A good settlement is one in which hazards, poisons, and diseases are absent or controlled, and the fear of encountering them is low. It is a physically secure environment. The attainment of safety involves problems of air and water pollution, the contamination of food, the presence of poison, the suppression of disease and disease vectors, the reduction of bodily accidents, defenses against violent attacks, the prevention of flood and fire, the resistance to earthquake, and the treatment available to someone who has been exposed to any of those hazards.
3. *Consonance*: The spatial environment should be consonant with the basic biological structure of the human being. It should support natural rhythms: sleeping and walking, alertness, and inattention. It should provide an optimum sensory input: neither overloading a person nor depriving her of adequate stimulus. Elements in the environment, such as steps, doors, rooms, and inclines, should all be fitted to human size and powers, such as height, reach, jointing, handedness, forward vision, and lifting capacity. These are the base data of ergonometric or human factors engineering. The setting should encourage the active use of the body so that no parts of the body degenerate for lack of exercise.

In his view, the definition of the health city, or in this case 'the good city':

The fundamental good is the continuous development of the individual or the small group and their culture… a settlement is good which enhances the continuity of a culture and the survival of its people, increases the sense of connection in time and space, and permits or spurs individual growth: development, within continuity, via openness and connection" [100]

Then he discusses five fundamental dimensions of a good city form that complement the health aspects:

1. *Vitality*: the degree to which the form of the settlement supports the vital functions, biological requirements, and capabilities of human beings – above all,

[100] Lynch, K. (1981). "A theory of good city form." The Massachusetts Institute of Technology.

how is an anthropocentric criterion, although we may someday consider how the environment supports the life of other species, even where that does not contribute to our own survival.

2. *Sense*: the degree to which the settlement can be clearly perceived and mentally differentiated and structured in time and space by its residents and the degree to which the mental structure connects with their values and concepts – the match between environment, our sensory and cognitive capabilities, and our cultural constructs
3. *Fit*: the degree to which the form and capacity of spaces, channels, and equipment in a settlement match the pattern and quantity of actions that people customarily engage in or want to engage in – that is, the adequacy of the behavior settings, including their adaptability to future action.
4. *Access*: the ability to reach in quantity and diversity other persons, activities, resources, services, information, or places.
5. *Control*: the degree to which the use and access to spaces and activities, and their creation, repair, modification, and management are controlled by those who use, work, or reside in them.

To these five dimensions, he added two other meta-criteria, which are always included in any list of good things. The first is *Efficiency*, which consists of alternative costs of creating and maintaining the settlement. The second is *Justice*, defined by how environmental benefits and costs are distributed among persons considering equity, need, and intrinsic worth principles. With that said, *Justice* is the criterion that balances the gains among persons, while *Efficiency* balances the gains among different values.

The concepts of health and sustainable development

In 1992, from 3-14 June, The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil. This global conference, held on the occasion of the 20th anniversary of the first Human Environment Conference in Stockholm, Sweden, in 1972, brought together political leaders, diplomats, scientists, representatives of the media, and non-governmental organizations (NGOs) from 179 countries for a massive effort to focus on the impact of human socio-economic activities on the environment.[101]

The Earth Summit brought the idea of sustainable development to the forefront of international policy and action and subsequently to the national and local levels. Above all, sustainable development is concerned with the human habitat and ensures that the environment is protected and cared for both for the environment itself and for human survival, since the health and well-being of present and future populations depend on this environment. The fundamental principles of sustainable development are therefore

[101] United Nations. "United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3-14 June 1992". https://www.un.org/en/conferences/environment/rio1992

quality of life, solidarity between generations, and social justice. The actions that grapple with the Agenda 21 address areas that influence the following factors: economic, environmental, social, political, cultural, ethical, and those related to health must be integrated into each of these.[102]

In the following years, HEALTH 21 was created. It has the constant goal to achieve full health potential for all. To achieve this goal, two main strategies for better health are individuated: the first is to promote and protect people's health throughout the course of their lives, and the second is to reduce the incidence of and suffering from the primary diseases and injuries. Three values are added to form the ethical foundation:

1. Healthy is a fundamental human right;
2. Equity in health and solidarity in action between countries, between groups of people within countries, and between genders; and
3. participation by and accountability of individuals, groups and communities, institutions, organizations, and sectors in health development.[103]

The HEALTH 21 program of the WHO European Region, which originated in the health sector, is therefore based on a human health perspective. It views sustainable development as a mechanism for improving human health, well-being, and quality of life. Environmental, economic, and social concerns are born from this "humanistic" agenda. The Agenda 21 originated from a concern about the mutual relationship between development and the environment, each of which can affect the other in positive or negative ways. Human health is a major concern. For the HEALTH 21 program, the most crucial difference between the concept of health and sustainable development is a question of representation. Many people misperceive sustainable development as only dealing with environmental issues and their global implications.[104]

Policy Rainbow model

In 1991, Dahlgren and Whitehead presented their model of health determinants, also known as Policy Rainbow. The model is a systematic framework for showing the relationship between approaches to health and total, whole-of-life development, including the spiritual dimension. It has been helpful in providing a framework for raising questions about the size of the contribution of each of the layers to health, the feasibility of changing specific factors, and the complementary action that would be required to influence linked factors in other layers. This framework has helped researchers to construct a range of hypotheses about the determinants of health, to

[102] Barton, H., Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants". S2D-International Association for the Promotion of Health and Sustainable Development. https://www.euro.who.int/__data/assets/pdf_file/0010/102106/E93982.pdf

[103] European Health for all. (1999) "Health 21. The health for all policy framework for the WHO European Region". https://www.euro.who.int/__data/assets/pdf_file/0010/98398/wa540ga199heeng.pdf

[104] Barton op. Cit.

explore the relative influence of these determinants on different health outcomes, and the interactions between the various determinants.[105]

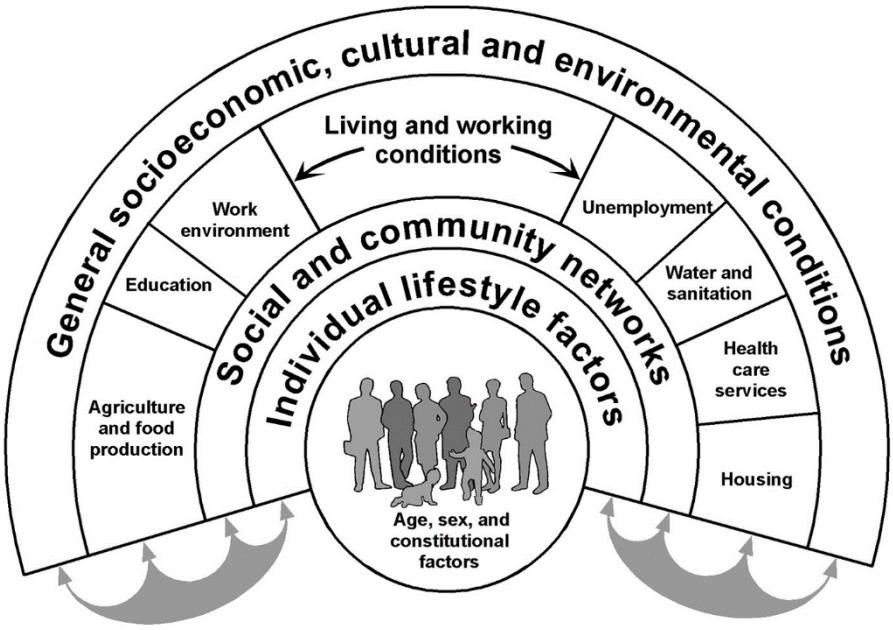

Figure 12: Determinants of Heath model.
(Dahlgreen, G., Whitehead, M. European strategies for tackling social inequities in health: Levelling up Part 2. World Health Organization, 2006)

In the center of the determinants of health rainbow, individuals have age, sex, and constitutional factors that influence their health. Surrounding them, we see that personal behavior, such as smoking and physical activity habits, as well as individuals' interactions with their peers and immediate community, influence health. After this, on the third layer, it is noticed that a person's ability to maintain their health is influenced by their living and working conditions, food supply, and access to essential goods and services. And last, as mediators of population health, economic, cultural, and environmental influences prevail in the overall society. This model for describing health determinants emphasizes interactions: individual lifestyles are embedded in social norms and networks and in living and working conditions, which in turn are related to the broader socioeconomic and cultural environment.[106]

According to Dahlgren and Whitehead, the determinants can be influenced by positive health factors, protective factors, or risk factors related to the individual, commercial and political decisions:

1. *"Positive health factors. These contribute to the maintenance of health. Fundamental positive health factors are, for example, economic security,*

[105] 2007. "Collective and individual responsabilites for health, both physical and mental". Health Knowledge.
[106] Dahlgreen, G., Whitehead, M. (2006) "European strategies for tackling social inequities in health: Levelling up Part 2." World Health Organization. https://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf

adequate housing and food security. Control over life outcomes and enjoying good relationships in the home and other emotionally rewarding social relationships are also important positive health factors.

2. *Protective factors. These are factors that eliminate the risk of, or facilitate resistance to, disease. The classical example is immunization against a variety of infectious diseases. Psychosocial factors, such as social support and a sense of purpose and direction in life, are also increasingly recognized as factors that protect health. Healthy diets, such as the Mediterranean diet with a high consumption of fruit and olive oil, is also considered to be protective.*
3. *Risk factors or risk conditions. These cause health problems and diseases that are potentially preventable. These risk factors or risk conditions can be social or economic or can be associated with specific environmental- or lifestyle-related health hazards, such as polluted air and smoking*."[107]

3.3. Guideline

Besides the parameters already presented, this thesis also explores additional parameters related to healthy urban planning: pollution, urban mobility, public spaces, sustainability, and the importance of community involvement in the process. The choice of these parameters is due to the fact that they are frequently mentioned in the bibliography on health urban planning. In the following chapters, these topics will be discussed in detail, wherein the majority of the information was obtained from manuals developed by the World Health Associations (WHO) and the United Nations (UN). Further analyses have been produced by examining real projects that implemented the corresponding parameters.

3.3.1. Pollution (air, water, sanitation)

As mentioned before (chapter 1.1), the cholera outbreaks ended in London thanks to the construction of a new sewage system. This is just one example of diseases caused by the lack of a proper sanitation system, which consists of the disposal of human wastes. Sanitation reduces or prevents human fecal pollution of the environment, thereby reducing or eliminating the transmission of diseases from that source. Effective sanitation isolates excreta and inactivates the pathogens within feces.[108] It also supports personal and domestic hygiene, saves time, and ensures access to sufficient quantities of water for consumption. In 2020, the proportion of the global population that has access to sanitation was 74 percent, of which 54 percent is a system safely

[107] Dahlgreen, G., Whitehead, M. (2006). "European strategies for tackling social inequities in health: Levelling up Part 2". World Health Organization. https://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf

[108] Prüss-Üstün A., Bos R., Gore F., Bartram J. (2008). "Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health". World Health Organization. https://apps.who.int/iris/handle/10665/43840

managed.[109] It is crucial to increase this number not only because of physical diseases but also because of the mental impact a lack of proper access to this infrastructure can cause.

According to Wutich and Ragsdale, in a data collection in a squatter settlement in Cochabamba, a Bolivian city of more than 600.000 people, they examined the extent to which water-related emotional distress is linked with three dimensions of water insecurity: inadequate water supply; insufficient access to water distribution systems; and dependence on seasonal water sources, and with gender. These results suggest that water-related emotional distress develops as a byproduct of the social and economic negotiations people employ to gain access to water distribution systems in the absence of clear procedures or established water rights rather than as a result of water scarcity per se.[110]

Water, sanitation, and hygiene interventions interact with one another, and available evidence indicates that the impact of each may vary widely according to local circumstances. Some health impacts are minor at a global level but may reach high local or national importance; assisting national-level analysis is, therefore, an essential next step. As a consequence, the interventions in this field should be prioritized based on local conditions.[111]

Building sewer systems eliminates the need for extensive land parcels for onsite wastewater treatment systems (OWTs), and building density can be much higher than is possible in communities using OWTs. However, once the sewer system exists, failure to invest in its maintenance and upgrades can also lead to high future costs, including fines for failure to maintain local water quality and the need to redirect limited resources toward emergency repairs.[112] With that said, high-tech solutions are not always necessary, but it is important to take care of the system chosen, keeping it in good condition and working with maximum efficiency.

Besides the pollution caused by the lack of sewer systems, we also need to pay attention to air pollution, which is by definition the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities, and forest fires are common sources of air pollution.

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[109] World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) (2021). "Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs." https://www.who.int/publications/i/item/9789240030848

[110] Wutich A., Ragsdale K. (2008). "Water insecurity and emotional distress: Coping with supply, access, and seasonal variability of water in a Bolivian squatter settlement". 10.1016/j.socscimed.2008.09.042

[111] Prüss-Üstün A., Bos R., Gore F., Bartram J. (2008). "Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health". World Health Organization. https://apps.who.int/iris/handle/10665/43840

[112] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide.[113]

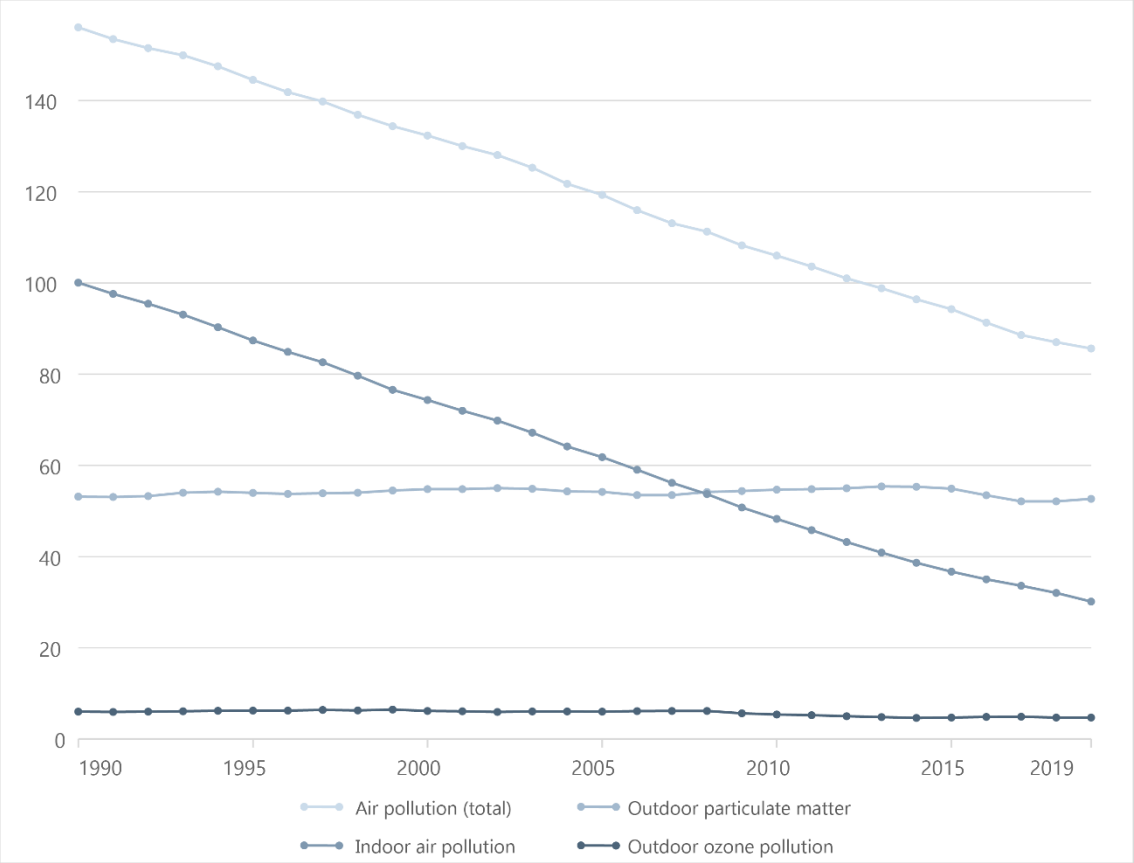

Figure 13: Deaths rates from air pollution, World, 1990 to 2019.
(https://ourworldindata.org/grapher/death-rate-by-source-from-air-pollution)

Outdoor and indoor air pollution cause respiratory and other diseases and is an important source of morbidity and mortality. Based on the data provided by the Institute for Health Metrics and Evaluation (IHME), we can analyze the deaths caused by air pollution. In the graphic (figure 10), the death rates are given as the number of attributed deaths from pollution per 100.000 population. These rates are age-standardized, meaning they assume a constant population age structure: this allows for comparison between countries and over time.[114] From 1990 to 2019, the death rates from air pollution dropped from 156.05 to 85.62 per 100.000 habitats, which means that by 2019 an estimated seven million people worldwide have died because of air pollution.[115] WHO data shows that almost all the global population (99%) breathe air that exceeds WHO guideline limits containing high levels of pollutants, with low- and

[113] World Health Organization (WHO). "Air pollution". https://www.who.int/health-topics/air-pollution#tab=tab_1
[114] Ritchie, Hannah; Roser, Max. (2021) "Air Pollution". Our World in data. https://ourworldindata.org/air-pollution
[115] Institute for Health Metrics and Evaluation (IHME), 2021. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. https://www.healthdata.org/gbd/2019

middle-income countries suffering from the highest exposures.[116] This influence directly on population health and death rates.

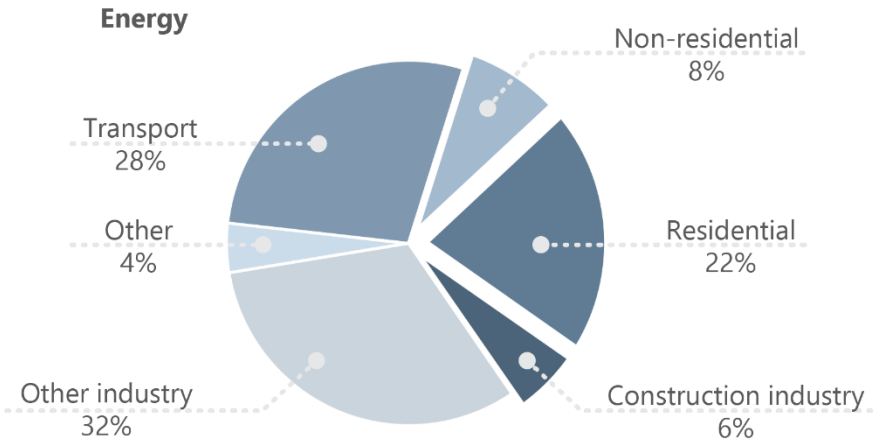

Figure 14: Global share of buildings and construction final energy, 2018.
(Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme. 2019 Global Status Report for Buildings and construction: Towards a zero-emissions, efficient and resilient buildings and construction sector, 2019.)

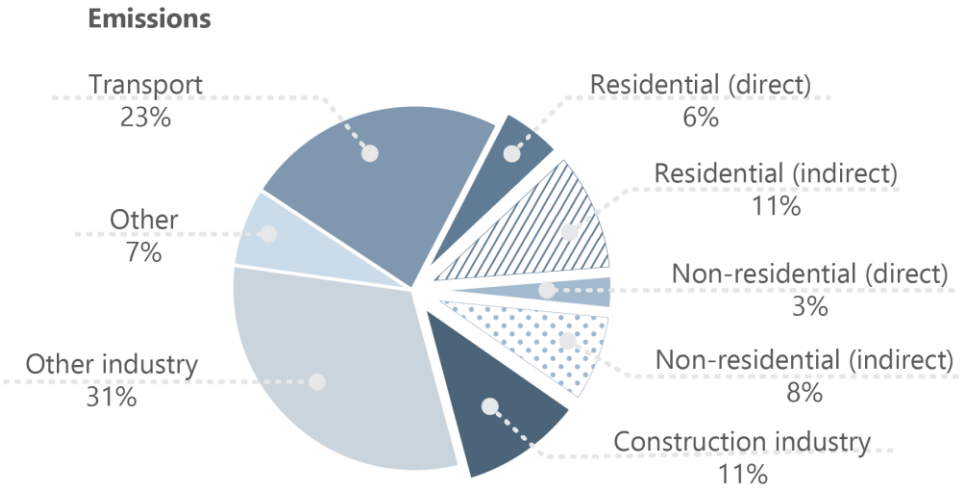

Figure 15: Global share of buildings and construction final emissions, 2018.
(Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme, 2019)

One of the biggest challenges regarding air pollution has been the emission of greenhouse gases (GHG), which causes not only climate changes by trapping the heat, but also air pollution and, as a consequence, respiratory diseases. The primary GHG is

[116] World Health Organization (WHO). "Air pollution".

Carbon dioxide (CO_2), which is responsible for about three-quarters of emissions,[117] and the buildings and construction sector have a significant influence in these emissions. In 2018, buildings accounted for the largest share of both global final energy use, with 36%, and energy-related CO2 emissions, with a total of 39%, as shown the figures 13 and 14.

The 2019 Global Status report for buildings and construction highlights that the population size, floor area, and the demand for energy-intensive services, such as cooling equipment, how buildings are constructed and used, and climate variations are the main contributors to the global building energy use. Those factors are divided into three different categories in the graphic (figure 15). Activity includes population, climate, and use of the buildings. Structures include floor area, occupancy, and service demand. Efficiency includes components that have helped to offset the energy demand growth, such as cooking equipment. With the perspective of the world population increase by 2.5 billion by 2050 and the building sector currently impact in mind, several key policies, investments, and design actions will have an important effect on building energy and emission.[118]

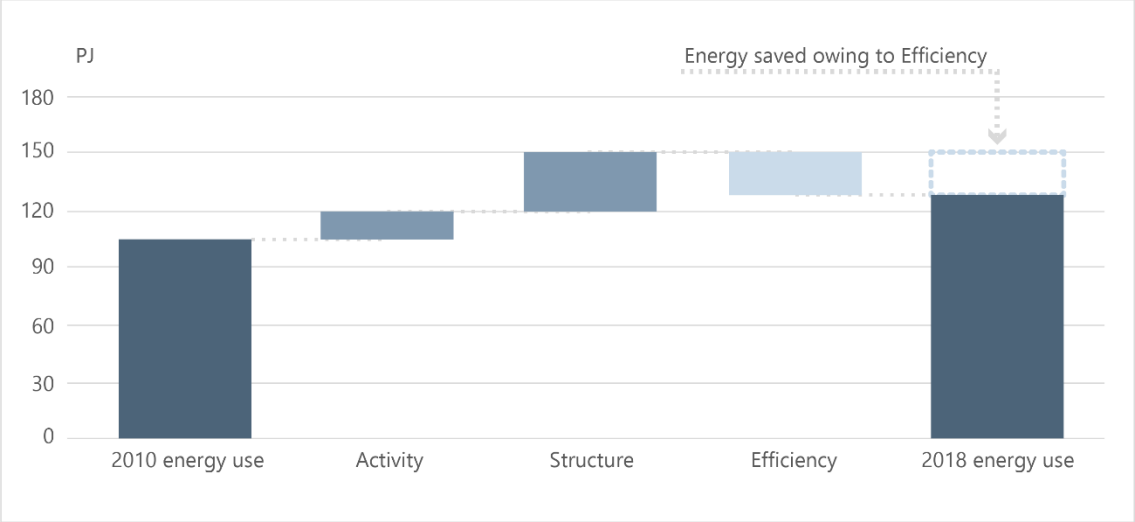

Figure 16: Factors influencing building energy use, 2010-18.
(Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme, 2019)

The report suggests a series of recommendations in order to achieve a highly energy-efficient and low-carbon buildings and construction sector, which is essential to realize global ambitions to limit the rise in average global temperature to less than 2°C above preindustrial levels by 2030. Regarding urban planning, it is suggested that policies

[117] Nunez, C. (2019). "Carbon dioxide levels are at a record high. Here's what you need to know" National Geographic. https://www.nationalgeographic.com/environment/article/greenhouse-gases

[118] Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme (2019) "2019 Global Status Report for Buildings and construction: Towards a zero-emissions, efficient and resilient buildings and construction sector". https://www.readkong.com/page/2019-global-status-report-for-buildings-and-constructi-on-6718378

should be used to reduce energy demand, increase renewable energy capacity and improve infrastructure resilience. Globally, local jurisdictions have significant control over how energy is used, and the emissions created by transportation, building construction, and lifetime building operations can be regulated through urban planning. Urban planning can also help combat climate risks by ensuring building resilience. Key actions in the area of urban planning include:

- Enacting urban planning policies that account for the long-term goal of decarbonizing the buildings and construction sector;
- District energy planning, i.e., enabling a systemic approach that can integrate energy demand and supply at the district level to deliver more efficient low-carbon solutions.

Regarding the use of materials, taking a lifecycle approach can reduce their environmental impact. Key actions to increase the sustainability of building materials and products include:

- Encouraging people to purchase low-energy and low-emissions products and materials by implementing policies that promote better purchasing decisions based on embodied carbon and energy;
- Reducing demolition by implementing policies to help people make better decisions based on the impact of building demolition versus reuse;
- Recycling construction materials. Support the development of material recycling processes for products and materials that can reduce lifecycle embodied energy and emissions;
- Introducing information and awareness campaigns to disseminate information on low-carbon materials and technologies (e.g., wood and earth constructions, innovative concrete) among professionals involved in building design and construction;
- Leading by example by developing policies that ensure all government buildings invest in low emissions and efficient materials based on lifecycle analyses;
- Developing a circular economy by embracing a cradle-to-grave or cradle-to-cradle lifecycle approach in the buildings sector to promote systemic, material-neutral, performance-based methods and business models.

3.3.2. Urban Mobility and Space

The *World Health Report 2002* paid considerable attention to the potential of physical activity to reduce the burden of various diseases such as heart disease, diabetes, and cancer.[119] Recent studies show that regular physical exercise for at least 30 minutes during the days of the week greatly reduces the risk of cardiovascular disease and

[119] World Health Organization. Office of World Health Reporting. (2002) "The World health report: 2002: reducing risks, promoting healthy life: overview". https://apps.who.int/iris/handle/10665/67454

improves immunity.[120] Physical activity has traditionally been divided into utilitarian and recreational categories. Functional physical activity, such as laying bricks or walking to school each day, has a primary purpose (such as earning a living or getting to school) other than the activity itself. Recreational physical activity, such as playing basketball or taking a walk around the block, is performed for its own sake, enjoyment, or getting in shape. The distinction is important in the context of the built environment since design strategies that promote each of these two kinds of physical activity may differ.[121]

Physical Activity

According to Frank et al., community design is significantly associated with moderate levels of physical activity. Seeking to understand this connection, the population was recruited to participate and have their data collected. The results indicate that when people have many destinations near their homes and can get there in a direct pathway, they are more likely to engage in moderate physical activity for ≥30 minutes on a random day. Modest changes in the walkability of a neighborhood can translate into meaningful, health-enhancing population-level increases in activity. Only 18% of those living in communities with the lowest level of walkability recorded ≥30 minutes of walking on at least one day, compared with 28.1% in the second, 32.3% in the third, and 37.5% in the top quartile of walkability.

This result suggests that designing neighborhoods for pedestrian use could help many people meet the guidelines, although a confounding effect of neighborhood selection cannot be ruled out. In contrast to physical activity promotion programs for individuals that typically have short-term effects, building walkable neighborhoods could be expected to have relatively permanent effects. [122] It also suggests that city planners and public health professionals need to work closely together to advocate for policies that will make all neighborhoods as "activity friendly" as possible.

Communities can encourage pedestrians by installing wide, well-maintained sidewalks, providing adequate lighting and street furniture, and providing public safety. As with bicycle infrastructure, contiguous sidewalks that allow pedestrians to reach their destination are essential.[123] In Carver, Timperio, and Crawford's study, the local environment and physical activity associations were examined. The obtained results show that the presence of road environmental measures related to safety in children's neighborhoods are associated with increased habitual walking/cycling among girls, and increased moderate-to-vigorous physical activity (MVPA) among boys. This highlights the importance of informing efforts to create "child-friendly" neighborhoods

[120] Moreno-Collazos, J. M., Orti, E. S. (2018)." The effect of physical exercise on neurogenesis factor production in glial cells". Current Pharmaceutical Design. 10.2174/1381612823666170828134515

[121] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

[122] Frank, L.D., Schmid, T.L., Sallis, J.F., Chapman, J., Saelens, B.E. (2005) "Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ." 10.1016/j.amepre.2004.11.001

[123] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

and guide environmental interventions aimed at increasing physical activity by improving the safety of local streets.[124] In general, a place with sidewalks and safe street crossing, attractive surroundings, a feeling of safety, numerous pedestrians, and multiple desirable destinations nearby is more walkable than a place missing one or several of those elements.

Safety on local roads

To improve safety on local roads, Traffic Calming measures can be applied. In the analyses made in the Province of Catania, the benefits of this technique were proved efficient. Three different Traffic Calming measures were analyzed, all of which have resulted in a reduction of accidents always greater than 30%. In the case of speed tables, the reduction in accidents exceeds even 40%. The consequences of road accidents are also mitigated thanks to the traffic calming interventions considered: a) the reduction of injured people is between 32% (road narrowing) and 50% (chicane) and in the case of speed tables injured people will reduce by almost 40%; b) fatal accidents are entirely eliminated. It has been observed that the reduction in pedestrian injuries is between 33% (road narrowing) and 50% (speed tables). In the case of the chicane, the reduction of injured pedestrians is 40%. The fatal pedestrian accidents in the road section in which the speed tables were subsequently installed have been reduced to zero.[125] This study shows how traffic calming measures found in literature work in everyday life. Also, evidence of how safety can be improved with small actions and investments.

Other effective Traffic Calming strategies can be used to create safer traffic conditions, such as:

- Corner Radii: to reduce vehicle turning speed in intersections;
- Gateway Treatments: alert drivers in advance that they are about to enter a low-speed area;
- Medians and Refuge Islands: raised center of roads can create a safer stop for pedestrians and narrow car spaces, leading to a lower traffic speed on crossing intersections;
- Mini Roundabouts: reduce traffic speed and make it more efficiently organized;
- Pavement Materials and Appearance: alternating material between asphalt, concrete, or concrete paws make traffic calming measures more notable through a visual effect;
- Signal Progression: timed signals can alert drivers in advance in an effort to reduce speeds;

[124] Carver A., Timperio Anna F., Crawford David A. (2008) "Neighborhood Road Environments and Physical Activity Among Youth: The CLAN Study". Journal of Urban Health. 10.1007/s11524-008-9284-9

[125] Distefano N., Leonardi S. (2019) "Evaluation of the Benefits of Traffic Calming on Vehicle Speed Reduction"

- Shared streets: shared between cars, bicycles, and pedestrians, forcing the vehicles to reduce their speed.[126]

Walkability and Park-based activity

Additionally to well-designed neighbors, parks are also prominent allies for places that encourage physical activity. In Zhang et al. studies, trails and paths received the greatest support (71% positive) for promoting park-based physical activity, regardless of age and gender. The presence of artificial lighting (or light poles) that allowed the use of parks at night was also important. The link between trails/paths and park-based physical activity suggests that people are more likely to engage in walking, jogging, and cycling in parks when trails/paths are available. It was also found that several park features, including playing and skating areas, fitness stations, and picnic areas, have the potential for increasing park-based physical activity, although the evidence was mixed.[127] It is important that parks, besides providing suitable spaces for sedentary behaviors such as relaxing and picnicking and for contact with nature, also contain facilities that provide ample opportunities for physical activity.

Places that support or encourage physical activity can help to prevent and treat depression. More than a dozen studies reported that higher levels of physical activity are associated with a reduced risk of depression[128]. Significant associations have been reported between higher levels of neighborhood walkability and lower levels of depressive symptoms in men after adjusting for individual-level factors of income, physical activity, education, smoking status, living alone, age, ethnicity, and chronic disease.[129] In conclusion, the design of buildings and neighborhoods can have systematic impacts not only on physical health, but also on psychological health by creating places that encourage people to walk, run, play, and ride bicycles, among other physical activities. Safety, access to nature, daylight, and social interaction are also important contributors to a healthier neighborhood.

Access to nature in particular, can be beneficial to memory and concentration. The Attention restoration theory (ART) suggests that people can develop attentional fatigue from excessive concentration, resulting in memory loss, diminished ability to focus, and impatience and frustration in interpersonal interactions. Accordingly, contact with nature could be restorative by renewing attention and improving cognitive abilities. In Berman, Jonides, and Kaplan's experimental research, they proved that this theory is correct. They found that a nature walk resulted in substantial improvements in cognitive performance reflecting directed attention, whereas a walk

[126] Global Design Cities Initiative. "Traffic Calming Strategies". https://globaldesigningcities.org/publication/global-street-design-guide/designing-streets-people/designing-for-motorists/traffic-calming-strategies/

[127] Zhang R., Wulff H., Duan Y., Wagner P. (2019) "Associations between the physical environment and park-based physical activity: A systematic review". Journal of Sport and Health Science.

[128] Saxena S. et. Al. (2005). "Mental health benefits of physical activity". Journal of Mental Helath.

[129] Berke Ethan M., Gottlieb Laura M., Moudon A., Larson E. (2007) "Protective association between neighborhood walkability and depression in older men". Journal of the American Geriatrics Society.

in a dense urban environment did not.[130] Many people appreciate a walk in a park just for leisure, but once it is proved that this could provide tranquility, comfort restoration, and healing because of the contact with nature, these walks become an important component of our well-being.

Nature contact may also improve health through *stress reduction*. According to Wells and Evan, the effect of stressful life events on children's psychological distress varies as a function of the amount of nearby nature to which the children are exposed. Specifically, the impact of stressful life events on psychological distress is weaker under conditions of high nature than under low nature conditions. The interaction effect is illustrated in figure 16. The difference in levels of psychological distress between low and high nature exposure was particularly pronounced among children who experienced the highest levels of stressful life events.[131] This confirms the hypothesis that contact with nearby nature moderates or buffers the impact of life stress on children.

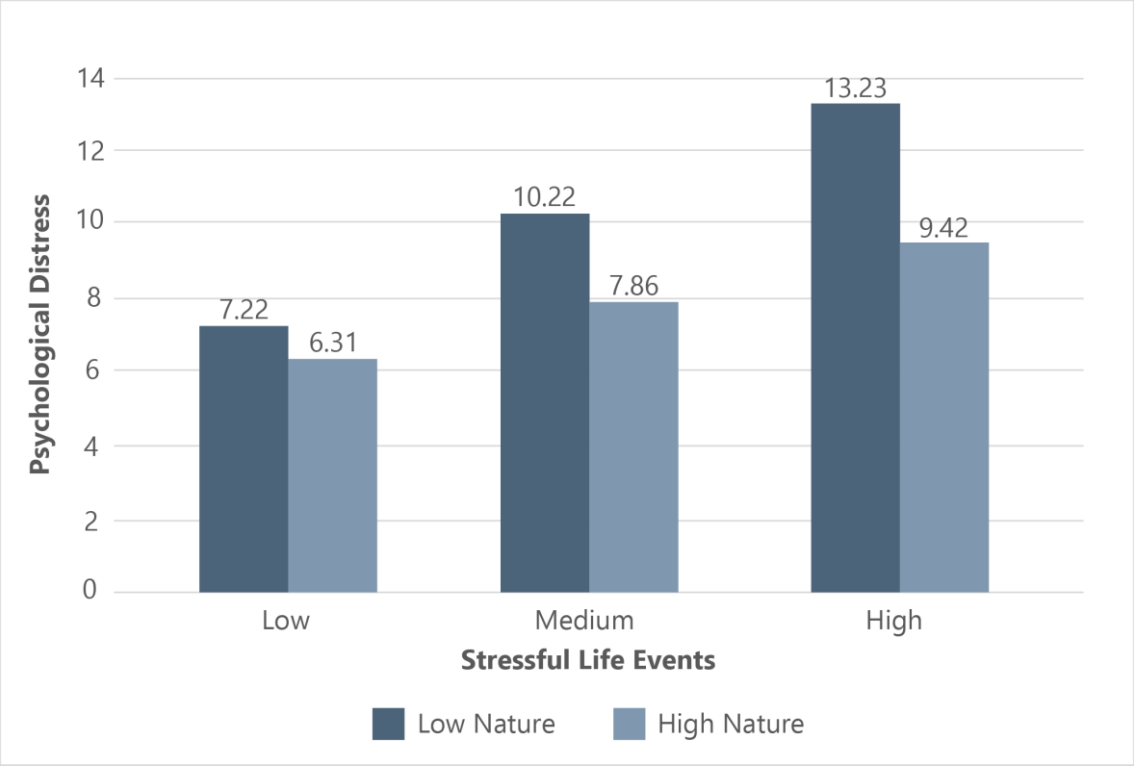

Figure 17: Nature Moderates Effects of Distressful Life Events on Psychological
(Wells, N. M., Evans, G. Nearby Nature: A Buffer of Life Stress among Rural Children. SAGE Publications, 2003)

[130] Berman Mare G., Jonides J., Kaplan S. (2009) "The Cognitive Benefits of Interacting with Nature". Psychological Science. 10.1111/j.1467-9280.2008.02225.x

[131] Wells, N. M., Evans, G.. (2003) "Nearby Nature: A Buffer of Life Stress among Rural Children". SAGE Publications. https://www.ltl.org.uk/wp-content/uploads/2019/02/nearby-nature.pdf

The role of public transportations

Besides walking and cycling in the neighbors and parks, another effective urban mobility form is the use of public transportation. The availability of public transit allows people who are not able to drive, such as handicapped, elderly, or too young to drive, to be able to have the mobility to go anywhere.[132] Transit also provides a community with a way to move potentially large numbers of people while consuming fewer resources. A single bus, if it is full (50 to 80 passengers), can carry as many people as 50 or 60 cars, which normally operate with fewer than two occupants. The bus requires less street space, equivalent to 2 or 3 automobiles, and, when it is full, will produce less pollution per person-trip than an automobile. Finally, because professional drivers operate them, buses have a lower accident rate than automobiles.[133]

The study of Gess et al. sought to examine whether stress due to traffic and travel was associated with well-being. The data suggest that concerns over traffic, vehicle maintenance, and accidents were stressors faced by persons living in Los Angeles and that these stressors are associated with lowered health status and greater depressive symptoms. Also, the effect of traffic stress on health is worse for persons living in environments with more vehicle use compared to those living in areas with less vehicle use.[134] Public transportation can reduce the traffic and consequently reduce the stress caused by it when policies are developed prioritizing it. Compact development policies are essential to create sufficient useful, attractive transport options. Public transit systems usually need subsidies for their operating expenses, and decisions by local and state governments about providing those subsidies impact the frequency, quality, and se of transit service.[135]

3.3.3. Community participation

The term community participation is used so widely that its meaning is often unclear. To understand community participation, it is useful to look at the two words separately. The term *community* can be defined as:

"A group of people who share an interest, a neighborhood, or a common set od circumstances. They may, or may not, acknowledge membership of a particular community."

While the term *participate* means:

A process by which people are enable to become actively and genuinely involved in defining the issues of concern to them, in making decisions about factors that affect

[132] Berggren, Christopher C. "The top 10 benefits of Public Transportation". Smart Cities Dive.
[133] Britannica. "mass transit"
[134] Gess Gilbert C., Takeuchi David T. (2004) "Traffic stress, vehicular burden and well-being: A multilevel analysis". Social Science & Medicine.
[135] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

their lives, in formulating and implementing policies, in planning, developing and delivering services and in taking action to achieve change.[136]

Simply defined, community engagement is what results when all people in a defined community have meaningful opportunities to provide input on a project or process.[137] The HEALTH 21 program (chapter 2.2) emphasizes the need for public participation in decisions that affect human health. Promoting health also means contributing to the development of the community, which enables the development of individuals and groups within it. It enables them to define their needs and priorities. In other words, individuals will be encouraged to define their needs and seek their own solutions. In urban planning terms, the right to participation derives from the right of the citizen to be kept informed and consulted on decision-making processes affecting the place where they reside.[138] In other words, community engagement enlists the perspectives, talents, and skills of members to articulate community needs, concerns, visions, and expectations in ways that result in better, healthier outcomes and more livable environments for residents.

Organized, engaged community members have the potential to create healthy and sustainable built environments. Direct organizing, public education, policy advocacy, and litigation are among the wide range of tactics stakeholders can employ. Community engagement can positively influence how streets are designed, where retail outlets are located, what services and products are available, how dense new developments will be, and to what extent infrastructure – such as affordable housing, parks, or public transit – will be available and accessible to residents.[139]

Community engagement is an effective mechanism for creating lasting health improvements and an essential ingredient for those working to create healthy and sustainable communities. At its strongest, community engagement begins with building relationships early in the planning processes, providing consistent opportunities for community input, offering ongoing mechanisms for decision-making by community participants, and demonstrating tangible ways in which community input influences outcomes. Such collaboration, when done well, helps ensure that health improvement efforts are viable and sustainable because they fully integrate the needs and concerns of the community into both the process and solutions.[140]

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[136] 2002. "Community participation in local health and sustainable development. Approaches and techniques". World Health Organization.

[137] Dannenberg, Andrew L op. cit.

[138] Bartons, H. Tsourou, C. (2004). "Urbanisme et Sante: Un guide de l'OMS pour un urbanisme centré sur les habitants"

[139] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

[140] Minkler M., Wallerstein N. (2005) "Improving health through community organization and community building: Perspectives from health education and social work". Rutgers University Press. https://www.researchgate.net/publication/287900244

When people do not feel safe, they are less likely to visit neighborhood parks or let their children walk to school. Community engagement not only reshapes the physical aspects of the community but also alters the social landscape by creating strong bonds among community members, thus potentially contributing to an increase in healthy eating and active living. For these reasons, community engagement is vital to the viability and longevity of efforts to build healthy places. It can also:

- Provides a mechanism for collecting community-based data to complement traditional sources of data.
- Forms the social connections required to protect, maintain, and further improve community environments.
- Decreases the likelihood that projects will be derailed because of a lack of early community participation.
- Increases the potential that a project will be context-sensitive and embraced by the community
- In sum, it makes the project better and the community better.[141]

Engagement can happen in many ways: through quasi-governmental entities such as volunteer panning commissions, nongovernmental organizations such as community health councils, or community-led processes such as door-to-door surveys. It can also happen using online media: in late 2010, an earthquake shook the Canterbury region, and again in early 2011, a second earthquake struck six kilometers from the Christchurch Central Business District (CBD). In response, the Christchurch City Council (CCC) launched a recovery planning process for the CBD with a public engagement campaign known as "Share an Idea", which aimed to involve and engage the people of Christchurch in the design of the city's future. NV Interactive, a New Zealand digital marketing company, partnered with the CCC to create an approachable, engaging online crowdsourcing tool that delivered outstanding results: during the six-week consultation, 21% of Christchurch's population participated, generating 106,000 ideas.

Using Twitter and Facebook, as well as traditional means of information dissemination such as postcards, the Council tried to market the project as widely as possible. The use of online consultation was a big benefit due to the fact that movement was severely restricted in the devastated city; the Internet allowed people to access information without physically changing location.

The Share an Idea initiative has been awarded numerous international prizes for both its inventiveness and its openness in responding to a crisis situation. In 2011, Share an Idea was voted 'unanimous overall winner' of the Netherlands-based Co-creation Association's Co-creation Award, particularly because it allowed people to put forward their views through a variety of media and because it fostered a sense of community in addition to forming aspirations for the city's rebuilding. Share an Idea has thus been

[141] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.

recognized for its originality and creativity, as well as for the extent of community consultation that it achieved.

The ideas put forward during the Share an Idea project formed the basis for the draft Central City Plan. Designed by the CCC in partnership with Gehl Architects, this project has also won international acclaim. In June 2013, the Plan received one of four Winner prizes in the Virserum Art Museum's triennial Architecture of Necessity Awards. Again, the awarding body explicitly referenced the centrality of community participation and the Central City Plan, which was developed from it.[142] This highlights how important and effective community involvement can be.

In Italy, the city of Bologna developed a Regulation on Collaboration between Citizens and the City for the care and regeneration of Urban Commons" in 2014. The program's purpose was to regulate active citizens' participation in collaboration proposals to improve urban services and public spaces through regeneration and care interventions agreed upon between citizens and the municipality. Community participation is open to everyone, without the need for any title of legitimation. The collaboration proposals, on the other hand, need to clearly describe the intervention to be realized with many details as possible and should aim to improve the city for all.[143]

According to Dahlgreen and Whitehead, policy options on social and community inclusion are:

- Foster horizontal social interactions – that is, between members of the same community or group – to allow community dynamics to work. These options range from:
    - initiating community development initiatives that enable people to work collectively on their identified priorities for health;
    - building up the infrastructure in neighborhoods – creating relaxing meeting places and facilities, for instance – to make it easier for social interaction to take place.
- Strengthen or develop systems that foster vertical social interactions on a society-wide basis. These are aimed at creating vertical bonds between different groups from the top of the social scale to its bottom to build inclusiveness and full economic and political participation. The underlying theory behind the vertical initiatives is that fostering solidarity throughout society produces a less divided society, one with smaller social inequities and hence more equitable access to the resources for health. Examples include the following:

[142] Trujillo, M., Theckethil, R., King, I., Fairholm, J., Iturrizaga, M. (2020). "Guidelines for Community Participation in Disaster Recovery". United Nations Development Programme. https://www.gfdrr.org/sites/default/files/Guidelines%20for%20Community%20Participation%20in%20Disaster%20Recovery.pdf

[143] City of Bologna (2014). "Regulation on collaboration between citizens and the city for the care and regeneration of urban commons". http://www.comune.bologna.it/media/files/bolognaregulation.pdf

- building inclusive social welfare and educational systems in which everyone contributes and everyone benefits;
- employment policies that aim to integrate all groups in society into the labor market; and
- initiatives to strengthen the democratic process and make it easier for the disenfranchised to participate in it.[144]

3.3.4 Sustainability

Sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. Together with this concept, there is also *Smart Growth*, which consists of an urban planning approach that aims to manage the growth and land use of a community so as to minimize damage to the environment, reduce sprawl, and build livable, walkable, mixed-use communities.[145] The need to implement these concepts on urban development is becoming more urgent every day, especially knowing how much environmental damage the construction industry and transportation field (chapter 3.3.1) cause and the expectations for the future world population growth. To help with that, different approaches can be used, and one of the most popular is the *Circular Economy* (CE).

Circular Economy

An important aspect of the CE approach to urban design is to put limits on urban sprawl, emphasizing increased density and reusing brownfield land as much as possible. We need to make use of what already exists, to the extent that we can, rather than using new land unnecessarily. As existing infrastructure and services can be reused or expanded, the extent to which new utilities have to be built or extended is reduced or eliminated. The CE approach to the built environment is not just about design or about the social responsibility of private actors; it is about the responsibility of all humans to be better custodians of our planet than we have been so far. It is, therefore, time to work together as a society to promote and honor these principles as part of our duty toward future generations.[146]

The more urban design projects which take this approach, the greater the benefits for the planet and the well-being of its people. In planning urban neighborhoods, it is becoming increasingly important to take on board an integrated planning team from the outset of the design process because choosing the suitable materials and

[144] Dahlgreen, G.; Whitehead, M. (2006). "European strategies for tackling social inequities in health: Levelling up Part 2". World Health Organization. https://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf
[145] Dannenberg, Andrew L. et al. (2011). "Making health places: designing and building for health, well-being, and sustainability". Island Press.
[146] Grau, X. (2021). "The circular economy and sustainable urban planning". Chapman Taylor. https://www.chapmantaylor.com/insights/the-circular-economy-and-sustainable-urban-planning

coordinating the various trades are becoming increasingly important in ensuring a finished product that complies with the principles of the circular economy.[147]

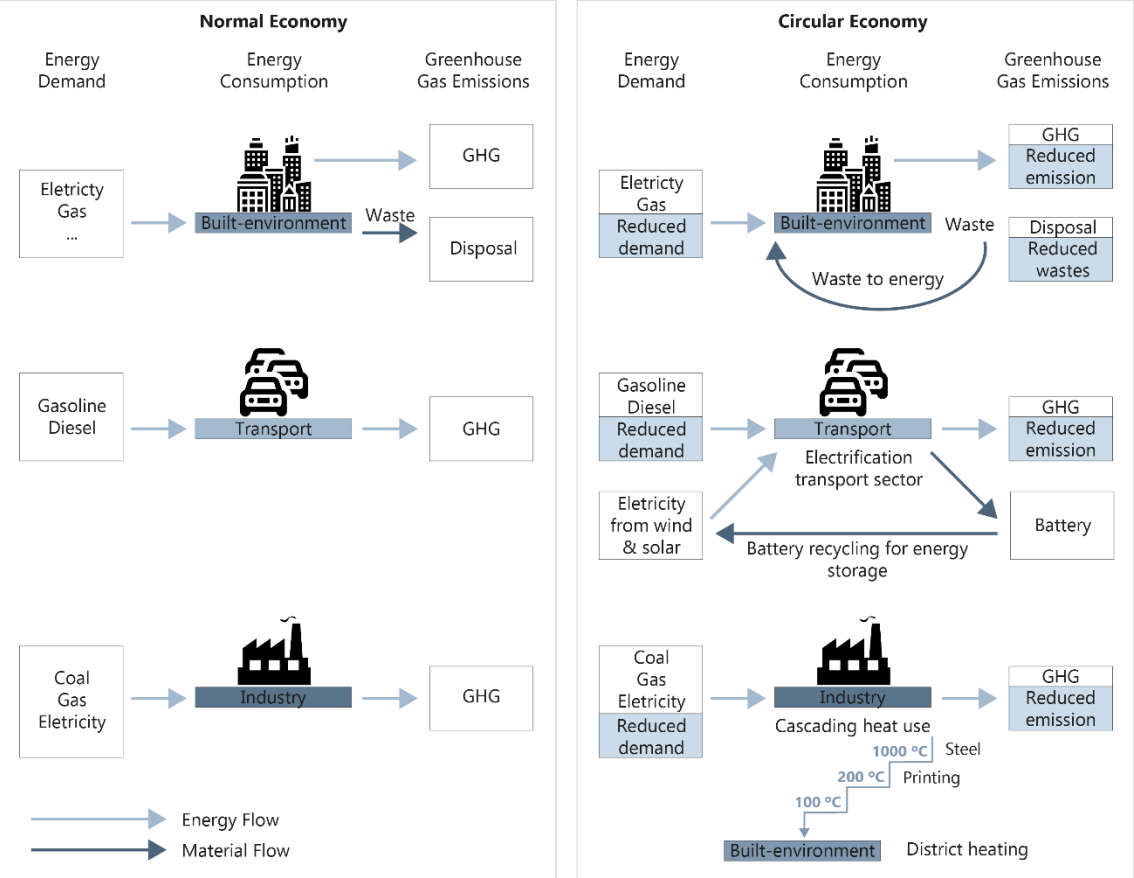

Figure 18: Illustration of the difference between a normal economy and a circular economy.
(Su, C., Urban, F. Circular economy for clean energy transitions: A new opportunity under the COVID-19 pandemic. Applied Energy, 2021)

Sustainable urban planning applies a CE´s principles to the planning of buildings and cities. The aim is to make cities act as an ecosystem with circular dynamics through various strategies, such as, for example, optimizing the collection of resources such as electricity and water for reuse whenever possible.[148] Besides, the centralization and integration between wastewater, waste, and energy systems should be explored to enable efficient recovery of energy, nutrients, and water. A new kind of idea on a symbiosis between urban and rural areas is evolving with objectives of sustainable food

[147] Grau, X. (2021). "The circular economy and sustainable urban planning". Chapman Taylor.
[148] González, S. (2021). "Redesigning cities with Sustainable urbanism and Circular Economy". Open Mind. https://www.bbvaopenmind.com/en/science/environment/redesigning-cities-sustainable-urbanism-circular-economy/

production, recovering valuable materials, saving water, and harvesting of renewable energy has been investigated.[149]

Reduce, reuse and recycling

An excellent example of sustainable urban planning is the Le Marine Eco-district in Colombes, North-Paris, France. The goal of the project was to reclaim an industrial wasteland for the construction of a new sustainable neighborhood of 6.7 hectares. The Charles de Gaulle district conceived the project to open up the site and create an urban and social link between the present and the future. Several project innovations contribute to the quality of the project: a biomass heat network supplies all the buildings in the eco-district and the social housing stock in the south; the parking lots are shared to reduce the construction of infrastructure and limit the traffic impact on the neighborhood, and an installation aims to achieve zero rainwater discharge both in public spaces and at the level of each plot. The project started in 2008 and was delivered in 2002. The community was involved during the project planning and helped to co-develop the master plan.[150]

Good waste management is also an essential subject of the CE, and it is divided into three different actions: reduce, reuse and recycling. Reduction is prioritized highest in the waste hierarchy and refers to waste prevention, defined as any measure taken before a resource crosses the waste threshold.[151] It can be improved through smart design and use of products such as design-for-disassembly (DfD) to enable reuse in the post-use phase and product-service system (PSS) to intensify the use phase. PSS would move focus in development of infrastructure and manufacturing from tangible goods and ownership towards fulfilling customers' needs and has the potential to reduce consumption by providing more value with a smaller amount of spaces, vehicles, and consumer products.[152]

Reuse and recycling are the second and third priorities in the waste management hierarchy. Reuse is a preferable principle in general and is found to be an effective way of reducing the volume of waste. Still, both principles share the same barrier, which is establishing a source-separating collection system with supply chains for different materials or reusable products and components. To solve this, a collection system with smart technologies could be further investigated as options for improving the feasibility of the source separating supply chain. Also, research on inclusive practices

[149] Joensuu, T., Edelman, H., Saari, A. (2020). 'Circular economy practices in the built environment". Journal of Cleaner Production. 10.1016/j.jclepro.2020.124215

[150] Papot, Jean F. (2019) "Le Marine Eco-District". Construction 21: The social media for sustainable buildings & cities. https://www.construction21.org/city/fr/la-marine-eco-district.html

[151] Hutner, P., Helbig, C., Thorenz, A., Tuma, A. (2018). "Transdisciplinary Development of a Life Cycle–Based Approach to Measure and Communicate Waste Prevention Effects in Local Authorities". Journal of Industrial Ecology. https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.12781

[152] Joensuu, T. et al. op. cit.

for the development of waste management would be needed to achieve both pollution control.[153]

In recent studies, researchers have suggested the concept of urban symbiosis (US) to provide resource-saving, reduction in mining, waste disposal, and CO2 emissions, as well as to generate revenue for companies and to create local business opportunities.[154] Another broadly discussed practice for cutting the environmental impact of building materials production is the concept of industrial symbiosis (IS) with the idea of building positive synergies among industries. The concept of US expands that of IS by also involving the urban areas in the symbiotic activities, for example, by providing excess heat. Still, it also carries a risk of wasting efforts on practices that are getting out of date, such as replacing coke with waste plastics or finding solutions for contaminated municipal solid waste incineration (MSWI) ash. In Joensuu, Edelman, and Saari's research, it was verified that IS has significant merits on energy saving, resource recycling, and waste reuse, and can further mitigate emissions (especially CO2), reduce solid wastes, increase corporate profits, and achieve sustainable and economic transition of the resource-dependent cities.[155]

Life Cycle Assessment (LCA) has been well-established as a key method for the assessment and management of sustainability of construction projects. It is a useful method, especially in buildings that cause significant resource consumption in both material production and operation energy over time. CE cause in buildings' LCA a paradigm shift from cradle-to-gate or cradle-to-grave to cradle-to-cradle (C2C) and whole life cycle approaches where the phases of planning and design, materials production, materials distribution, and construction process, maintenance and renovation, deconstruction and disposal, to the material reuse and recycle phase are taken into account.[156] In buildings, each component that has an effect on thermal performance could be reliably assessed only as a part of the whole building in local conditions. There is also a call for research on broadening approach to buildings' LCA, for example, through integration to life cycle costing, social LCA and building information model, development of LCA database through industrial collaboration and taking compensating elements such as integrated renewable energy into account.[157]

In order to create a sustainable built environment, carbon footprint should be reduced, and the use of affordable and sustainable energy is a strategy to achieve this. Besides

[153] Joensuu, T., Edelman, H., Saari, A. (2020). 'Circular economy practices in the built environment". Journal of Cleaner Production..

[154] Li, H., Dong, L., Ren, J. (2015) "Industrial symbiosis as a countermeasure for resource dependent city: a case study of Guiyang, China". Journal of Cleaner Production. 10.1016/j.jclepro.2015.04.089

[155] Joensuu, T., Edelman, H., Saari, A. (2020). 'Circular economy practices in the built environment". Journal of Cleaner Production.

[156] Ng, S. Thomas, Wong, J., Skitmore, S., Veronike, A. (2012). "Carbon dioxide reduction in the building life cycle: a critical review". Proceedings of the Institution of Civil Engineers - Engineering Sustainability. 10.1680/ensu.11.00005

[157] Joensuu, T., Edelman, H., Saari, A. (2020). 'Circular economy practices in the built environment". Journal of Cleaner Production.

the measures regarding urban planning and materials (chapter 3.3.1), the *2019 Global Status report for buildings and construction* suggests the use of clean energy can be supported by:

- integrating onsite renewable energy by including building-integrated photovoltaic (BIPV), solar thermal, and micro-wind renewable energy projects in the planning and design of buildings and neighborhoods;
- eliminating onsite fossil fuel-burning equipment by replacing systems with equipment that uses clean energy; connecting buildings to low-emissions district energy systems;
- and implementing zero-carbon policies that support the clean energy transition based on the lifecycle benefits of the measures.[158]

In the built environment, the usage and the construction both cause a heavy environmental impact, even with a slow renewal of building stock. This is why both of the phases call for solutions for improving resource efficiency.

Regarding transit, urban planning may aim at integrative measures that lower emission rates, such as promoting highly efficient, service-oriented, and clean public transport and improving traffic flow. Revitalizing railway systems for freight transport can reduce not only road travel but also the risk of increased air pollution due to the spread of urban areas. The development of technologies likely to lower the emission levels of conventional vehicles should be promoted. Control mechanisms of proven effectiveness (such as mandatory car inspections to eliminate gross polluters and poorly maintained vehicles) should be more widely used. As previously outlined, alternative vehicle technologies and substitute fuels hold the potential for substantial future reductions in emissions of hazardous air pollutants.[159]

The Superblocks in Barcelona

One example regarding traffic is the Superblocks in Barcelona. As mentioned before (chapter 2.3.2), the city is divided into a grid with building blocks, and in 2016 in some parts of the city, they were split into groups of nine blocks which are named "superblocks". The aim was to reduce pollution from vehicles and give residents much-needed relief from noise pollution. They are designed to create more open spaces for citizens to meet, talk and do activities. There are currently only six superblocks in operation, and residents have broadly welcomed the change. For this reason, the plan is to implement another 503 superblocks in the city, which would bring considerable long-term benefits to the city and its populations. Journeys by private vehicle would fall by 230,000 a week as people switch to public transport, walking, or cycling; ambient

[158] Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme (2019) "2019 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector".

[159] Krzyzanowski, M. (2005) "Health effects of transport-related: summary for policy makers". World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/341777/9789289013758-eng.pdf?sequence=1&isAllowed=y

levels of nitrogen dioxide (NO_2) would be reduced by a quarter, bringing levels in line with recommendations from the World Health Organisation (WHO); and more green spaces will encourage people to get outdoors and lead a more active lifestyle.[160]

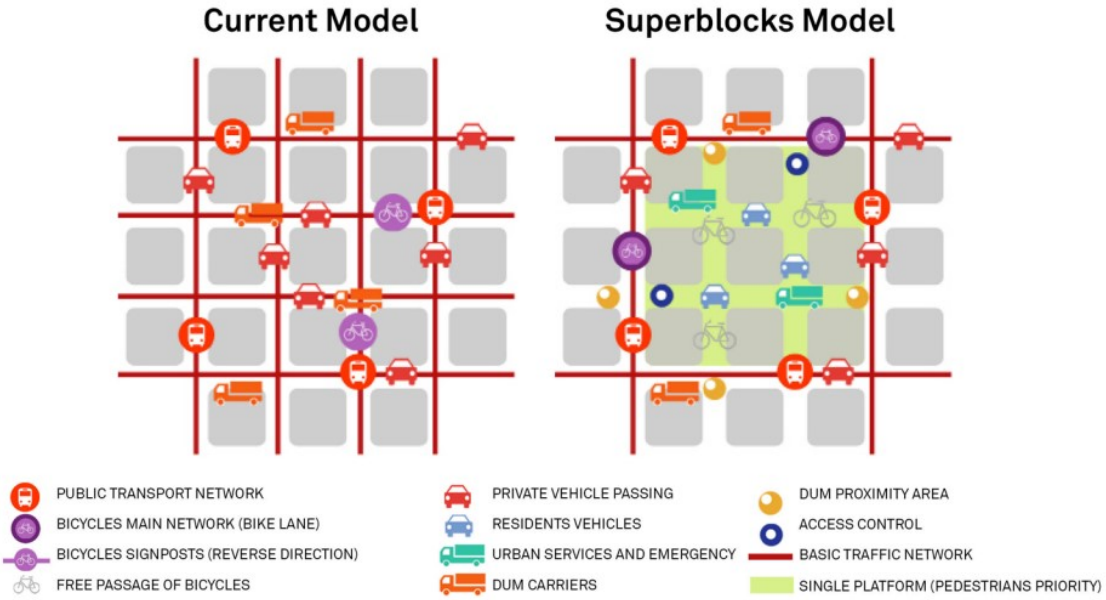

Figure 19: Barcelona Urban planning - Before and After Superblocks.
(Ajuntament de Barcelona. Urban Mobility Plano for Barcelona PMU 2013-2018. 2014)

Barcelona is one of the densest cities in Europe. It comes with high road-accident rates, a lack of greenery, and quality places for social interaction and outdoor exercises, leading to sedentarism, especially for kids and teenagers. The Superblocks Model aims to promote independence among people by reducing traffic congestion and making it safer; increasing people's affective links with their city environment; inspire social relations through suitable public meetings and leisure spaces. During the definition process to develop the Superblocks proposal for each specific area of Barcelona, local neighbors and groups were consulted, establishing a design adapted to each different reality.[161]

[160] Nanda, A. (2019). "Superblocks: Barcelona's car-free zones could extend lives and boost mental health". The conversation. https://theconversation.com/superblocks-barcelonas-car-free-zones-could-extend-lives-and-boost-mental-health-123295

[161] Ajuntament de Barcelona, Commission for Ecology, Urban Planning and Mobility (2016). "Let's fill streets with life: Establishing Superblocks in Barcelona". https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/en_gb_MESURA%20GOVERN%20SUPERILLES.pdf

3.4. Summary

In this chapter, we realize and understand that the question "what is a health city?" can be answered in various ways according to the population's professions, culture, and interests. Moreover, the parameters discussed (pollution, urban mobility and space, community participation, and sustainability) are efficient not only in theory but also in real projects. Of course, these parameters should not be viewed as a dogmatic rule and should be adapted to each individual city's needs and requirements. They are a guideline to design healthier urban environments through community involvement in the project process, use of clean energy, and building neighborhoods that are safe and have access to nature, which encourage not only physical activities but also improve the population's mental health. The main strategies applied in each parameter are:

Pollution:

- Water treatment system;
- Sewer systems;
- Decabornising the construction sector;
- Circular economy;
- Implement reuse policy;
- Recycling

Urban mobility and space:

- Design neighborhoods for pedestrians;
- Well-designed neighborhoods to motivate physical activity;
- Parks;
- Trails and paths for walking and cycling;
- Traffic calming;
- Investment in Public transportation;

Community participation:

- Increase the potential of a project to be well received by the community;
- Can be done through door-to-door surveys, online surveys, and volunteer participation;

Sustainability:

- Circular Economy;
- Reduce, reuse and recycle;
- Life Cycle Assessment (LCA);
- Use of renewable energy;
- Use of alternative vehicles fuel

Finally, we have identified that risk factors (chapter 3.2), such as waterborne disease, respiratory disease, and stress, could be prevented using the measures described on each parameter: built sewerage systems, use of clean energy, reductions of GHG gases, reduced traffic and availability of green spaces in neighborhoods.

4. THE COVID-19 OUTBREAK

In December 2019, Chinese authorities informed WHO's China office of pneumonia cases in Wuhan City, Hubei province, China, with unknown cause. By the end of January 2020, the mystery disease had already reached more countries. By 11th February 2020, WHO assigned the disease its official name: COVID-19, which by 11th march 2020 was declared a pandemic.[162] In a matter of months, the world has been transformed: millions of people have fallen ill and an unprecedented mortality has been registered.

The pandemic found many cities and countries unprepared despite many warnings and recent epidemics such as Ebola and Severe Acute Respiratory Syndrome (SARS).[163] Critical urban studies have shown that while, in recent decades, the worldwide tendencies of rapid urbanization and globalization have improved the lives of millions of people, the adverse side effects of these trends have become all the more obvious. Of note, too, is the transpiring of the Covid-19 pandemic since 2019 has intensified such predicaments. Given this situation and considering the contagion's severity, its wide geographical diffusion, and the fact that the vast majority of its victims are urban dwellers, a fresh debate has been prompted as to how the configuration of built environments can affect citizens' well-being. Governments, civil groups, academics, architects, and planning practitioners have therefore elicited new discussion as to how, as an example, public space is planned, accessed, and used.[164]

The challenged the current urban development model

The pandemic has challenged the current urban development model including mobility, urban form, urban food systems, and local economy. Cumulative social, economic, and environmental inequalities reinforced by chronic spatial injustice have shaped exposure, vulnerability, and ultimately, the risk and outcome of non-communicable and infectious diseases. The pandemic has exposed stark inequalities in accessibility to risk-reducing infrastructure and services, highlighting disparities in accessibility, quality, and distribution of green and public spaces across the urban divide. In the same context, green and public spaces have emerged as basic risk-reducing infrastructure, an essential urban service, an infrastructure of opportunity to build back better.[165]

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[162] Lei Ravelo, J., Jerving, S. (2020). "COVID-19 in 2020 – a timeline of the coronavirus outbreak". Devex. https://www.devex.com/news/covid-19-a-timeline-of-the-coronavirus-outbreak-96396

[163] Chong, J., Rana, S., Ojal, M. (2020). "Public Spaces as an Invaluable Resource for Delivering Healthy and More Equitable Cities and Communities". The Journal of Public space. https://www.journalpublicspace.org/index.php/jps/article/view/1415

[164] Morley, I. (2020). "Rethinking Past Green Space Manufacture to Boost Equitable Future Urban Recovery." The Journal of Public Space. https://www.journalpublicspace.org/index.php/jps/article/view/1283

[165] Chong, J., Rana, S., Ojal, M., op. cit.

Socioeconomic and demographic factors indicate that COVID-19 is not affecting everyone in the same way. To fully comprehend why infectious pandemics affect different socioeconomic groups differently is quite difficult, with data credibility as the key concern. Socioeconomic indicators such as education, rural or urban area, the density of population, and the number of tenants in a household are important as, unfortunately, Covid-19 spread is related to these.[166] For instance, a household with more residents can result in people getting infected without much social contact with other people, as one person can bring the virus and infect the others. To avoid the spread of the virus, measures such as social distancing were used worldwide, but different reasons can contribute to its effectiveness. One good example is the home office: it can limit social contact with other people, but only higher socioeconomic jobs can benefit from this.[167]

Each country applied its own measure to contain and suppress the spread of the virus, but some measurements were more commonly utilized: quarantine, lockdowns, and social distancing. These measures were proven to be effective against the spread of the virus but also affected life in many different ways: economically, environmentally, and socially. To analyze the impacts, measures, and future urban planning after covid, the selection of case countries is based on two criteria. First, some countries were chosen based on their similarity and comparability but with different responses (Denmark and Sweden), while some countries were non-similar but with different responses (Japan and Sweden). Second, the rest of the countries were chosen based on the magnitude of the pandemic, both outbreak epicenters (China, Italy, and Spain) and very controlled low transmission (Australia and New Zeeland). With such selection, the analysis can be thorough by utilizing comparisons, and "success" and "failure" cases.

As such, the following countries were selected:

- Denmark and Sweden – geographical, cultural, and political similarities, but different restrictions and measures implemented. Denmark utilized a strategy, also adopted by Finland and Iceland, with a stricter response; whereas Sweden deviated with a softer and more open strategy.
- Japan – utilized similar restrictions and measures as Sweden, but is geographically, culturally, and politically non-similar. Moreover, Japan's strategy differed from other Asian success countries with its cluster approach and low testing rate.
- China, Italy, and Spain – epicenters of covid outbreaks, sometimes referred to as "failures". All countries have had substantial transmission rates with massive

[166] Messner, W. (2020). "The Institutional and Cultural Context of Cross-National Variation in COVID-19 Outbreaks". MedRxiv. https://www.medrxiv.org/content/10.1101/2020.03.30.20047589v1

[167] Bashir, M. MA, B., Shahzad, L. (2020). "A brief review of socio-economic and environmental impact of Covid-19." Air Qual Atmos Health 13. https://link.springer.com/article/10.1007/s11869-020-00894-8

problems containing the spread. China differs somewhat with somewhat of a success with its draconic lockdowns.

- Australia and New Zeeland – hard response to covid outbreaks enforced by a zero-transmission strategy, sometimes referred to as "success". Culturally and politically similar to European countries, but geographically very different.

4.1. Urban responses and policies

On January 23, only two days before the start of the Chinese New Year, Wuhan went into lockdown: approximately 11 million people were put into quarantine, and social distancing and facemasks became mandatory.[168] Roads and transportation into and out of lockdown-cities became closed; all shops except for those selling food and medicine, as well as schools and universities, were also closed.[169] Wuhan managed to construct new hospitals and care centers to care for the sick. As the disease spread, more cities utilized the strict lockdown strategy, often to draconic extents (e.g., apartment building doors being welded shut). As such, to prevent community infection, strict blockade and quarantine measures were implemented. Entryways to modes of transportation, vehicles, and railways were all subject to inspection for potential infected. Suspected infections were put into isolation, with close contacts quarantined into either home-based supervision or centralized.[170] In later lockdowns, officials started to test residents, going door to door, forcing people into quarantine if they tested positive.[171]

In contrast to the strict measures adopted in most countries, Japan has adopted fewer restrictive social-distancing policies following the COVID-19 pandemic. The containment measures implemented by the Japanese government include non-mandatory closures and remote-working of non-essential business employees, closures of schools, stay-at-home requests, and in-bound entry restrictions. Because the Japanese government cannot legally enforce lockdowns on citizens and residents, its strategies have relied largely on requests for voluntary self-restriction.[172]

The Danish government was among the first countries in Europe to act and act firmly against the virus by declaring a national lockdown and closing its borders. The

[168] BBC News (2021). "Wuhan lockdown: A year of China's fight against the Covid pandemic." https://www.bbc.com/news/world-asia-china-55628488

[169] Graham-Harrison, E. and Kuo, L. (2020). "China's coronavirus lockdown strategy: brutal but effective". The Guardian. https://www.theguardian.com/world/2020/mar/19/chinas-coronavirus-lockdown-strategy-brutal-but-effective

[170] Yu, X. and Li, N. (2021). "Understanding the beginning of a pandemic: China's response to the emergence of COVID-19". Journal of Infection and Public Health. https://www.sciencedirect.com/science/article/pii/S1876034120307802

[171] Graham-Harrison, E. and Kuo, L. op. cit.

[172] Wu, L., Shimizu, T. (2022). "Analysis of the impact of non-compulsory measures on human mobility in Japan during the COVID-19 pandemic". Cities. 10.1016/j.cities.2022.103751

country's approach was more drastic and differed greatly from its neighbor – Sweden, where relatively few measures, except 'social distancing', were imposed on public life. Denmark banned large public gatherings, closed down all unnecessary venues across its cities, and heavily discouraged the use of public transportation and all manner of travel unless absolutely essential. Daycares, schools, and universities were very quickly shut down, and air travel was severely restricted – and while these restrictions have become the 'new normal' across the continent, Denmark was among the first countries to impose such restrictions.[173]

Moreover, the Danish health care system is very equitable and free for everyone, independent of health insurance, and with a tradition of a large public sector of high-quality hospitals and clinics, with relatively few private clinics. This aspect was also a contributing factor to the impressive pace and flexibility with which the entire health care system was able to prioritize and reorganize medical departments, isolation wards, and hospital beds, as well as doctors and nurses, to be optimally prepared to isolate and treat admitted patients.[174]

Italy was the most affected country by the pandemic at its beginning in Europe. On 9 March 2020, the government imposed a national lockdown or quarantine, restricting the movement of the population except for necessity, work, and health circumstances, in response to the growing pandemic of COVID-19 in the country. From the 21st of March to the 3rd of May 2020, all Italian public parks were closed, and citizens had to stay within a distance of 200m from their homes. During these 44 days, people were allowed to leave home only for food provisioning and pharmaceutical supplies, working, walking the dog, or for serious health problems.[175] When the second wave of the virus came, a new strategy was adopted, and the restrictions were progressively increasing. Besides the national restrictions, the country regions were divided according to a color scheme: yellow, orange, and red, corresponding to increasing levels of restrictions. The tiered measures involved further limitations to retail and service activities, individual movement restrictions (ranging from a curfew between 10 p.m. and 5 a.m. to a full-day stay-home mandate with a ban on inter-regional mobility), and reinforced distance learning in schools.[176]

In Milano, the most important line of intervention is concerned with the reallocation of the uses of roads and public spaces with the main objective to increase soft mobility supply and develop areas that allow commercial, recreational, cultural, and sporting

[173] Olagnier, D., Mogensen, T. H. (2020). "The Covid-19 pandemic in Denmark: Big lessons from a small country." Cytokine and Growth Factor Reviews. 10.1016/j.cytogfr.2020.05.005
[174] Ibidem
[175] Larcher, F. et al. (2021). "Perceptions of Urban Green Areas during the Social Distancing Period for COVID-19 Containment in Italy". Horticulturae. https://www.mdpi.com/2311-7524/7/3/55
[176] Manica, M. et al. (2021) "Impact of tiered restrictions on human activities and the epidemiology of the second wave of COVID-19 in Italy." Nature Communications. https://www.nature.com/articles/s41467-021-24832-z

developments, while respecting the appropriate physical distances. In this respect, the adaptation strategy envisioned the development of 35 km of new bicycle lanes, the re-development of the city's pedestrian paths with new and widened pavements, and the extension of Limited Traffic Zones (LTZ) and pedestrian areas. A further line of intervention concerned with the simplification, expansion, and acceleration of digital services available to the citizens in order to reduce the need to travel and contain physical contact between public servants and city users.[177]

In Spain, a state of alarm was declared on the 14th of March 2020, and it changed, as well as in Italy, the distribution of powers between the national and the regional -local governments. It meant that decisions were centralized at a state level. Face-to-face education was suspended, including classes from kindergarten, primary school, high schools, and universities. Buildings and activities related to the public sector were closed. Retail establishments were closed except for food stores, pharmacies, newspapers, tobacconists, fuel stations, technological and telecommunications equipment, and dry cleaners. The measures on mobility restricted the freedom of movement of persons except for essential activities such as grocery shopping, pharmacy, and commuting to work.[178]

Public transport service was reduced to 50% of the usual capacity. The cleaning activities of transport vehicles were reinforced, and the use of a mask on public transport became mandatory from May 2020 onwards. One of the biggest challenges has been creating spaces for people to walk while maintaining social distancing. In Madrid, 65% of its sidewalks are less than 3.5 meters wide, and for this reason, the mayor of the city temporarily pedestrianizes 29 streets throughout the city on weekends, adding 19 kilometers and 235,000 square meters of urban space. During the confinement, Madrid's public bike service was withdrawn from public roads. Once people could leave their homes for a walk during certain hours of the day, bikes were back in service, and by mid-May, the service reached a "historic" record of users.[179]

Australia implemented various types of measures to combat the spread of COVID-19. In March 2020, Australia's borders closed for non-residents for international travel, including both business and recreational purposes. In addition, domestic traveling also became restricted by late march, subduing the populace's options for intra-country

[177] Angielo, G. (2020). "Toward greener and pandemic-proof cities: Italian cities policy responses to Covid-19 outbreak". TeMA Journal of Land Use Mobility and Environment 2. http://www.serena.unina.it/index.php/tema/article/view/7047

[178] Prieto, A. (2020). "Reinventing cities in post-COVID-19 era: Spain." IGLUS – Innovative Governance of Large Urban Systems. https://iglus.org/reinventing-cities-in-post-covid-19-era-spain/

[179] Prieto, A. (2020). "Reinventing cities in post-COVID-19 era: Spain." IGLUS – Innovative Governance of Large Urban Systems

travel plans.[180] Furthermore, non-essential businesses (such as luxury goods, hair salons, and clothing stores) were temporarily closed, public venues received a limit of attendees, and general stay-at-home orders were enforced, compelling the closure of daycare centers, schools, and universities.[181] Australia's states experienced some autonomy, causing different states to adopt different lockdown rules of both measures and duration[182]; the lockdown rules ranged from restricting travel to non-essential services to limited outdoor time. During the various lockdowns, outdoor activity was limited to 1 hour per day. Facemasks were mandatory to wear, and social distancing had to be exercised if a person were outside of their home.[183]

Following the World Health Organization's advice to limit movements and enact physical distancing measures, New Zealand implemented lockdowns orders and developed an Alert Level system in response. There were four different alert levels, as described in figure 18.[184] Another key public health intervention was hotel-managed isolation and quarantine (MIQ). All citizens, permanent residents, or pre-approved non-residents arriving in NZ by air were required to remain in MIQ hotels for at least 14 days with very limited exceptions.[185]

New Zealand was the first country to invest in pop-up bike lanes and promote wider sidewalks during the lockdown period, the same strategy further adopted by Italy and Spain. The idea came as part of the Tactical Urbanism initiative, which refers to a "*rapid and low-cost and scalable approach to making temporary changes to the urban environment, often in urban gathering areas. The process combines a development process with social interaction."*[186] New Zealand has been investing in this urbanism strategy since before the pandemic. At a moment when social distancing was required, it seemed reasonable to support efforts to create wider paths for pedestrians and

[180] Moloney, K., Moloney, S. (2020). "Australian Quarantine Policy: From Centralization to Coordination with mid-Pandemic COVID-19 Shifts". Pub Adm Rev. https://onlinelibrary.wiley.com/doi/10.1111/puar.13224

[181] Minister for Health and Medical Research (2020). "Public Health (COVID-19 Restrictions on Gathering and Movement) Order 2020." New South Wales Gov. https://legislation.nsw.gov.au/file/Public%20Health%20(COVID-19%20Restrictions%20on%20Gathering%20and%20Movement)%20Order%202020_200501.pdf

[182] Moloney, K., Moloney, S. op. cit.

[183] Minister for Health and Medical Research (2021). "Public Health (COVID-19 Additional Restrictions for Delta Outbreak) Amendment (No 27) Order 2021." New South Wales Gov. https://legislation.nsw.gov.au/file/Public%20Health%20(COVID-19%20Additional%20Restrictions%20for%20Delta%20Outbreak)%20Amendment%20(No%2027)%20Order%202021.pdf

[184] Mayer, B., Boston, M. (2022). "Residential built environment and working from home: A New Zealand perspective during COVID-19". Cities. 10.1016/j.cities.2022.103844

[185] Gray, L. et al. (2022). "The lived experience of hotel isolation and quarantine at the Aotearoa New Zealand border for COVID-19: A qualitative descriptive study". International Journal of Disaster Risk Reduction. https://www.sciencedirect.com/science/article/pii/S2212420921007408

[186] Thakkar, K. (2021). "An overview of Tactical Urbanism". Re-thinking the future. https://www.re-thinkingthefuture.com/designing-for-typologies/a6052-an-overview-of-tactical-urbanism/#:~:text=The%20term%20tactical%20urbanism%20refers,development%20process%20with%20social%20interaction.

cyclists. This shows the city's concern for the health of its inhabitants, and the project was so well accepted that communities considered making it permanent.[187]

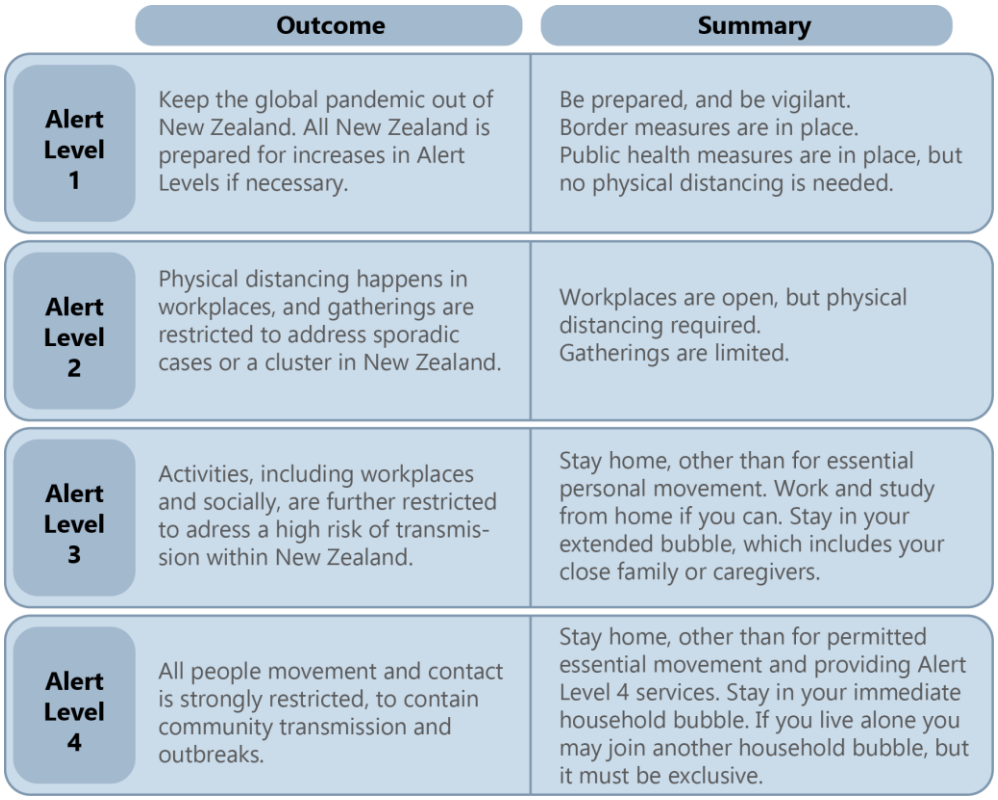

Figure 20: New Zealand's COVID-19 Alert Level measures.
(Mayer, B., Boston, M. Residential built environment and working from home: A New Zealand perspective during COVID-19. Cities, volume 129, 2022.)

4.2. The pandemic impacts

Although pandemics are rare in modern history, some studies on the effects of epidemics and their restrictions on mobility were carried out prior to the outbreak of COVID-19. In a study on the Ebola outbreak in Sierra Leone using cell phone data, Peak et al. (2018) found a dramatic reduction in human mobility during a three-day lockdown.[188] Regarding previous epidemics not involving lockdowns, a survey-based study with 900 respondents from each of the five countries analyzed found that, although variation between countries was large, social distancing measures were less common than public protective measures such as handwashing. The measures of social

[187] Reid, C. (2020). "*New Zealand First Country To Fund Pop-Up Bike Lanes, Widened Sidewalks During Lockdown*". Forbes. https://www.forbes.com/sites/carltonreid/2020/04/13/new-zealand-first-country-to-fund-pop-up-bike-lanes-widened-sidewalks-during-lockdown/?utm_campaign=Making%20News%20in%20Transport&utm_source=hs_email&utm_medium=email&utm_content=86435769&_hsenc=p2ANqtz-9fHRF2t3d7pX7pBZ7KRa_0FAcCCpV6AJGbU4LzJhYOCf4I4zC9LMl2pmbV6q3llzvRSDYELmGBMKehZ4PWWGTyQJu39A&_hsmi=86435769&sh=49c4ac9546e1

[188] Peak, C. M. et al. (2018). "Population mobility reductions associated with travel restrictions during the Ebola epidemic in Sierra Leone: use of mobile phone data". International Journal of Epidemiology. 10.1093/ije/dyy095

distancing included avoiding crowded places, avoiding long-distance travel, and avoiding public transportation.[189] These measures are similar to the ones implemented in most of the countries during the COVID-19 breakdown.

CHINA

China's strict traffic restrictions and self-quarantine measures to control the expansion of SARS-CoV2 generated changes in air pollution. Due to quarantine, NO2 was reduced by 22.8 μg/m3 and 12.9 μg/m3 in Wuhan and China, respectively. PM 2.5 fell by 1.4 μg/m3 in Wuhan but decreased by 18.9 μg/m3 in 367 cities.[190] The proportion of days with "good quality air" was up 11.4% compared with the same time last year in 337 cities across China, according to its Ministry of Ecology and Environment.[191]

With the purpose of modeling the impact of COVID-19 lockdowns on urban surface ecological status (USES), Firozjaei, M. et al. have used a comprehensive ecological evaluation index (CEEI) to model and compare the USES during the lockdown and pre-lockdown periods. The results show that during the lockdown period, the USES has significantly improved due to the reduction of destructive human activities in the urban environment. The best USES is related to green spaces. Within the COVID-19 pre-lockdown, the worst USES were related to built-up lands in these cities, but on the lockdown dates, the mean CEEI of built-up lands decreased while it was lower than the mean CEEI of bare soils. Most of the changes in surface ecological conditions between the COVID-19 lockdown period and the COVID-19 pre-lockdown period were related to the built-up lands. Results of this study show that the effect of human activities on the heterogeneity of spatial distribution of surface ecological status in the urban environment can be higher than the effect of other parameters such as climatic conditions.[192]

Another impact of the lockdown measure is how it affected people's health. Collected data on a sample of college students at the time of the spread of the epidemic in China showed how about 24.9% of college students had experienced anxiety because of this COVID-19 outbreak. Living in urban areas, living with parents, and having a steady family income were protective factors for college students against experiencing anxiety during the health emergency.[193]

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[189] SteelFisher, G. K. el at. (2012). "Public response to the 2009 influenza A H1N1 pandemic: a polling study in five countries." The Lancet Infectious Diseases. 10.1016/S1473-3099(12)70206-2

[190] Zambrano-Monserrate, M. et al (2020). "Indirect effects of COVID-19 on the environment". Science of total environment. 10.1016/j.scitotenv.2020.138813

[191] Henriques, M. (2020). "Will Covid-19 have a lasting impact on the environment?". BBC. https://www.bbc.com/future/article/20200326-covid-19-the-impact-of-coronavirus-on-the-environment

[192] Firozjaei, M. et al. (2021). "Modeling the impact of the COVID-19 lockdowns on urban surface ecological status: A case study of Milan and Wuhan cities". Journal of Environmental Management. 10.1016/j.jenvman.2021.112236

[193] Cao, W. et al. (2020). "The psychological impact of the COVID-19 epidemic on college students in China." Psychiatry Research. 10.1016/j.psychres.2020.112934

JAPAN

In Japan, the working and commuting activities exhibited a moderate decrease (16.1% decrease for working activity and 18.9% decrease for commuting activity) after the government issued a remote-working request on February 26, 2020. Both activities decreased significantly (47.8% decrease in working activity and 49.1% decrease in commuting activity) after the declaration of a state of emergency on April 7, 2020. It is worth noting that a mild drop in working and commuting activities was observed at the end of March 2020, suggesting that individuals started to change their mobility behavior even before the official declaration of the state of emergency, probably due to the increasing number of confirmed cases of COVID-19. The trend of social gathering activity is similar to that of working activity. A two-stage decrease in social gathering activity was observed: a mild drop (13.7% decrease) after the government's remote working request and a sharp decrease (84.1% decrease) after the declaration of a state of emergency. Compared with working activity, social gathering activities decreased to a much greater extent because they are associated with a higher risk of infection.[194]

DENMARK

In Denmark, there was a significant drop in downtown activities - especially on commercial shopping streets. The city is being used more for recreation, play, and exercise and the use of public space is more or less the same as before, while movements and mobility from one place to another have decreased significantly. Local places that already offer a public activity (such as a playground) are even more popular than before, and some of them are too popular where social distancing rules are difficult to follow. The search for essential outdoor and climatic human needs is now more valuable, the public spaces are being used like never before, especially by children and older people, and new activities and forms of urban life are emerging in many cities. Women use public space differently than men and are often seen in pairs, while men are often seen alone or in groups of 4 or more. Overall mobility has decreased in the city, but pedestrian movement is increasing in neighborhoods outside of the city center.[195]

SWEDEN

Even though Sweden has not had any form of lockdown, the Covid-19 pandemic has during a relatively short period of time brought changes to society, significantly disrupting everyday life. Data from the largest mobile phone operator in the country revealed a decrease in the number of trips by almost 50 percent in some Swedish cities

[194] Wu, L., Shimizu, T. (2022). "Analysis of the impact of non-compulsory measures on human mobility in Japan during the COVID-19 pandemic". Cities. https://openknowledge.worldbank.org/handle/10986/37738
[195] Gehl (2020). "Public Space, Public Life & COVID-19". https://covid19.gehlpeople.com/

during March 2020. In Stockholm and Malmö, travel decreased by 28 percent, in comparison to a decrease of 37 percent for Copenhagen.[196] A Swedish study indicates a transition from using public transport to traveling by private car, cycling, or walking, highlighting that every second respondent is doubtful about returning to public transport after the pandemic.[197]

Another study focused on understanding how the early stages of a pandemic have translated into changes in mobility as an element of everyday life and travel behavior. Several respondents from Malmö mentioned and mapped out new activities in which they have begun to engage since the outbreak of the Covid-19 pandemic. These activities were highly typified by *a shift to the outdoors*. Mentions of new activities were characterized by walking for leisure or in forested areas or parks, hiking, trips to the beach, and exercising outdoors instead of indoors. These activities were usually linked to mentions of running, jogging, yoga, and, less frequently, tennis and basketball. New or more frequent visits to playgrounds, DIY stores, and garden centers were also tangible.[198]

Hobbies and sports were less characterized by cancellation and more by the individual's optional, voluntary adjustment of her participation in the activity. While some mentioned the activities being stopped, discontinued, or canceled by the providers, the individuals having themselves chosen to no longer partake in the activity – most often the gym – were more apparent. Less visible than expected, although still mentioned, were activities such as meeting friends online, reading books, at-home activities, gardening, exercising at home, studying, spending time with the family, cycling, getting take-away food, and working from (someone else's) home. Spending more time in a holiday home, helping friends, and helping people in at-risk groups were also mentioned.[199]

In Stockholm, the noise level was analyzed to understand the impact of the Swedish authorities' recommendations. A substantial and sustained drop in noise levels was observed during March and April 2020, wherein a peak drop of more than 4 dB(A) was observed on the daily average. During the week of Midsummer celebrations in June, an important holiday for the country, the noise levels were still lower than the usual,

[196] Telia (2020). "Så har corona-krisen påverkat svenskarnas resvanor". https://www.telia.se/privat/aktuellt/hemma-i-folknatet/resvanor

[197] WSP (2020). "Så påverkas pendlingsvanor av en pandemi". https://www.wsp.com/sv-SE/insikter/sa-paverkas-pendlingsvanor-av-en-pandemi

[198] Bohman, H. et al. (2021). "A study of changes in everyday mobility during the Covid-19 pandemic: As perceived by people living in Malmö, Sweden." Transport Policy. 10.1016/j.tranpol.2021.03.013

[199] Bohman, H. et al. (2021). "A study of changes in everyday mobility during the Covid-19 pandemic: As perceived by people living in Malmö, Sweden." Transport Policy.

characterizing a lower human activity.[200] Just like in Japan, there was no strict lockdown over that period in Sweden, but these noise measurements indicate rapid compliance of the Stockholmers embracing the recommendations and slowdown of urban activities.

ITALY

In Italy, the most extensive travel restrictions were put in place since World War Two.[201] As in Wuhan, the city of Milan had improvements in urban surface ecological status (USES) related to green spaces during the lockdown.[202] The restrictions imposed by COVID-19 in Italy also strongly influenced the population's perceptions of urban green areas, with a consequent increase in general interest in such spaces. A study based on a survey indicates that more than 70% of the respondents felt the need to use green areas, in some cases even urgently. Moreover, the potential for becoming a volunteer to contribute to maintaining green areas near their homes (such as in the context of a time bank) was a measure of their increase in interest about the topic. In addition, it was possible to see how respondents associated a feeling of psychophysical wellbeing with green areas and, in particular, with gardening activities linked to plant cultivation. Furthermore, one out of two respondents stated that they would like to use urban green spaces much more frequently at the end of the lockdown.[203] The study supports the idea that the citizens' need for green spaces increased, and the population could perceive how important it was for their well-being especially in times of quarantines and social isolation.

Reduced transport has had a positive impact on air quality during the confinement in many parts of the world, including Italy. Levels of nitrogen dioxide (NO2), a pollutant linked to cars, dropped around 45% between 13 March and 13 April 2020 compared to the year before in the city of Milan and Roma in Italy, and also in Madrid, Spain.[204] Besides that, the restrictions also impact the mental health of children and young adults in both countries. Research involving 1,143 participants that were parents of Italian and Spanish children aged 3 to 18 years shows that 85.7% of the parents perceived changes in their children's emotional state and behaviors during the quarantine. The most frequent symptoms were difficulty concentrating (76.6%), boredom (52%), irritability

[200] Rumpler, R. et al. (2020). "An observation of the impact of COVID-19 recommendation measures monitored through urban noise levels in central Stockholm, Sweden." Sustainable Cities and Society. 10.1016/j.scs.2020.102469

[201] Henriques, M. (2020). "Will Covid-19 have a lasting impact on the environment?". BBC.

[202] Firozjaei, M. et al. (2021). "Modeling the impact of the COVID-19 lockdowns on urban surface ecological status: A case study of Milan and Wuhan cities". Journal of Environmental Management.

[203] Larcher, F. et al. (2021). "Perceptions of Urban Green Areas during the Social Distancing Period for COVID-19 Containment in Italy." Horticulturae.

[204] OECD Policy Responses to Coronavirus (COVID-19) (2020). "Tackling coronavirus (COVID-19): Contributing to a Global Effort. Cities Policy Responses". https://www.oecd.org/coronavirus/en/policy-responses

(39%), restlessness (38.8%), nervousness (38%), feelings of loneliness (31.3%), uneasiness (30.4%), and worries (30.1%). Spanish parents reported more symptoms than Italians. As expected, children of both countries used monitors more frequently, spent less time doing physical activity, and slept more hours during the quarantine.[205]

SPAIN

In Spain, the reduction in traffic was noticeable since the beginning of the restrictions. The city of Madrid registered a 14% drop in rush hour traffic after the first days of confinement,[206] and in Santander mobility decreased by 76 percent, while public transport users dropped by 93 percent, with less substantial effects on the use of the private car. NO2 emissions were reduced by up to 60%, and traffic accidents were reduced by up to 67% in relative terms.[207] Two-thirds of the country's population that used to visit urban green spaces (UGS) regularly stopped going, while 36 percent continued making their way to some UGS. The reduced visitation was in fact not evenly distributed among different population groups; for example, a larger reduction was seen among female visitors.[208] This evidence that the need for greenery and open air certainly did not disappear with the restrictions to access such places, but most of the people respected the restrictions rules. The lack of tourists has caused a notable change in the appearance of many beaches worldwide. For example, in Barcelona, the beaches looked cleaner and had crystal clear water during the lockdown.[209]

NEW ZEALAND

In New Zealand, people felt more connected with nature during Alert Levels 3 and 4, generating a sense of calm and appreciation.[210] This may provide a partial explanation for the increase in outdoor recreation activity reported by New Zealand's Department of Conservation (DOC) following the lifting of the Level 4 restrictions. For example, data from the Awaroa/Godley Head coastal walking track near the city of Christchurch showed a 55 percent increase on 2019 in visitor numbers for May 2020—which coincides with both the shift from Level 4 to Level 3 (April 27, 2020) and the shift from Level 3 to Level 2 (May 13, 2020). In the winter that followed, outdoor recreation also received significant attention in the New Zealand news media for its unexpected popularity. Outdoor walking was perceived to increase across all three periods, but by

[205] Orgilés, M. (2020). "Immediate Psychological Effects of the COVID-19 Quarantine in Youth From Italy and Spain". Frontiers in Psychology. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.579038/full
[206] OECD Policy Responses to Coronavirus (COVID-19) op. cit.
[207] Aloi, A. et al. (2020). "Effects of the COVID-19 Lockdown on Urban Mobility: Empirical Evidence from the City of Santander (Spain)." Sustainability. https://www.mdpi.com/2071-1050/12/9/3870
[208] Ugolini, F. et al. (2020). "Effects of the COVID-19 pandemic on the use and perceptions of urban green space: An international exploratory study." Urban Forestry & Urban Greening. 10.1016/j.ufug.2020.126888
[209] Zambrano-Monserrate, M. et al (2020). "Indirect effects of COVID-19 on the environment". Science of total environment. 10.1016/j.scitotenv.2020.138813
[210] Whenua, M., & Landcare Research. (2020). "Slowing down enabled connection with nature". https://www.landcareresearch.co.nz/news/slowing-down-enabled-connection-with-nature/

far the most frequently discussed aspect of walking was the displacement to neighborhood walking during the restricted period. This suggests that neighbourhood walking as a substitute for other recreational settings and activities may have been a useful temporary coping strategy for New Zealanders during the restricted period. However, it was not an enduring behavioral change once restrictions were lifted.[211]

AUSTRALIA

In Australia, an examination of attitudes to green spaces and their utilization in October 2020 compared various metropolitan and regional communities. Of particular relevance is the comparison of Melbourne, a metropolitan community of 4.9 million people in lockdown, with Sydney, a metropolitan community of 5.2 million people not in lockdown but subject to social distancing rules (e.g., 1 person/4 sqm). People in lockdown reported an increased visitation of green spaces, for longer periods of time (cumulative), with greater levels of perceived benefits, not only in terms of physical exercise, but also in terms of solace/respite and an increased sense of connectedness with neighbors.[212] Broadly similar patterns, with particular emphasis on the physical and mental health benefits, were observed by other authors for Brisbane, a metropolitan community of 2.6 million people. About 36% of the surveyed people increased their urban green space use, but 26% reduced it, indicating a great deal of flux. Furthermore, 45% of the previous non-users of urban green space began using it for the first time during the restrictions period. Older people were less likely to increase their green space use, and those with a backyard were more likely to increase their use of green spaces.[213]

The COVID pandemic brought about a greater use of green spaces in the metropolitan centers of Australia compared with the regional communities. Furthermore, people working from home were more likely to use green spaces, to utilize them more often and for longer periods for respite and exercise, and were also more likely to discover previously unvisited green spaces. Significant, unanticipated findings were that a decreased use of green spaces was correlated with the perceived financial situation. People experiencing increased financial difficulty due to the COVID situation were less likely to utilize green spaces and found them less relevant to stay connected with

[211] Espiner, M., Degarege, G., Stewart, E., Espiner, S. (2022). "From backyards to the backcountry: Exploring outdoor recreation coping strategies and experiences during the 2020 COVID-19 pandemic in New Zealand". Journal of Outdoor Recreation and Tourism. 10.1016/j.jort.2022.100497

[212] Spennemann, D. (2021). "Exercising under COVID-2x: Conceptualizing Future Green Spaces in Australia's Neighborhoods". Urban Science. https://www.mdpi.com/2413-8851/5/4/93

[213] Berdejo-Espinola, V., Suárez-Castro, A.F., Amano, T., Fielding, K.S., Oh, R.R.Y., Fuller, R.A. (2021). "Urban green space use during a time of stress: A case study during the COVID-19 pandemic in Brisbane, Australia." People and Nature. 10.1002/pan3.10218

neighbors, to find respite, or to conduct exercise.[214] A study by Dushkova et al. examined the perceived future demand for urban green spaces as a result of the experiences during the pandemic. For Perth residents, more street greening (77%) was the top priority, followed by natural bushland (60%). More than 40% of the respondents argued for more pocket parks, more green spaces close to home, more community gardens, and more greening of front yards. In terms of public park infrastructure, more seating (benches) and more shelter/shade were deemed desirable.[215]

4.3. Future built environments

CHINA

With the COVID-19 outbreak under control, Chinese authorities started thinking proactively about more systemic measures to recover from the pandemic impacts. To build resilience against future pandemics and emergencies, the Ministry of Housing and Urban-Rural Development (MoHURD) announced urban residential planning and design standards. These provide clear requirements on FAR, building density, building height, and green space ratio. In response to the need to build infectious hospitals, the Urban Planning Society of China developed guidelines for site selection, design, construction, and operation management of emergency infectious disease hospitals.[216]

The General Office of MoHURD issued a notice in March 2020 requesting that besides coordinating and promoting the prevention and control of the new crown pneumonia epidemic, urban drainage and waterlogging prevention work should be done as well. The "Notice" requires that work responsibilities should be assigned to specific positions and individuals one by one to prevent blind spots. The person in charge of urban drainage and waterlogging prevention and control shall, according to the local situation of COVID-19 prevention and control, solidly promote the urban drainage and waterlogging prevention work, ensure the safety of the city during the flood season, and avoid personal casualties and major property losses caused by heavy rain and waterlogging.[217]

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[214] Astell-Burt, T., Feng, X. (2021) "Time for 'green' during COVID-19? Inequities in green and blue space access, visitation and felt benefits". International Journal of Environment Research and Public Health. https://www.mdpi.com/1660-4601/18/5/2757

[215] Dushkova, D., Ignatieva, M., Hughes, M., Konstantinova, A., Vasenev, V., Dovletyarova, E. (2021). "Human dimensions of urban blue and green infrastructure during a pandemic. Case study of Moscow (Russia) and Perth (Australia)". Sustainability. https://www.mdpi.com/2071-1050/13/8/4148

[216] Wu, X., Wang, S. (2021). "Influence of COVID-19 on China's Urban Planning and Design Regulations: A Systematic Review of Recent Policy and Regulatory Changes." https://openknowledge.worldbank.org/handle/10986/37738

[217] Ministry of Housing and Urban-Rural Development – China (2020). "Ministry of Housing and Urban-Rural Development: Coordinate the promotion of epidemic prevention and control and do a good job in urban drainage and waterlogging prevention". https://app.www.gov.cn/govdata/gov/202003/29/456638/article.html

Another important measure taken by the Chinese government is to promote the reduction of construction waste using a waste management system in order to save resources and protect the environment. For this reason, the MoHURD issued the "Guiding Opinions on Promoting the Reduction of Construction Waste" (hereinafter referred to as the "Opinions") to guide and urge all the competent departments of housing and urban-rural construction at the first level shall establish and improve the working mechanism for the reduction of construction waste, strengthen the control of the source of construction waste, promote the transformation of the production organization mode of engineering construction, effectively reduce the generation and discharge of construction waste in the process of engineering construction, and continuously promote the sustainable development and development of engineering construction.[218]

The "Opinions" emphasize that the primary responsibility of the construction unit in the reduction of construction waste should be implemented; all construction entities should actively carry out green planning, implement green design, promote green construction, and adopt advanced technology, equipment, and management measures; The competent departments of housing and urban and rural construction at the first level should strengthen organizational guarantee and overall management, actively guide and support, improve the standard system, strengthen supervision and guidance, and increase publicity efforts to ensure that the reduction of construction waste is implemented. At the same time, the Ministry organized the compilation of the "Guidebook for the Reduction of Construction Waste at Construction Sites (Trial)", put forward corresponding technical and management measures, and provided further specifications and guidance for the reduction of construction waste at construction sites.[219]

The country also wants to promote a strong transportation system and build new infrastructure in the field of transportation: Smart Highway; Smart railways; Smart waterway; Smart port; Smart civil aviation; Smart Post; Wisdom Hub; New energy and new material industry applications. By 2035 the country expects to achieve a transportation infrastructure that operates with a low level of energy consumption.[220] Another action to reduce the emission of pollutants is the guarantee that from January

[218] Ministry of Housing and Urban-Rural Development – China (2020). "Ministry of Housing and Urban-Rural Development: Promoting the reduction of construction waste".
https://app.www.gov.cn/govdata/gov/202005/17/458565/article.html
[219] Ministry of Housing and Urban-Rural Development – China (2020). "Ministry of Housing and Urban-Rural Development: Promoting the reduction of construction waste"
[220] Transportation Department – China (2020). "Guiding Opinions of the Ministry of Transport on Promoting the Construction of New Infrastructure in the Field of Transportation"
https://xxgk.mot.gov.cn/2020/jigou/zhghs/202008/t20200806_3448021.html?from=timeline

1, 2021, to December 31, 2022, the purchase of new energy vehicles will be exempted from vehicle purchase tax.[221]

JAPAN

As part of Japan's recovery strategy, the country has developed the "Roadmap to Zero Emissions from International Shipping", which provides emission pathways for global decarbonization as soon as possible in this century and a plan of actions during this decade, with a view to leading and contributing to the global efforts to tackle the climate challenge. Japan is also investing in research on how natural disasters will change over the next 100 years, quantifying the probability of climate change impact on typhoons and flooding etc., and assessing the impact of climate change with the worst-case scenarios. These research studies are expected to contribute to better adaptations in Japan after the COVID-19 crisis.[222]

To address waste management issues relevant to COVID-19, Japan is implementing initiatives to promote environmentally sound management of infectious waste, such as considering various countermeasures based on individual circumstances, creating communication documents related to measures, and sharing information with local governments and relevant organizations and developing a collection with automated control.[223]

The drastic decrease during 2020 in the number of foreign tourists visiting Japan has had a major impact on the management of tourism businesses, and for this reason, the Ministry of the Environment has developed the "National Park Enjoyment Project". The project aims to revitalize the local economy by maintaining and securing employment for businesses related to national parks, appealing first to the domestic market. Furthermore, the project also promotes the "Workation", which is defined as people enjoying vacations while working by telecommuting outside of their everyday workplaces, such as in tourist areas. Japan is planning to promote "workations" in National Parks and hot springs through providing infrastructural support (Wi-Fi availability).[224]

[221] Ministry of Finance – China (2020). "Announcement of the Ministry of Finance and the State Administration of Taxation of the Ministry of Industry and Information Technology on New Energy Vehicles Exemption from Vehicle Purchase Tax." State Taxation Administration. http://www.chinatax.gov.cn/chinatax/n371/c5148803/content.html
[222] Platform for REDISIGN 2020. (2021). "Policies, measures and actions on climate change and environmental protection in the context of COVID-19 recovery. – JAPAN". https://platform2020redesign.org/countries/japan/
[223] Platform for REDISIGN 2020. (2021). "Policies, measures and actions on climate change and environmental protection in the context of COVID-19 recovery. – JAPAN".
[224] https://www.env.go.jp/guide/budget/r02/r0204-hos-gaiyo/full.pdf

DENMARK

Since the beginning of 2021, Member States and EU institutions have been preparing intensively to launch the recovery instrument, Next Generation EU (NGEU). The largest part of the NGEU budget (90%) is dedicated to the Recovery and Resilience Facility (RRF), which is a key, temporary, short-term instrument that aims to draw up national recovery and resilience plans by the Member States to address the consequences of and challenges posed by the Covid-19 pandemic. With that said, all the European Countries analyzed in this chapter have produced their own recovery and resilience plan that are based on six pillars: Green transition; Digital transformation; Smart, sustainable and inclusive growth; Social and territorial cohesion; Health and economic, social and institutional resilience; and Policies for the next generation.[225]

The Danish Recovery and Resilience Plan combined with national stimulus funds aims at ensuring a swift and green recovery from the pandemic.[226] The combined stimulus funds will simultaneously accelerate the green transition of the Danish society. Massive investments are necessary to ensure 70 percent reductions in greenhouse gas emissions by 2030 and climate neutrality by 2050, which is why more than 90 percent of the funds in the Danish Recovery and Resilience Plan are allocated to initiatives that support the green transition.

The Danish Recovery and Resilience Plan will prove that economic growth and green transition are not opposites. The solution to both climate change and the restoration of the economy following the COVID-19 pandemic is to invest in the creation of green jobs and growth. For the economy to recover, it is crucial that the Danish government contributes to bring back the lost jobs by restoring demand. The Danish recovery plan contains measures that will contribute to job creation in 2021 and 2022 as well as investments in technologies that will potentially create many more jobs in the future. Job creation will contribute to maintaining a high degree of social cohesion and making sure that no one will be left behind as the economy recovers from the pandemic.[227]

The Danish Recovery and Resilience Plan is divided into seven different initiatives, and the first one is to Strengthen the Resilience of the Healthcare System., which has been challenged by the large numbers of hospitalizations during the COVID-19 pandemic. It is important that the healthcare system has the necessary resources to handle the

[225] Sapala, M., Thomassen, N. (2021). "Recovery plan for Europe: State of play, September 2021". EPRS – European Parliamentary Research Service.
https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/696209/EPRS_BRI(2021)696209_EN.pdf
[226] Ministry of Finance (2021). "Denmark's Recovery and Resilience Plan – accelerating the green transition".
https://fm.dk/media/18771/denmarks-recovery-and-resilience-plan-accelerating-the-green-transition_web.pdf
[227] Ministry of Finance (2021). "Denmark's Recovery and Resilience Plan – accelerating the green transition".

aftermaths of the COVID-19 pandemic as well as being ready to handle future pandemics or other large disease outbreaks.

The transport sector is one of the largest emitters of greenhouse gasses in Denmark. The sector alone is responsible for approximately 25 percent of the Danish emissions. In order to reach the ambitious target of reducing greenhouse gas emissions by 70 percent by 2030, reductions in the transport sector are essential. Within road transportation, new technology allows for a transition towards greener and more environmentally sustainable solutions. To achieve this goal, the Danish government will invest in campaigns to encourage car sharing and carpooling, infrastructure for cycling and electric bikes, and green ferries.

Cycling combines mobility with exercise and contributes to improving public health, while at the same time being a very environmentally and climate-friendly form of transport. Denmark is among the world's best cycling nations. However, continued focus on cycling and investments in bicycle infrastructure is necessary if this leading position is to be maintained and more people are to choose the bicycle. For this reason, the focus is to scheme new infrastructure for electric bikes.

As it is not decided whether the funds will be targeted for cycling commuters or recreational cycling, it is not possible to estimate exactly how many, e.g., bike charging stations the investment will be able to finance. The bicycle can be used as an alternative to other modes of transport both in the cities and in the rural areas to a much greater extent than today. Especially electric bicycles can expand the bikeable distances while also improving public health.

The Danish Recovery and Resilience Plan also outline investments in bike paths on state roads and a bicycle subsidy scheme for municipalities. In Denmark, the bicycle traffic has been stagnant or even declining for several years. Only in the larger cities, where cycling is a faster and easier choice than other modes of transport, has bicycle traffic been increasing. Outside the urban areas, the bicycle is not a natural first choice in everyday life. Therefore, it is necessary to make it more attractive to choose the healthy and CO2 neutral bike instead of the car.

Denmark is one of the countries with the highest production of waste per capita: 844 kilograms per person while in Europe the media is 502 kilograms per person.[228] Thus, there is a need for Denmark to reduce waste and recycle such waste such that new products are produced largely from renewable resources instead of fossil raw materials. The strategy to decrease plastic and textile waste and increase the quantity and quality of reusable materials is focused on "private-public partnerships with projects within

[228] Eurosat – Your key to European statistics. (2021). "Half a tonne of municipal waste generated per person in the EU". https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210216-1

circular economy and technologies that can help reuse and reduce plastic and textile waste can apply for funding through Innovation Fund Denmark."[229]

Regarding the Digital transformation pillar, Denmark's plan will implement a new digital strategy that consists of five sub-reforms covering all sectors of society: Creating the digital public sector; Securing the digital professions and jobs of the future; Creating better opportunities for co-creation and innovation by using new technologies and public-private partnerships; and promote high-speed internet access for citizens, households, and companies in rural areas across the country.

SWEDEN

Following the unprecedented crisis caused by the COVID-19 pandemic, Sweden's recovery and resilience plan respond to the need of fostering a strong recovery and making Sweden future-ready. The reforms and investments in the plan will help Sweden become more sustainable, resilient, and better prepared for the challenges and opportunities of the green and digital transitions. To this end, the plan consists of 15 reforms and 12 investments.[230] The reforms and investments describe general measures regarding the six pillars defined to all Member States of the EU, but do not specify where and how these will be implemented. For instance, regarding sustainable and inclusive growth, it is said that the country will invest in new bike lanes, but no specific location or deadline is given. Furthermore, a website was developed to keep the community informed about the Recovery Plan, but the community was never involved in its production.

The Swedish government see the recovery from the pandemic as an opportunity to solve two crises at the same time: the economic crises and the climate crises.[231] For this reason, one June of 2020, the Scandinavian Airlines System, known as short SAS, presented a plan for the recapitalization of the company and a plan to accelerate its climate action, including halving emissions by 2030. The company is a multi-national airline from Sweden, Norway, and Denmark, and, as Sweden is the largest owner, it is natural that it takes responsibility in this crisis, but responsibility will also be required from other stakeholders.[232]

[229] Ministry of Finance (2021). "Denmark's Recovery and Resilience Plan – accelerating the green transition".
[230] European Commission. (2022). "Recovery and resilience plan for Sweden". https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility/recovery-and-resilience-plan-sweden_en
[231] Platform for REDISIGN 2020. (2020). "Policies, measures and actions on climate change and environmental protection in the context of COVID-19 recovery. – SWEDEN".
https://platform2020redesign.org/countries/sweden/
[232] Ministry of Enterprise and Innovation, Ministry of Finance (2020). "Recapitalisation of SAS AB". Regeringskansliet.

According to the Minister of Financial Markets and Housing, the Swedish Government has imposed strict climate and environmental requirements on SAS in conjunction with its recapitalization. As a consequence of these, the company is now sharpening its climate targets and will now decrease carbon dioxide emissions by 25 percent by 2025, five years earlier than previously planned before the pandemic. It is very positive that SAS considers that emissions can be reduced by 50 percent by 2030. This target must be achieved, and, as an owner, the Government will continue its dialogue with the company on these issues.[233]

The corona pandemic has caused profitability problems for freight operators by rail, and to stimulate and secure the transfer of goods from road to rail, in 2020 the Swedish government invested in environmental compensation for goods operators that used the rail. The investment is part of the work to reduce emissions in the transport sector and make a green restart after the corona pandemic. It contributes to a more environmentally friendly transport system and to achieving our lofty climate and environmental goals.[234]

In 2020, the "15-minute city", which will be discussed further, became one of the hottest ideas in urban planning. Now Sweden is pursuing a hyperlocal twist called the one-minute city. It aims to transform entire neighborhoods, one street at a time.[235] The Street Moves' project was piloted by the Swedish national innovation body Vinnova and design think tank ArkDes. The approach focuses on "the space outside your front door — and that of your neighbours adjacent and opposite". The goal is not to make everything available within one minute, but rather to reimagine the patches of street immediately outside the home as "critical connecting spaces for communities" and not just "places to move and store cars." It is being tested in four sites around Stockholm, and if successful, Sweden plans to implement the program in every street in the country by 2030. [236]

[233] Ministry of Enterprise and Innovation, Ministry of Finance (2020). "Recapitalisation of SAS AB". Regeringskansliet.
[234] Finansdepartementet, Infrastrukturdepartementet (2020). "200 miljoner kronor till godstransporter på järnväg." Regeringskansliet. https://www.regeringen.se/pressmeddelanden/2020/06/200-miljoner-kronor-till-godstransporter-pa-jarnvag/
[235] Poon, L.. (2021). "CityLab Daily: Make way for "One-Minute City". Bloomberg. https://www.bloomberg.com/news/newsletters/2021-01-05/citylab-daily-make-way-for-the-one-minute-city
[236] Antunes, M., Barroca, J., Oliveira, D. (2021). "Urban Future With a Purpose - 12 trends shaping the future of cities by 2030." Deloitte. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/deloitte-urban-future-with-a-purpose-study-set2021.pdf

Figure 21: 1-minute city on Halsingegatan, Stockholm.
(Yapp, R. The one-minute city: how Stockholm is going 'hyperlocal'. The Local, 2021)

As a result of this transformation, residents will be able to decide how street space is used and allocated through community workshops and consultations. The concept encourages every location to activate individual blocks using shared spaces. The models used in the transformation strategy draw inspiration from 'parklet' models and contribute to Sweden's commitment to becoming a carbon-neutral city by 2045.[237]

ITALY

In September 2020, the proposal for guidelines for the drafting of the *Piano Nazionale di Ripresa e Resilienza*, was approved and the Government was invited to prepare the Plan, guaranteeing a broad involvement of the private sector, local authorities, and the country's productive forces. The project intends to support the sustainable and resilient development of rural and mountain areas that intend to exploit in a balanced way the main resources they have, including, first of all, water, forests, and landscape, starting a new subsidiary and exchange relationship with the urban and metropolitan communities. In particular, the scope of these plans will include in an integrated way (for a total of 30 Green Communities): the production of energy from local renewable sources, such as micro hydroelectric plants, biomass, biogas, wind, cogeneration, and biomethane; the construction and sustainable management of the building stock and infrastructure of a modern mountain; energy efficiency and intelligent integration of plants and networks; and the integration of the services of mobility.

[237] Antunes, M., Barroca, J., Oliveira, D. (2021). "Urban Future With a Purpose - 12 trends shaping the future of cities by 2030." Deloitte

The National Plan provides for the construction of approximately 570 km of urban and metropolitan cycle paths and approximately 1,250 km of tourist cycle paths. It also provides for the construction of 240 km of a network equipped for rapid mass transport infrastructures divided into metro (11 km), trams (85 km), trolleybuses (120 km), and cable cars (15 km). The focus of the intervention will be mainly on the metropolitan areas of the major Italian cities. The goal is to achieve a shift of at least 10 percent of the traffic on private cars to the public transport system.

There are plans to speed up the main passenger lines and increase the capacity of rail freight transport along the country's priority North-South and East-West axes, in order to promote territorial connectivity and the transfer of traffic from road to rail over long distances. In particular, in the North of the country, the Milan-Venice, Verona-Brenner, and Liguria-Alpes rail routes will be upgraded, improving transalpine connections with the ports of Genoa and Trieste; in the Center of the country, two East-West axes (Rome-Pescara and Orte-Falconara) will be strengthened, significantly reducing travel time and increasing capacity; the Adriatic line from North to South will also be upgraded and speeded up.

High-speed rail will be extended to the South with the completion of the Naples-Bari line, further advancement of the Palermo-Catania-Messina line, and the construction of the first functional lots of the Salerno-Reggio Calabria and Taranto-Potenza-Battipaglia lines. One of the big advantages of these improvements is the reduction of travel time with more than 60 minutes on each route.

Italy will also invest in the digitalization of public services, allowing citizens to have proper access to them even in times of social distance. Investments in technology to improve economic development and sustainability in connection with the climate changes are predicted in the plan. The new technologies can anticipate the implications of climate change through satellite observation, both for the natural continental / European scale that distinguishes the scope of action and coordination of investments.

Besides the *Piano Nazionale di Ripresa e Resilienza*, each city had also worked on its own measures for the post-pandemic environment. Milan worked on its *Strategie di adattamento* since the first months of the COVID-19 emergency. With the involvement of 2.967 city inhabitants during April and May 2020, the strategy includes a future improvement proposal for urban mobility and spaces and also was a fundamental document for the implementation of the bike lanes during the lockdown period.[238] Milan is implementing the 15-minute city idea mentioned in chapter 2.3.2. The concept

[238]Comune di Milano (2020) "MILANO 2020. STRATEGIE DI ADATTAMENTO". https://partecipazione.comune.milano.it/processes/milano2020

was popularized by Paris mayor Anne Hidalgo who used it during her re-election campaign in 2020, for which Moreno served as scientific advisor. Since then, it's been mentioned as a strategy to recover from the COVID-19 outbreak by many other cities around the world, such as Portland (USA), Buenos Aires (Argentina), and Milan.[239] Before that, in 2019, the city of Melbourne had already used the strategy of 20-Minutes Neighborhoods.[240]

SPAIN

The outbreak of the COVID-19 pandemic at the beginning of 2020 has had a strong impact on the Spanish economy and has led to a particularly intense drop in activity in those sectors, putting an end to more than five years of growth affected by the reduction in demand and mobility restrictions. To revert this situation, the Spanish *Plan de Recuperación, Transformación y Resiliencia* incorporates an important agenda of investments and structural reforms, which are interrelated and provide feedback to achieve four cross-cutting objectives: moving towards a greener, more digital Spain, more cohesive from a social and territorial point of view, and more egalitarian.[241]

The Government has incorporated the participation of the different public institutions and political groups, social agents, and the business fabric as a central element in the preparation of the Plan, under the conviction that only in this way, through dialog and collaboration, reforms and investments can be designed with the potential to transform a country. The objective has been for the Plan to be defined based on a broad consultative process, in which the social agents have a relevant role, both in the definition of the reforms and investments, and in the execution of the Plan itself. The incorporation of the social agents has also contributed to providing transparency to the drafting process of the Plan.

To facilitate this participation process, different consultation spaces have been defined in order to collect the proposals and opinions of all the relevant actors: the social agents, the Autonomous Communities, the Local Entities, the forces parliamentarians, representative institutions, and organizations of each sector involved, the potential beneficiary companies of the Plan, and the citizenry as a whole.

Aiming to achieve a higher sustainable, safe, and connected urban and metropolitan environment, the government wants to promote the decarbonization of urban

[239] C40 Cities Climate Leadership Group, City of Buenos Aires (2022). "Benchmark: 15-minute cities". https://www.c40knowledgehub.org/s/article/Benchmark-15-minute-cities?language=en_US

[240] Victoria State Government (2019). "20-Minute Neighbourhoods – Creating a more liveable Melbourne". https://www.planning.vic.gov.au/__data/assets/pdf_file/0031/428908/Creating-a-more-liveable-Melbourne.pdf

[241] Gobierno de Spaña, Spaña Puede (2021). "Plan de Recuperación, Transformación y Resiliencia". https://planderecuperacion.gob.es/#:~:text=Espa%C3%B1a%20podr%C3%A1%20recibir%20hasta%20140.000,resto%20corresponde%20a%20cr%C3%A9ditos%20disponibles

mobility, the improvement of air quality, and the quality of life in cities, taking advantage of the economic, social, and industrial opportunities associated with this transformation. To this end, the Spanish policies incorporate a deployment plan for recharging and boosting the infrastructure of the electric vehicle and new law on Sustainable Mobility and Financing of Transport that will regulate activities related to transport and mobility. This includes issues related to the planning and financing of transport infrastructure and services, the improvement of governance, alternative fuels, inclusive mobility, the promotion of innovation and digitization, improving transparency and accountability.

Investments in low emission zones and digital and sustainable transformation of urban and metropolitan transport are also present in the Recovery Plan. Furthermore, an incentive plan for the installation of public and private charging points, for the acquisition of electric vehicles and battery fuel and drive lines for unique projects and innovation in electromobility, as well as recharging and green hydrogen to promote electric mobility.

For housing rehabilitation and urban regeneration, the main objectives are to promote the rehabilitation of the building stock in Spain, in line with the European Renovation Wave, and to increase the stock of social rental housing in energy-efficient buildings. To achieve this, it is essential the implementation of the Spanish Urban Agenda, which forms part of the current government program and frames a series of measures that constitute a true National Urban Policy, in which the Spanish Municipalities have a fundamental role and which is aligned with the objectives for sustainable rural and urban development.

Another Recovery strategy is the conservation and restoration of ecosystems and their biodiversity. Its objective is to achieve a good state of conservation of ecosystems through their ecological restoration when necessary and to reverse the loss of biodiversity, guaranteeing the sustainable use of natural resources and the preservation and improvement of their ecosystem services. Also, the preservation of the coastal space and water resources through actions for purification, sanitation, efficiency, savings, reuse, and safety of infrastructures.

The COVID-19 emergency situation has accelerated the digitization process in Spain, highlighting its strengths and also its shortcomings from an economic, social, and territorial point of view. Together with the goal of a green transition, the Recovery plan seeks to achieve modernization for the country. To this end, some of the strategies are:

- Shock plan for sustainable, safe, and connected mobility in urban and metropolitan environments;

- Housing rehabilitation and urban regeneration plan; Modernization of Public Administrations;
- Modernization and digitization of the education system, including early education from 0 to 3 years;
- Institutional reform and capacity building of the national science and innovation system;
- Digital connectivity, promotion of cybersecurity, and deployment of 5G.[242]

Besides the Plan for Recovery, by the end of June of 2020, Madrid has announced that it is considering an ambitious plan that would transform the city into car-free "superblocks", following Barcelona's model mentioned before. The idea would be to free up to 70% of the space dedicated to cars, which would also allow to increase green areas that would improve air quality and liveability. Furthermore, the Plan 360 in Madrid focuses on restricting private transport in the city center and promoting public transport with the expansion of 45 kilometers of bus lanes and the creation of Line Zero, the first free metropolitan bus line that will connect the city center district with its neighborhoods.[243]

NEW ZEALAND

Increased infrastructure investment will continue to play a critical part in securing New Zealand's recovery from COVID-19. Minister Grant Robertson states that for decades New Zealand's infrastructure has been neglected, which has helped fuel the housing crisis, made it difficult to reduce emissions, and negatively affected the country's productivity and overall wellbeing. With the health emergency, the need to improve the country's infrastructure became more urgent: the restoration of the national rail network will improve city resilience, support freight rail and metropolitan rail growth, and reduce emissions and congestion. Furthermore, investments in modernizing hospitals and schools are also planned from 2022 to 2026.[244]

In July 2020, Transport Minister Phil Twyford announced details of Auckland transport projects to help the region's economic recovery. Approximately 800 jobs are expected to be created through a $182 million investment in four transport projects, and this investment protects around 200 jobs on the two projects already underway. These projects will help create a safer, healthier, and more accessible city. They will not only motivate people to leave their cars at home and walk, cycle, or use public transportation instead, but will also help in reducing pollution and tackling climate

[242] Gobierno de Spaña, Spaña Puede (2021). "Plan de Recuperación, Transformación y Resiliencia"
[243] Prieto, A. (2020). "Reinventing cities in post-COVID-19 era: Spain." IGLUS – Innovative Governance of Large Urban Systems.
[244] Robertson, G. (2022). "Government delivers critical infrastructure". Beehive.govt.nz – The official website of the New Zealand Government. https://www.beehive.govt.nz/release/government-delivers-critical-infrastructure

change. One of the projects is the improvement of the North Western Motorway to allow faster and more frequent bus services, and another is a shared pathway along Whau River connecting the residential suburb of New Lynn and the waterfront suburb of Te Atatū. The projects also include local bus stop improvement, bus priority at motorway interchanges and along motorway shoulders in different parts of the city, and a 10-minute bus service to the airport.[245]

In August 2020, the Associate Minister of Transport, Julie Anne Genter, announced a new cycling and walking network along the Te Awa River Side. During the lockdowns, many families and kids went out with their bikes which was a motivation behind this new project: to make the population feel safer and more willing to cycle. When complete, the new infrastructure will be a 70 kilometers path, with an estimated 110,000 people will use the facility each year – which is likely to increase with the popularity of e-bikes and scooters, making the trip viable for both commuters and for those out for a recreational rides.[246]

The COVID-19 Recovery Fast-track Consenting Act 2020 is a key Government lever to grow the economy, boost jobs, speed up infrastructure development and improve environmental outcomes in response to the economic impacts of COVID-19. Approval for projects under the fast-track consenting process provides a significant reduction in the time taken to apply for resource consents – an average of 15 months per project – as well as provide the job and economic benefits that the act was designed to provide. The latest projects approved were two residential developments with supporting infrastructure and public open space. A third one is a repowering project that will redevelop and expand the existing wind farm, which will provide sustainable energy to the Tararua district.[247]

AUSTRALIA

In July 2020, the Australian Government announced a record $233 million investment into Parks Australia to deliver infrastructure upgrades across our national parks and at the Australian National Botanic Gardens. The welcome investment will be going towards projects to improve facilities across our parks to ensure the safety and wellbeing of the staff, visitors, and local communities and to enhance the visitor experience through new and upgraded infrastructure. New infrastructure and upgrades

[245] Twyford, P., Genter, Julie A. (2020). "Auckland transport infrastructure revealed". Beehive.govt.nz – The official website of the New Zealand Government. https://www.beehive.govt.nz/release/auckland-transport-infrastructure-revealed

[246] Genter, Julie A, (2020). "Green light for Te Awa River Ride in $220m nationwide cycleways investment". Beehive.govt.nz – The official website of the New Zealand Government. https://www.beehive.govt.nz/release/green-light-te-awa-river-ride-220m-nationwide-cycleways-investment

[247] Parker, D. (2022). "50 projects fast-tracked under Govt scheme." Beehive.govt.nz – The official website of the New Zealand Government. https://www.beehive.govt.nz/release/50-projects-fast-tracked-under-govt-scheme

to Commonwealth National Parks announced include: upgrades to shelters and water stations at visitor sites, upgrades to campgrounds including improved water storage, road repairs, improved staff housing, workshop and utility buildings, improved fuel storage and supply facilities, and car parks.[248]

HomeBuilder formed part of a range of Australian Government initiatives intended to support confidence in the residential construction sector and encourage consumers to proceed with purchases or renovations that may have been delayed due to uncertainty around the effects of the COVID-19 pandemic.[249]

[248] Australian Government (2020). "Record $233 million investment in Parks Australia". Parks Australia. https://parksaustralia.gov.au/news/record-investment-in-parks-australia/
[249] Australian Government (2022). "HomeBuilder". The Treasury. https://treasury.gov.au/coronavirus/homebuilder

4.4. Summary

The COVID-19 pandemic has caused tremendous damage to our society in terms of health, but also to the economy. Despite that, it has brought up thoughts about transferring some of the lessons learned from the pandemic and its lockdowns for climate change and its emerging consequences. The reduction of pollution emissions was a common effect of the pandemic in all the cities analyzed in this chapter and has been considered a key factor in planning for the recovery of a resilient city. In Italy and China, the improvement of the urban surface ecological status during each country's lockdown highlights how human activities can damage urban and non-urban environments and how it can be improved.

Spending time outdoors and visiting green areas was a trend all over the world. With the restrictions implemented to control the spread of the COVID-19 virus and due to social distancing, people started to use outdoor spaces more often to exercise instead of going to gyms. Going for a walk in the neighborhoods and public spaces became more common, and spending time surrounded by nature was a potential way to cope with the negative physical and psychological health impacts of major stressful life events. These changes were also noticeable in Japan and Sweden, the two countries that did not have lockdown policies, but the population still adapted their routines to the pandemic emergency. In Japan, there was a reduction in gathering activities, and in both countries, a shift to working from home.

From this analysis, it can be concluded that because of the COVID-19 led restrictions and advices, the need for green areas has become increasingly recognized. The benefits to well-being provided by urban green spaces seem to be strongly perceived by the population, especially in periods of social and spatial distancing. The COVID-19 pandemic provides an opportunity to build back better, rethinking the city from the group-up, integrating spatial and environmental justice in urban regeneration endeavors including mobility and accessibility of green and public spaces. Creating a well-connected and integrated system of public open spaces and streets makes more livable, resilient, and healthier cities and neighborhoods. These can help urban development decision-makers and practitioners to more prepare and adapt to a multiplicity of everyday risks and disasters, and also events such as pandemics.

Many countries planned to invest in general changes for the recovery from the COVID-19 pandemic, but some countries have taken further steps with interesting ideas:

- Car sharing and car poolings infrastructure for cycling (short and long trips) and electric bikes and green ferries (Denmark);
- Bike charging stations (Denmark) and car charging points (Spain, Italy);
- Decarbonization of urban mobility (Spain, Sweden);

- 1-minute city (Sweden);
- 15-minute city (France, Italy, Spain);
- "Workation" (Japan);
- Bus priority lanes (New Zealand);
- New bike and walking paths (New Zealand);

	Mobility Restriction	Mandatory Social Distance	Pop-up bike and walk paths
China	X		
Japan			
Denmark	X	X	
Sweden			
Italy	X	X	X
Spain	X	X	X
New Zealand	X	X	X
Australia	X		

Table 1: Summary of the restrictions taken to control the COVID-19 spread.

	Decreased air pollution	Decreased mental health	Decreased community mobility	Increased green areas visitation	Increased public space use
China	X	X	X		
Japan	X				
Denmark	X		X		X
Sweden	X		X	X	X
Italy	X	X	X	X	
Spain	X	X	X	X	
New Zealand	X			X	
Australia	X			X	

Table 2: Summary of indirect impacts of the COVID-19.

	Pollution		Urban mobility and space		
	Reduce GHG emission	Invest in Sewage Systems	Invest in public transport	Invest in bike structure	Invest in green areas
China	X	X	X		
Japan	X				
Denmark	X		X	X	
Sweden	X		X	X	
Italy	X		X	X	
Spain	X		X		
New Zealand	X		X	X	
Australia					X

	Community participation	Sustainability		
		CE (Circular economy)	Digitaliza-tion	Waste manage-ment
China			X	X
Japan				X
Denmark		X		X
Sweden				
Italy	X		X	
Spain	X		X	
New Zealand				
Australia				

Table 3: Summary of the strategies for the future urban planning.

5. STUDY CASE – Gothenburg, Sweden

In contrast to many other countries, Swedish authorities chose a path of strongly recommended measures rather than mandatory curfew or lockdowns. Citizens were advised to stay at home if they were feeling sick, to work from home as much as possible if able to, and to use public transport only if necessary. Furthermore, Sweden kept public transport services at or near nominal levels to achieve lower crowding and transmission risks. Even so, the shift in people's activity and mobility patterns were drastic, quick, and, as of yet, quite persistent. From an international perspective, Sweden exhibited high levels of transmission during spring 2020 but low levels during summer and early autumn.[250]

Even though there were no mandatory restrictions in Sweden, the virus impacted the country in various ways; previous studies compare the most significant three regions of the country to understand better the changes: the regions of Stockholm, Västra Götaland, and Skåne. Region Stockholm is the public transport authority for the Stockholm metropolitan area, which includes 26 municipalities with a total population of more than 2,3 million. Västra Götaland is a geographical area comprising 49 municipalities with a population of approximately 1,6 million. Although Västra Götaland Region is the public transport authority, the concrete tasks of planning, developing, commissioning, and marketing public transport are instead the responsibility of Västtrafik, which is a public company owned by the Västra Götaland Region. Region Skåne is a public transport authority in the most southern part of Sweden, for an area of 33 municipalities with a total population of approximately 1,3 million. Malmö is the largest city, but the region is polycentric and closely linked to Denmark's Copenhagen.

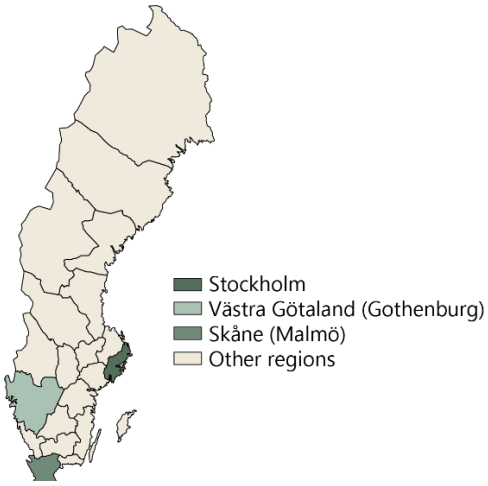

Figure 22: Sweden regions.
(WorldAtlas. Map of Sweden, 2021)

[250] Jenelius, E., Cebecauer, M. (2020). "Impacts of COVID-19 on public transport ridership in Sweden: Analysis of ticket validations, sales and passenger counts". Transportation Research Interdisciplinary Perspectives. https://www.sciencedirect.com/science/article/pii/S2590198220301536

Since the first reported Covid-19 case in Sweden (February 4th, 2020), the spread of the virus has drastically increased – particularly at the end of 2020 (and the beginning of 2021). The total regional number of confirmed Covid-19 cases was the largest in Stockholm for most of 2020, which is not surprising considering that Stockholm is also the most significant metropolitan region in Sweden. The number of confirmed Covid-19 cases per 100,000 inhabitants has, in fact, been quite similar in Stockholm Region and Västra Götaland Region. For Skåne Region, the number of confirmed Covid-19 cases was relatively low for most of 2020. However, this significantly changed at the end of the year when the number of Covid-19 cases per 100,000 inhabitants increased to almost twice the corresponding numbers for Västra Götaland and Stockholm in December 2020.[251]

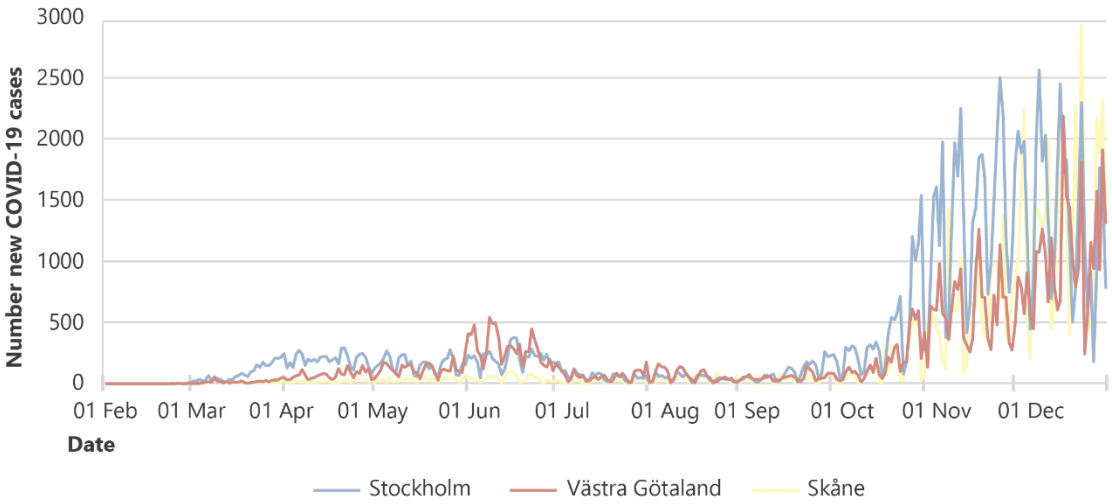

Figure 23: Number of new COVID-19 cases in Stockholm, Västra Götaland, and Skåne Region in 2020.
(Folkhälsomyndigheten. Bekräftade fall av covid-19 i Sverige, 2022)

The change in congestion is a consequence of a lower amount of travel, which also affects public transportation use. The effects on passenger journeys, revenues, and costs are similar across the three regions of Stockholm, Skåne, and Västra Götaland (table 4). The number of passenger journeys and ticket revenue decreased by around 30–40 percent, whereas total costs remained unchanged between 2019 and 2020 for all three regions. The additional government grant to compensate for lost revenue due to the Corona pandemic was lower for the Stockholm Region relative to the size of the decrease in ticket revenue. Hence, on a side note, Stockholm experienced the most significant relative drop in net profit between 2019 and 2020.

The Corona pandemic continued into 2021 and is still ongoing as this report is being written (May 2022), although, to a much lesser degree, the adverse effects on public

[251] Hultén, J. et al. (2021). "Public transport funding under pressure. Challenges, opportunities, and new pathways caused by the Covid-19 pandemic in Sweden". K2, The Swedish Knowledge Centre for Public Transport. https://www.k2centrum.se/sites/default/files/fields/field_uppladdad_rapport/k2_working_paper_2021_12.pdf

transportation have persisted as well. The number of travelers using public transport has continued to be much lower than before the pandemic in all three Swedish regions previously discussed, implying that ticket revenues are still far below what it was in 2019. For instance, the number of passenger journeys by public transport in the Skåne Region was around 5,5–7 million from January to April 2021. These low numbers correspond to the quietest monthly passenger journeys measured for 2020. In other words, the number of passenger journeys in 2021 is about half or less than the corresponding number of passenger journeys during the same period in 2019[252]. In March 2021, total ticket revenue was 313 million Swedish crowns, which was about 44% lower than the budget, 52% lower than 2020, and 56% lower than 2019. The region's problem was that the budget for 2021 did not consider a 'second wave' of Corona that started in the winter of 2020/2021 and continued until summer.[253]

	Stockholm		Skåne		Västra Götaland	
	2019	2020	2019	2020	2019	2020
Percentage change in passenger journeys compared to 2019		-35%		-38%		-31%
Ticket revenue (%-change 2019-2020)	8.811	5.405 (-39%)	2.905	1.742 (-40%)	3.481	2.398 (-31%)
Total revenue (%-change 2019-2020)	22.380	20.936 (-6%)	6.255	5.974 (-4%)	9.721	9.524 (-2%)
Total cost (%-change 2019-2020)	21.811	22.023 (1%)	6.145	6.063 (-1%)	9.614	9.545 (-1%)
Net profit (%-change 2019-2020)	569	-1.087 (-291%)	110	-89 (-181%)	107	-21 (-120%)

Table 4: percentage change in passenger journey and yearly ticket revenue, total revenue, total cost, and net profit for Stockholm Region, Skåne Region, and Västra Götaland Region. All revenues, prices, and profits are in million SEK.
(Hultén, J. et al. 2021)

The Västra Götaland Region made it clear early that Västtrafik should carry out the traffic to an average extent, despite the pandemic sweeping over the region. To complete this assignment, reinforcement and replacement traffic, communication to

[252] Region Skåne (2021). "Månadsuppföljning kollektivtrafiknämnd april 2021." https://www.skane.se/organisation-politik/om-region-skane/Ekonomi-och-uppfoljning/Uppfoljning/#55090
[253] Region Skåne (2021). "Månadsuppföljning kollektivtrafiknämnd mars 2021." https://www.skane.se/organisation-politik/om-region-skane/Ekonomi-och-uppfoljning/Uppfoljning/#55090

customers and a strategy for summer traffic became essential issues. Specific measures have also been developed to prevent driver shortages.[254]

In Västra Götaland Region, public transportation services are provided through buses (ca 48% of all trips in 2019), trams (46%), trains (6%), and ferries. Before COVID-19, around 450 thousand travelers used the system, and about 950 thousand daily trips were made. The data in this study come from two different sources: The daily number of trips per transport mode is based on automatic passenger counting (APC) sensors at the vehicle doors. These sensors are available for a subset of the vehicle fleet, and the number has been scaled up to be representative of the entire fleet. These data contain all transport modes except the ferries. As for Stockholm, data are available from 1 February 2020 to 1 May 2020 and the same period as the previous year. Unlike Stockholm, passenger load data for buses are also available during COVID-19.[255]

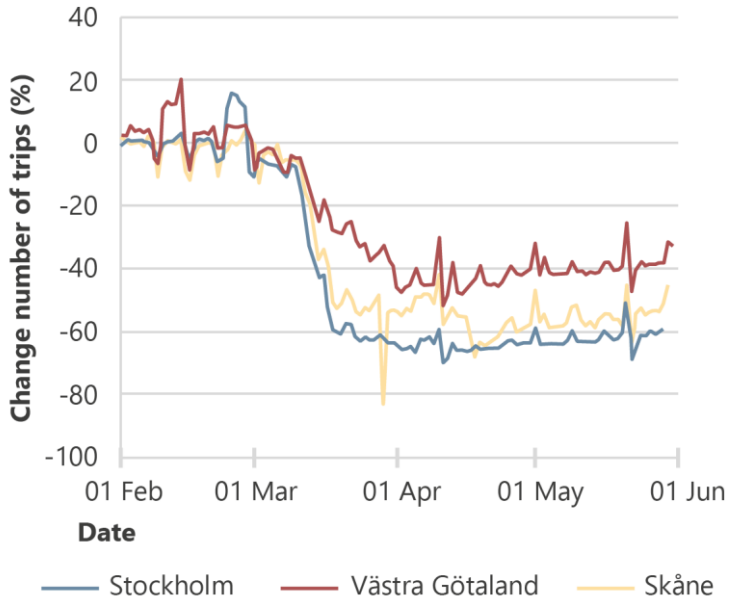

Figure 24: All regions, daily number of trips, relative change 2020 from the baseline 2019.
(Jenelius, E., Cebecauer, M.,2020)

Comparing the change in the numbers of trips from figure 4 with the numbers of new cases, in figure 24, in the same period, the relation between the numbers is transparent and shown in figure 25. The number of trips decreased considerably simultaneously as more new COVID-19 cases were being registered. Between the three

[254] Västtrafik (2020). Protokoll nr 4/2020 fört vid sammanträde i styrelsen för Västtrafik AB fredag 24 april 2020. Dnr 1-15-20.
[255] Jenelius, E., Cebecauer, M. (2020). "Impacts of COVID-19 on public transport ridership in Sweden: Analysis of ticket validations, sales and passenger counts". Transportation Research Interdisciplinary Perspectives.

regions, Stockholm has a higher number of new cases and a higher change in the percentage of the number of trips, as expected. Skåne was the region with the lowest number of new cases but still had a more significant change in the number of travels than Västra Götaland.

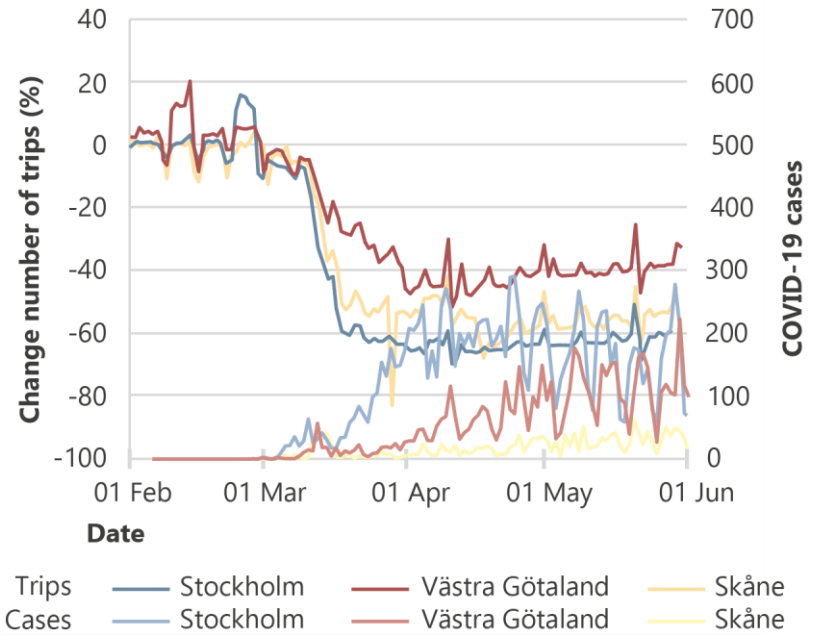

Figure 25: All regions, daily number of trips, relative change 2020 from the baseline 2019 compared with the number of new cases.

(Jenelius, E., Cebecauer, M.,2020 and Folkhälsomyndigheten. Bekräftade fall av covid-19 i Sverige, 2022)

According to the information collected regarding the three major regions of Sweden, the analysis proceeds with a focus study regarding Gothenburg. The reason why Gothenburg was chosen is due to the fact that the city is the capital of the Västra Götaland region, which had lower changes in mobility, as well as a lower decrease in changes of journeys and tickets revenue than expected when compared to the other two regions. Västra Götaland did not had the changes expected according to its size and importance for the country. Although there were no mandatory COVID-19 restrictions in Sweden, Skåne, which is a smaller region, show bigger changes than Västra Götaland. Meanwhile Stockholm had comparable changes in mobility as expected by its size. Also, the city of Stockholm invested in measures to improve urban environment during and after the pandemic with the implementation of the 1-minute city concept, which had not happened in the other regions.

The city of Gothenburg, located on the west coast of Sweden, and has a population of approximately 590,000 in the city proper and about 1.1 million inhabitants in the

metropolitan area. By 22nd March 2020, the city confirmed the first case of COVID-19, and as we can observe in figure 26. The new cases continuously grew and during the Gothenburg region's worst pandemic phase, more than 3000 new cases per day were confirmed, which occurred twice, both in December 2020 and December 2021. The warm summer months contributed strongly to fewer cases, easily observed from July to September in 2020 as well as July to October in 2021.

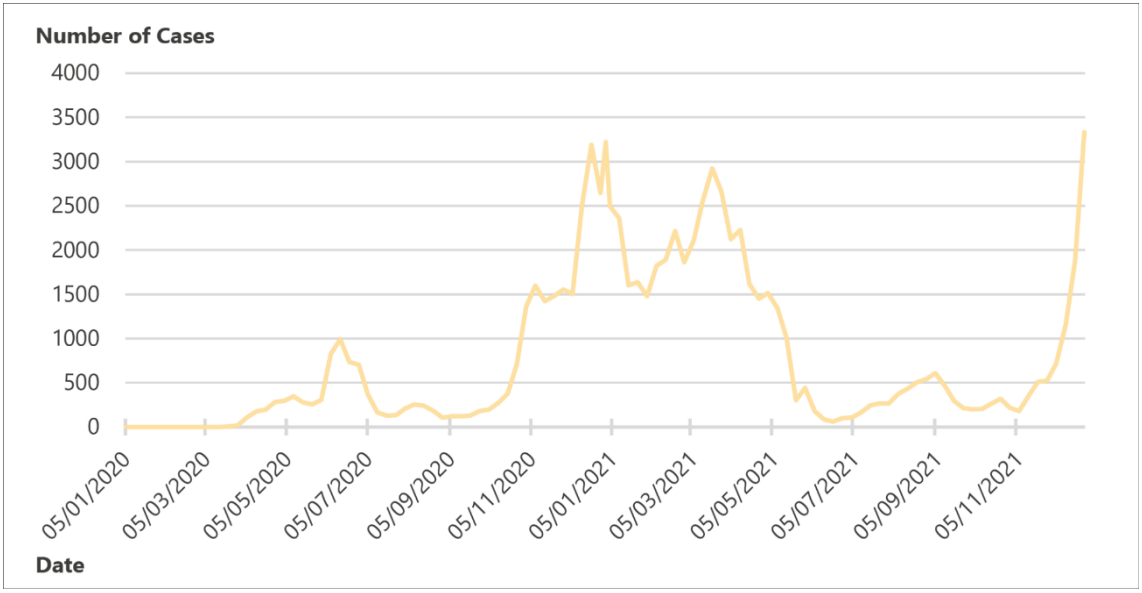

Figure 26: Number of new weekly COVID-19 cases in Gothenburg.
(Folkhälsomyndigheten. Bekräftade fall av covid-19 i Sverige, 2022)

5.1. Impacts of the Pandemic

As mentioned before, even though Sweden had not adopted quarantine regulations or lockdown measures to avoid the spread of the virus, the population followed the Government's advice to keep a social distance, avoid crowded places, and, most importantly, stay home if you are sick. These recommendations reflected equally on the traffic: fewer people traveling to their respective working places. In figures 27 and 28, the period with the lowest workplace presence is at the beginning of the pandemic in 2020, when the information and news regarding the virus were still new and uncertain. As expected, more new cases correspond well with reduced traffic and mobility. More interestingly, the generally much lower traffic during both 2020 and 2021 does not seem to significantly follow spikes in new cases; the less mobility appears to stem from government recommendations. The population worked more from home independently and/or due to less safe workplace conditions.

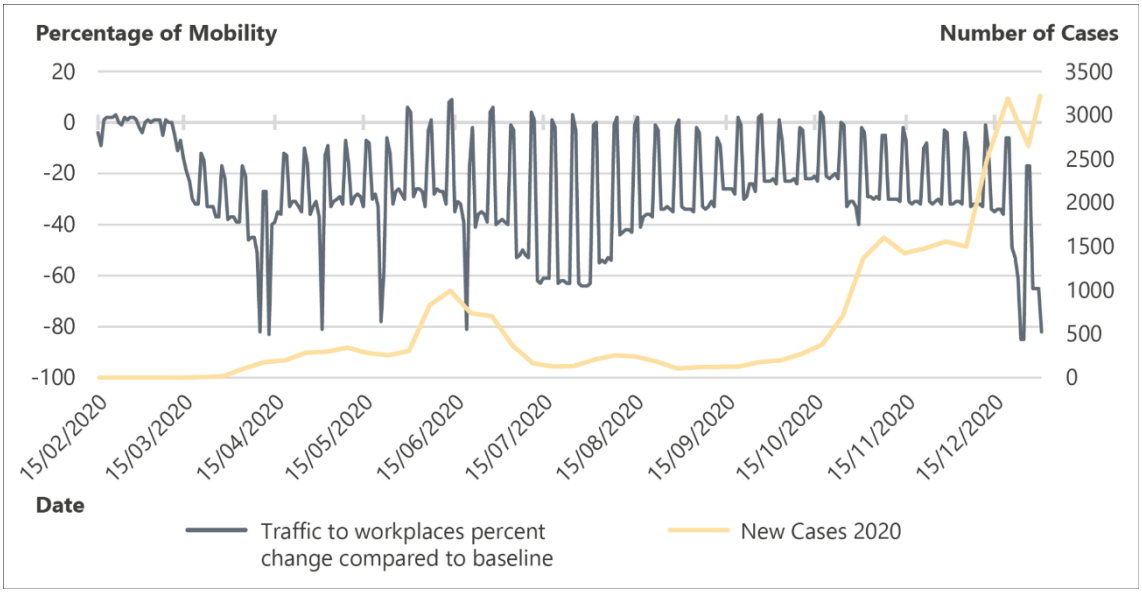

Figure 27: Changes in transit to workplaces in 2020 compared with the number of new COVID-19 cases. The changes in transit to the workplaces are calculated as a relative difference from the baseline value (the median value, for the corresponding day of the week, during the 5- week period Jan 3–Feb 6, 2020).
(Google. COVID-19 Community Mobility Reports, 2022)

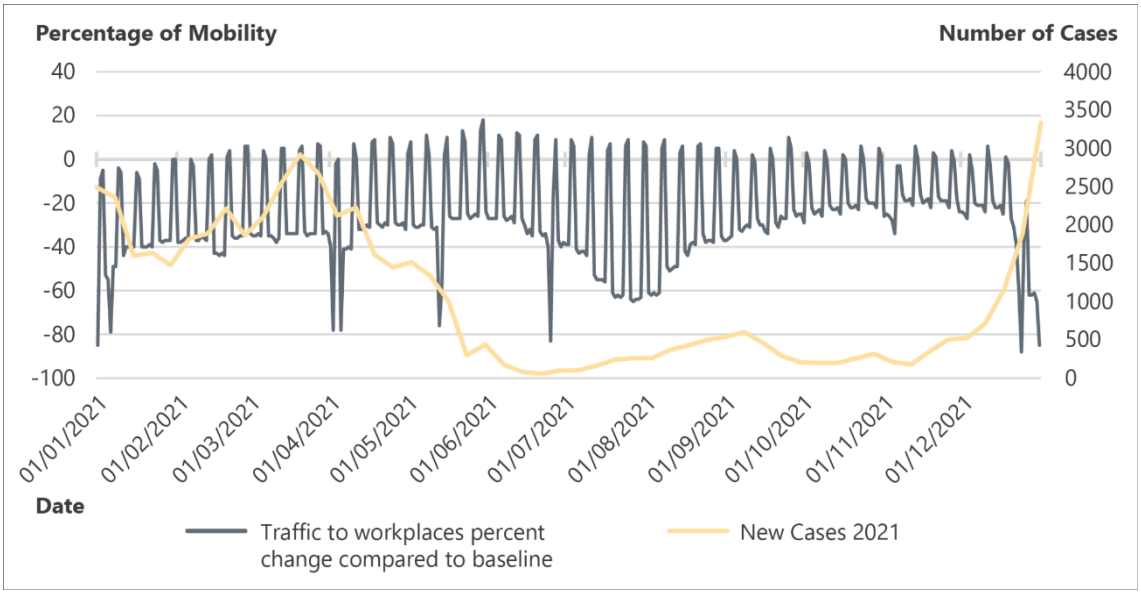

Figure 28: Changes in transit to workplaces in 2020 (compared with the number of new COVID-19 cases. The changes in transit to the workplaces are calculated as a relative difference from the baseline value (the median value, for the corresponding day of the week, during the 5- week period Jan 3-Feb 6, 2020).
(Google. COVID-19 Community Mobility Reports, 2022)

Note that some periods with lower traffic correspond to Swedish national holidays, such as the end of April and June and during Christmas and New Year. These holidays generally experience less traffic and mobility even without a pandemic, although

Covid-19 most likely reduced traffic even more due to the nature of these holidays and further recommendations that the population should not celebrate with their elderly relatives.

The pandemic affected the flow of visitors to the city center early on. Innerstaden Göteborg AB measures pedestrian passages in 18 places within the moat (the city center of Gothenburg), focusing mainly on the more prominent shopping streets. Figure 29 compares the pre-pandemic year 2019 and the subsequent two pandemic years, 2020 and 2021. A drastic reduction in visitors to the city center occurred in the first quarter of 2020. Interestingly, as the number of cases was still relatively low for this period, the decrease in visitors is most likely a result of the novelty and uncertainty effect of the virus. During the entire year 2020, the number of visitors decreased by 35%. In 2021 visitors steadily returned, with a particularly strong and not-so-surprising development during the summer months. The fourth wave during November and December in 2021 stabilized the average number of city-center visits during the last quarter at around 25 percent lower than in 2019.

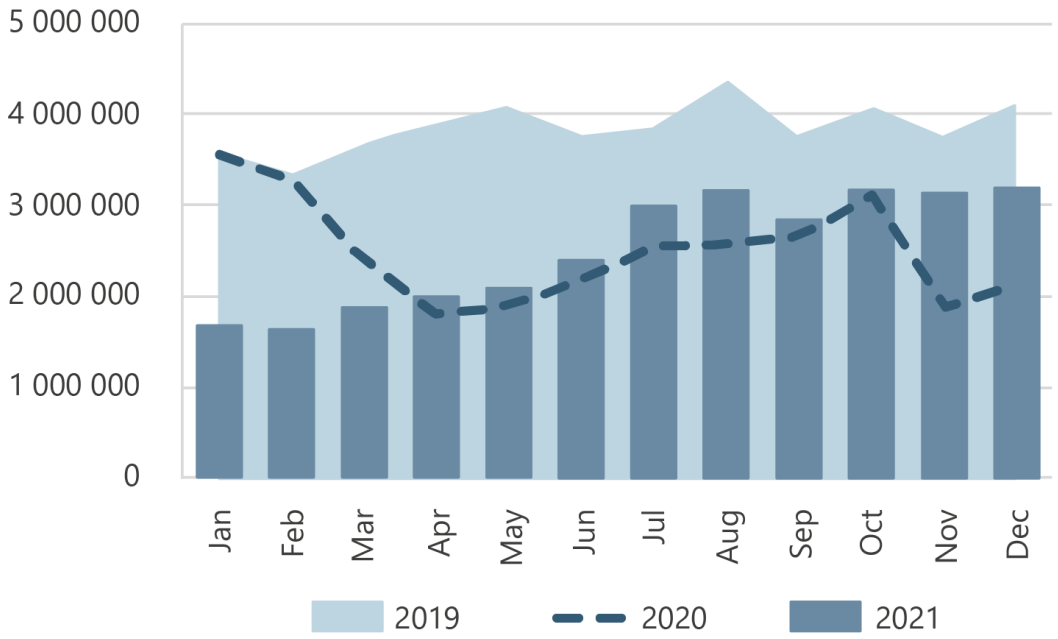

Figure 29: Number of visitors to the city center per month in 2019, 2020, and
(Trafikkontoret. Trafik- och resandeutveckling 2021. Göteborg Stad, 2022)

In Figures 30 and 31, the mobility in transit stations compared to new cases for 2020 and 2021, respectively, is shown. Similar to the reduction in workplace mobility, a drastic decrease in public usage of transit stations is observed in the first quarter of 2020, providing more evidence for the novelty and uncertain effect of the virus. Transit station visits improved somewhat during the summer months of 2020, reaching only a 10% reduction compared to 2019, followed by another decrease when summer ended, culminating in a reduction of approximately 70% during December and January in 2020/2021. It is easily observed that transit station usage corresponds to periods of

increase in new cases. The mobility around transit stations steadily increased during 2021, stabilizing around 30% below 2019. When new cases started rising fast in December of 2021, reversely, so did transit station usage fall; however, this reduction should largely be attributed to seasonal variations around Christmas time nevertheless, the prolonged increase at the beginning of 2021 should be seen as an effect of the sharp rise in cases.

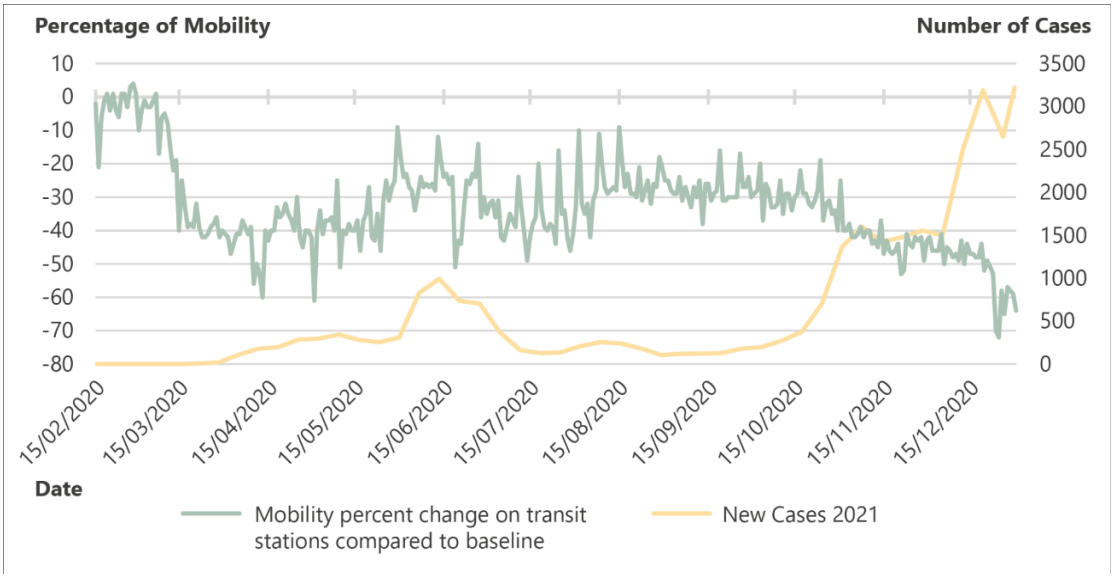

Figure 30: Changes in mobility on transit stations in 2020 compared with the number of new COVID-19 cases. The changes in mobility on transit stations are calculated as a relative difference from the baseline value (the median value, for the corresponding day of the week, during the 5- week period Jan 3–Feb 6, 2020).
(Google. COVID-19 Community Mobility Reports, 2022)

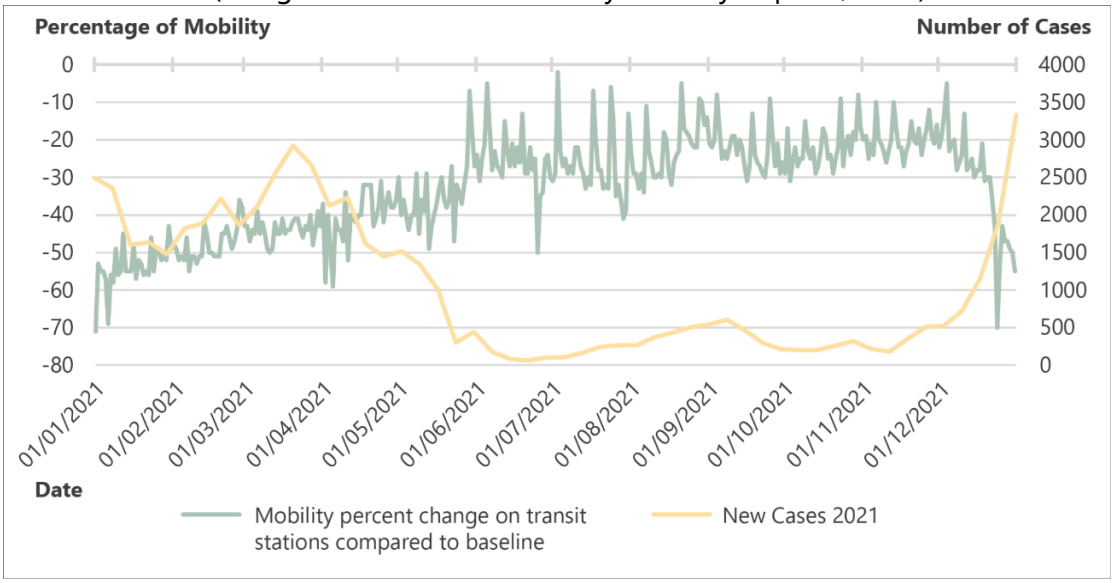

Figure 31: Changes in mobility on transit stations in 2021 compared with the number of new COVID-19 cases. The changes in mobility on transit stations are calculated as a relative difference from the baseline value (the median value, for the corresponding day of the week, during the 5- week period Jan 3–Feb 6, 2020).
(Google. COVID-19 Community Mobility Reports, 2022)

The congestion levels show that the weekday rush hours present a considerable (but minor compared to transit mobility and public transport passengers) reduction since the beginning of the pandemic. The morning rush in 2021 decreased by 11%, while the evening rush decreased by 8% compared to 2019.[256] This subordinate pandemic effect is not surprising: although an employer-mandated work-from-home situation caused a reduction in car travel, as covid cases rise, so does the fear of crowded public places, and more so does the population choose to drive their own vehicles, causing the congestion levels to remain relatively high.

The position and opinion of public transport before the pandemic were very good. In figure 32, it is possible to observe that during the first year of the pandemic, the public transportation travel development closely reversely mirrored the infection control situation; i.e., the number of trips increased during the periods when the infection was lower and vice versa. Although this relationship can be observed, a lag period is present before the increase (decrease) in new cases is followed by a decrease (increase) in public transport passengers. A proposed "news momentum" could cause such lag, wherein the population waits for multiple news about an increase or decrease in new cases before adapting to the infection situation. In 2021, an apparent recovery was seen, and the decline in traffic at the start of the fourth wave in December did not become more significant than the normal seasonal variation. This is interestingly a deviation from the previous pandemic periods discussed before and most likely an effect of pandemic-tiredness (people pre-maturing declaring the pandemic is overdue to approximately two years of restrictions and recommendations), causing the dramatic rise in new cases going unnoticed by the population.

In figure 33, it is possible to see that since 2017, cycling has steadily increased, but in 2021, this trend was broken, and cycling almost returned to 2018 levels. The extensive teleworking and work-from-home mentality is believed as the driving cause of this change. The number of bicycle trips in 2021 is estimated to be 36 percent higher than in 2011, which is the base year for the traffic strategy. Furthermore, assessing intra-pandemic cycling changes, cycling has decreased by 11–15% in 2021 compared with 2020. In connection with the introduction of the congestion tax in 2013, cycling increased sharply (22 percent.) between 2013 and 2017, but the development was relatively unchanged. During the last three years (2018–2020), we have seen a steady increase, and the number of bicycle trips in 2020 was estimated to be 57 percent higher than in 2011. With the 2021 decline, we are again close to the 2018 level. Despite this, cycling is still the mode of transport that has increased the most since 2011, but still increased less than expected, not only in the years of the COVID-19 emergency. As mentioned before, in 2013, the introduction of the congestion tax had a direct impact on the cycling increase, and this could be one of the challenges for the years that followed: a motivation to switch from motorized travel to cycling travels

[256] Tomtom (2022). Gothenburg Traffic. https://www.tomtom.com/en_gb/traffic-index/gothenburg-traffic/

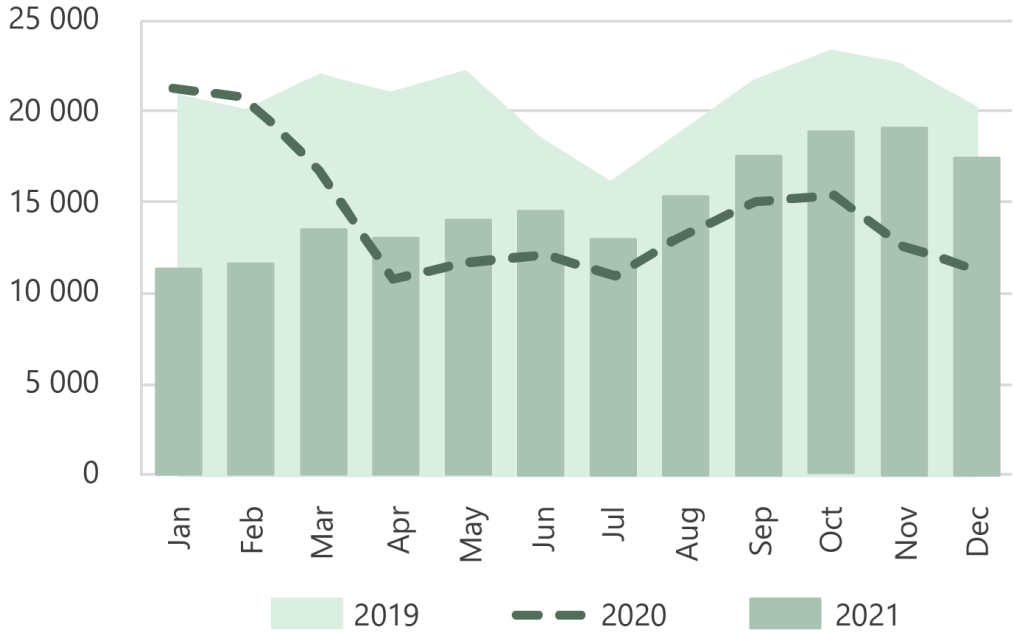

Figure 32: Number of journeys in Gothenburg using public transport per month in 2019, 2020, and 2021. Data per thousand journeys.

(Trafikkontoret. Trafik- och resandeutveckling 2021. Göteborg Stad, 2022)

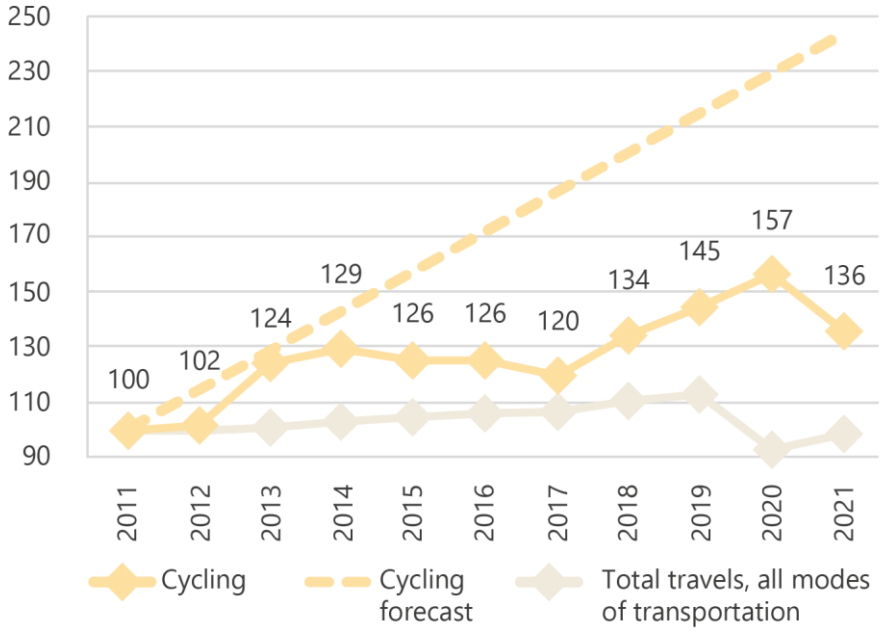

Figure 33: Development and goals for cycling in Gothenburg between 2011-2021 (index 2011=100).

(Trafikkontoret. Trafik- och resandeutveckling 2021. Göteborg Stad, 2022)

After the 2020 dramatic reduction in traveling time, Västtrafik is starting to welcome travelers back, though the year as a whole meant only a slight increase in the number

of travels. Public transport is still the mode of transport that has been affected hardest during the pandemic. The Swedish Public Health Agency included avoidance of public transport in their general advice and covid recommendations at an early stage. At the beginning of 2021, the advice was to avoid non-bookable public transport and to wear mouth guards (masks) in rush hour traffic. The general guidelines in public transport were not removed until September 29, 2021, but were reintroduced when the fourth wave began in December. The year as a whole has nevertheless meant a certain amount of recovery in travelers and passengers. As noticed in figure 34, the number of trips increased by 5 percent, which is in line with the increase in the total traveling. However, the reduction in travel in 2020 was so dramatic that the number of trips by public transport still is lower than the base year 2011.

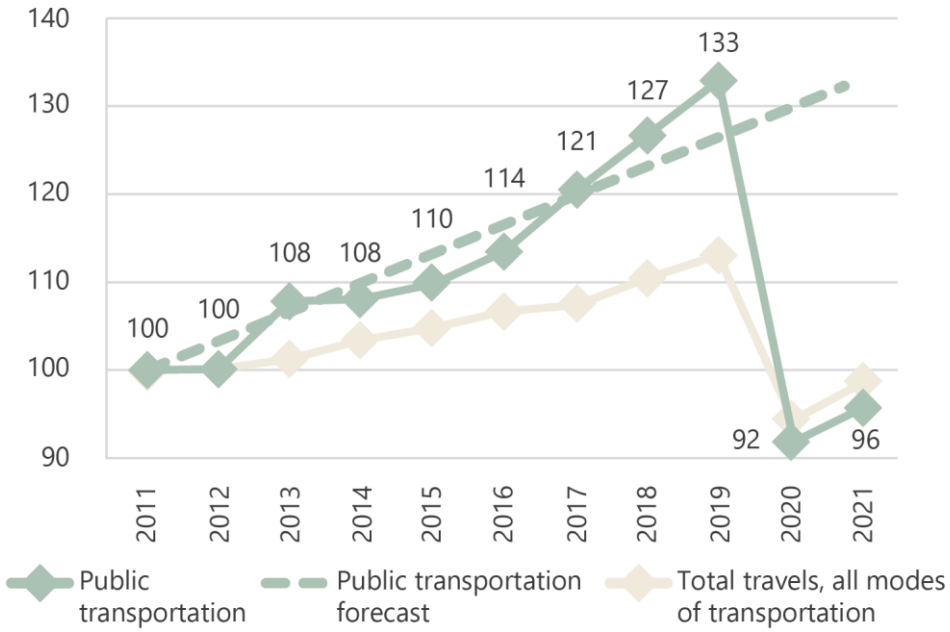

Figure 34: Development and goals for travel by public transport in Gothenburg between 2011-2021 (index 2011=100).
(Trafikkontoret. Trafik- och resandeutveckling 2021. Göteborg Stad, 2022)

The focus of Västtrafik's work in 2021 has been to get the travelers back on their buses and local trains. When the infection control situation improved, they carried out, among other things, a "welcome back" - campaign. As part of the work to recover travelers after the pandemic and meet the populations changed travel habits and working methods fiercely enforced by the pandemic, Västtrafik plans introduced a new type of bus at the beginning of 2022 and train ticket: the Flex ticket. The ticket directs mainly to people traveling by public transport 2-3 days a week and will be offered in the app Västtrafik To Go.

This substantial decline in motorized mobility has resulted in a reduction in externalities such as emissions. In terms of emissions, the analysis has focused on NO2, as it is the

substance most directly related to urban traffic, as opposed to other pollutants from alternative sources such as PM10 and PM2.5. The monthly average levels of NO2 in Gothenburg city are shown in the graph in figure 35. The data analysis from the City of Göteborg (Göteborgs Stad) reveals that in 2020 the monthly average of Nitrogen dioxide in the city decreased by over 55-33% compared with the average values measured in the period 2015–2019. Although this full-year reduction in NO2 emissions is an effect of the pandemic, a discernible pattern between spikes and falls in new cases and NO2 levels is hard to detect; this is signifying less of a significant relationship between new cases and levels of NO2, and instead a change in the population's overall habits of outdoors recreational time.

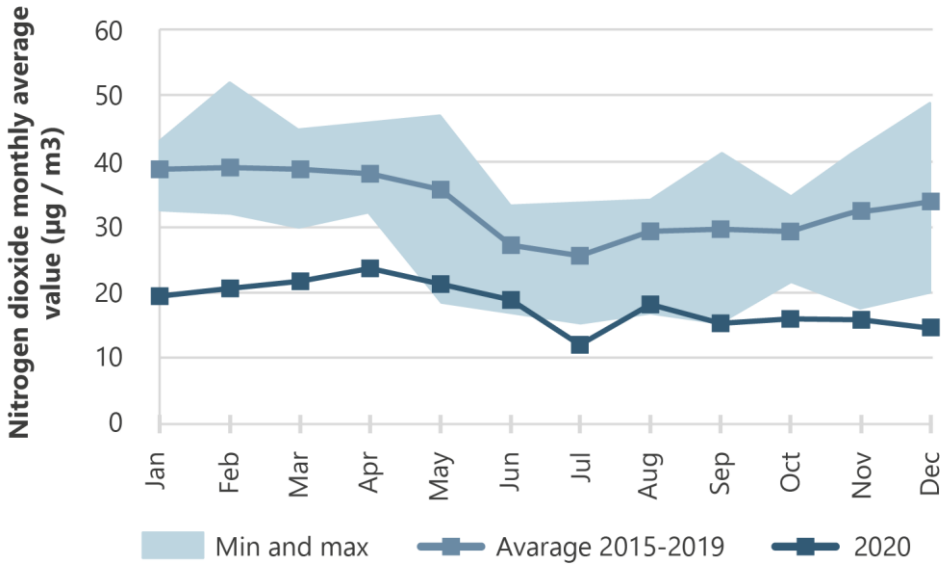

Figure 35: Monthly average NO2 (nitrogen dioxide) levels in
(Göteborg Stad. Luften i Göteborg. Årsrapport 2020. Rapportnummer 2021:12. 2021.)

In 2021 Västtrafik did its annual survey, Hållplats 2021, wherein a total of 4,195 people aged 16 or older responded to the survey. Two out of three answered that they want society to invest more in public transport. A majority of those surveyed, 52 percent, welcome new laws and regulations that make more people travel in a sustainable way. In this 2021 survey, 50 percent believe in increased travel by public transport, compared with 41 percent in 2020. It also shows a strong will to move by "their own machine": 51 percent answered that they want to walk more, and 58 percent want to cycle more.[257]

[257] Västtrafik (2021). "Hållplats 2021. En undersökning av resvanor och attityder." https://via.tt.se/data/attachments/00892/0487457f-385c-450a-9013-ead5d4cd167b.pdf?fbclid=IwAR1HPYx0F_WL2XTuI8omWAkRlPs-Lt1Q9pvG2SXmG-thSbihVg8FpL4O0qI

5.2. Analyses of the Neighborhood

As it is noticeable from the information retrieved, it is clear how everyday life changed in Gothenburg during the COVID-19 outbreaks: changes in visits to green areas, transit stations, and workplaces. The total number of travels reduced significantly in 2020, and at the same time, the percentage of cycling travels increased. This, together with the results of the Hållplats 2021, show the population's interest in walking and cycling more even after the end of the health emergency, which brings the opportunity to invest in cycling and walking path improvements in the city. Good urban environment conditions can give the people the motivation needed to go forward with the use of walking and cycling as more constant and sustainable travel modes, which would not only be good for their health but would keep the NO2 emission lower, as happened during the COVID-19 waves.

For this reason, a proposal for the Gothenburg city center and its adjacent neighbors was developed. The focus area in Gothenburg is shown in figure 17. Inom Vallgraven is the city center neighborhood characterized by being fully alive, with many restaurants, stores, and offices. The main road, Östra Hamngatan, is a big open-air shopping area that also gives access to the main indoor shopping center of the city, Nordstan, and connects with Kungsportsavenyn, popularly known as Avenyn. Vasastaden and Lorensberg have similar characteristics and Haga as well, but Haga's commerce is focused mainly on coffee shops where people can enjoy the famous Swedish Fika. Stampen, located east of the city center, is characterized by the Central Station transit. The other neighborhoods in the focus area (Olivedal, Annedal, Landala, Guldheden, Johanneberg, Krokslätt, and Heden) are mainly residential but still with important "landmarks/institutions," such as the sports arenas Ullevi, the University of Gothenburg and the University of Chalmers.

In the city center focus area, the public green spaces are at a maximum of 1-kilometer distance from each other, and they can be easily reached by public transportation, by walking or cycling, as all the main roads are provided with bike lanes or bike paths

Figure 36: Kungsportsavenyn in Gothenburg.

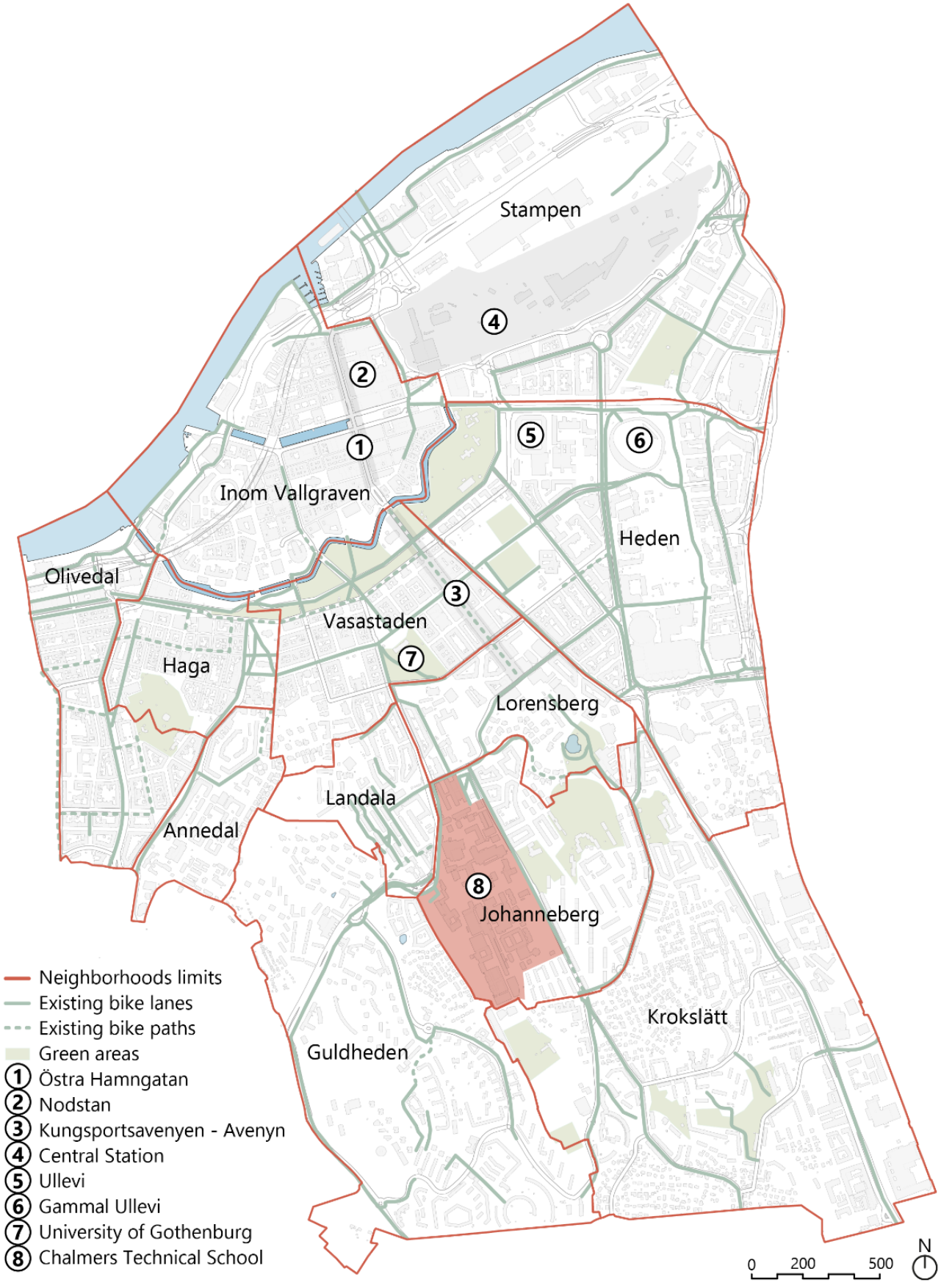

Figure 37: Illustration focus area on the Gothenburg city center.

Further, to analyze the viability of the 15-minutes city concept, largely indicated as the future model for after-pandemic cities, the Johanneberg neighborhood was chosen. One of the reasons for this choice is that the neighborhood is located on the Central area of the city, next to the city center, Inom Vallgraven, but its use, instead of mainly commercial, is mainly residential. The COVID-19 emergency highlighted the importance of understanding if residential neighborhoods have the ability to offer its inhabitants adequate life quality and how it can be improved.

During the 19th century many neighborhoods were built around the city center, such as Vasastaden and Lorensberg and the common characteristic between them is the large grand stone houses.[258] Johanneberg is a quite new neighborhood. Its city plan was draw on the 20th century, in 1930, and its long white buildings surrounded by green areas were built between 1937–1943, while its church was built between 1938-1940. The structure is dominated by the 62 metres tall tower which makes it the highest church tower in Gothenburg and a city landmark.[259] Another important landmark of the neighborhood is the Chalmers University campus, built between 1943-1968.[260]

Figure 38: Johanneberg's church.

[258] Redaktionen (2021) "Göteborgs historia och arv". Göteborg – Världens mest hållbara destination. https://www.goteborg.com/guider/goteborgs-historia-och-arv

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[260] Hult, J. (1998). Lite Chalmershistoria. https://www.chalmers.se/sv/om-chalmers/historia/Sidor/Chalmershistoria.aspx?fbclid=IwAR3skDOLyCXsxz1EjQO7r_AShvukgtSZZ6ofoiMUCX-qIQo4Znx-TuCilME

Johanneberg is one of the most popular neighborhoods of the city due to its proximity to the center, your calm streets, green areas and grocery store.

Figure 39 Johanneberg's calm streets and green areas.

On the figure 40, strategic points of the neighborhood were highlighted: bike lanes and paths, bike rent stations, vehicles charging points, health units, green areas, free wi-fi availability, church, and schools. Each one is graphically identified in different ways and colors and the schools are also identified by numbers. Education is compulsory in Sweden and it starts from age 6, before that, children go to *förskoleklass,* which is the preschool, year 0, represented by the number 1 in the map. The number 2 is *Lågstadiet* (year 1-3), number 3 is *Mellanstadiet* (years 4-6), number 4 is *Högstadiet* (year 7-9) and 5 is *Gymnasium* (10-13).

Johanneberg is well-provided with bike lanes and health units. Green areas are well distributed in the neighborhood area, as well as outdoor exercise stations that are really appreciated by the population. It is also common to see people exercising not only on parks and green spaces, but running in the street, especially in the mornings. Schools from all different years can be easily reached by Johannebergs inhabitants by walking, although the only closest *Gymnasium* is on the south of the area. The free-wifi spots are not many and are located on three strategic places of public transportation.

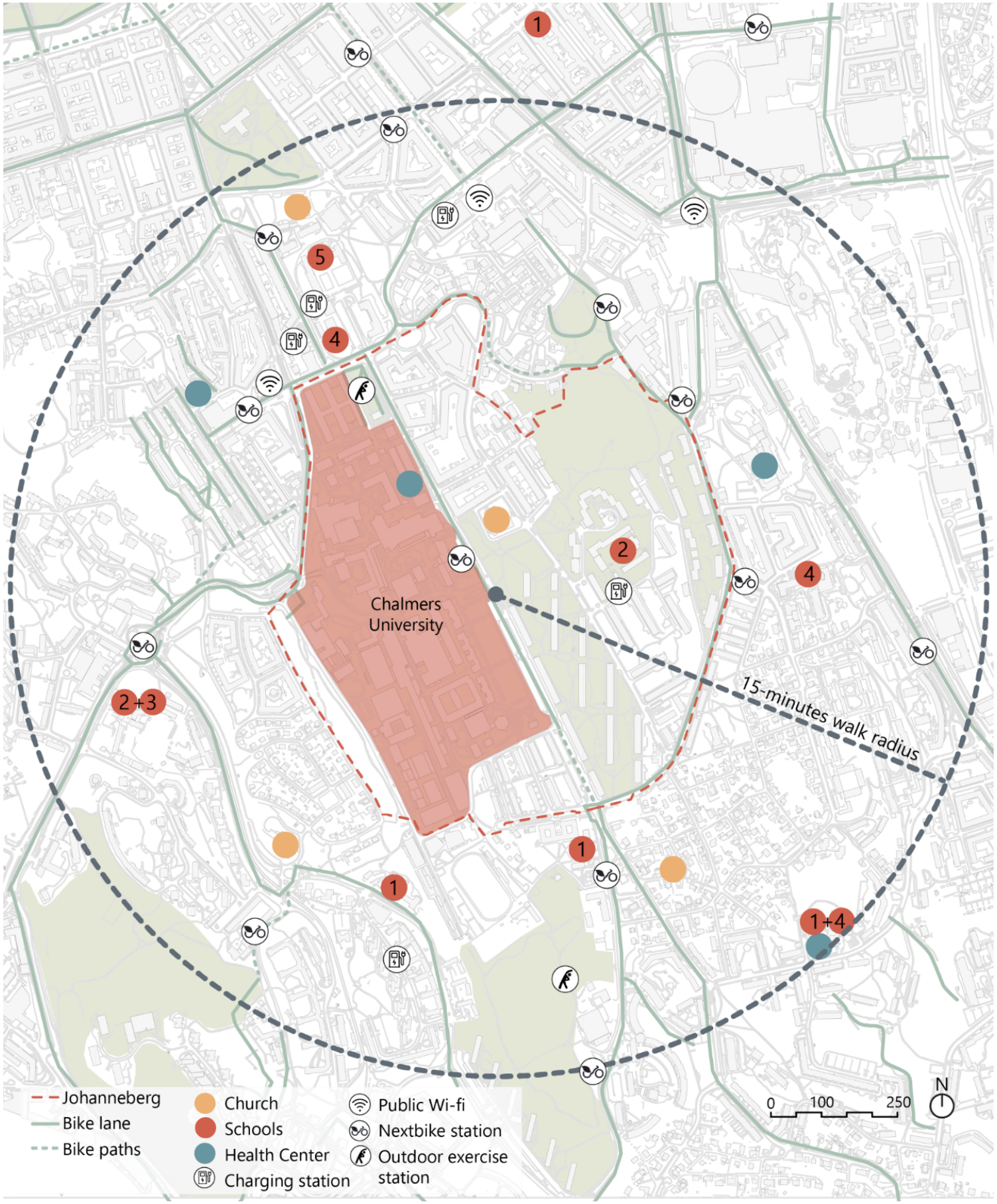


Figure 40: Johanneberg's analysis.

5.3. Interventions Proposal

Although the Gothenburg city center is well intra-connected, there is space for improvements. As highlighted in figure 44, the three proposals are:

1. New bike lane on Östra Hamngatan: the street has a clear division of roads for public transportation and cars, and although it has many bike parking spaces, it does not have a bike lane. Now the bike shares the same space as the cars. A new bike lane is connected to the existing one on Avenyn and creates a constant and safe path all the way through the center. The create a pleasant path, greenery will be added on the sides of the bikelines, creating a division between bikes and car. This greenery is characterized by vegetation capable to absorb higher amounts of rain water, as the city is known by its strong rains. The vegetation should also be adapted to the different temperatures of the year's seasons, and for that one of the suggestion is the use of Red elderberry (*Sambucus racemosa*).
2. Increase the width of the sidewalk on Gilbratargatan: at the beginning of the street, right on the limit of the Johanneberg neighborhood, the sidewalk of Gilbratargatan has a small width on the west side towards the University of Chalmers, considering the movement of students. The increased sidewalk width would also encourage people to walk and exercise (running) on the outdoor. The existing greenery along the side of the pedestrian's area has a generous width, which allows the insertion of a bioswale. A Bioswale is a swale drainage curse with gentle slope on the side that has the ability to retain larger amounts of water, keep it in the urban space for a longer time helping to relieve sewer systems during rainy days.
3. Föreningsgatan – Connect the existing bike lane from Annedal to Landala: create a safer environment for the area, as on the street there is a Preschool, and the bike lane would help to organize the traffic and avoid collisions between cars, bikes, and pedestrians.

Figure 41: Östra Hamngatan.

Figure 42: Gilbratargatan.

Figure 43: Föreningsgatan.

Figure 44: Illustration intervention proposals focus area on the Gothenburg city center.

Figure 45: Östra Hamngatan existing profile.

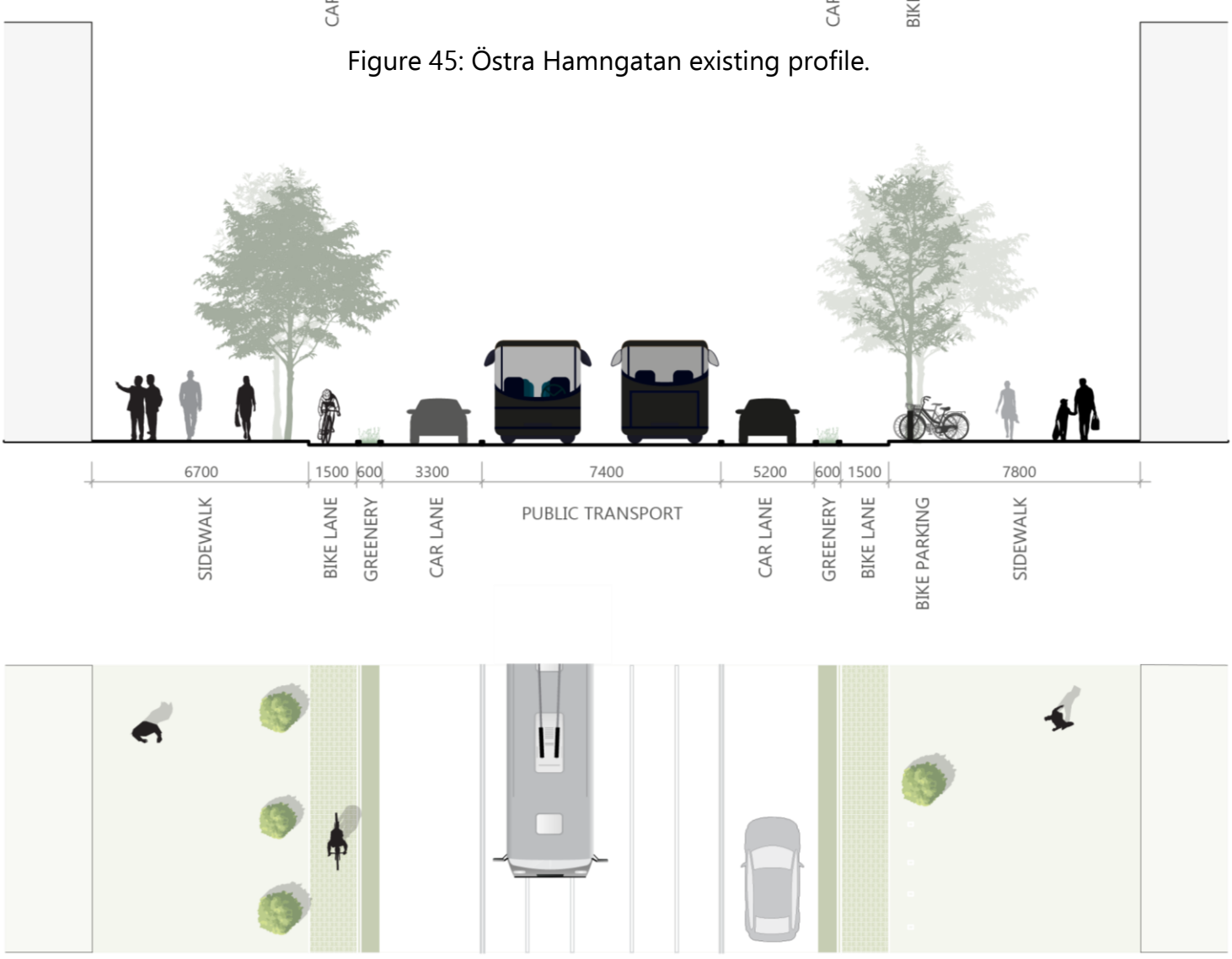


Figure 46: Östra Hamngatan intervention proposal.

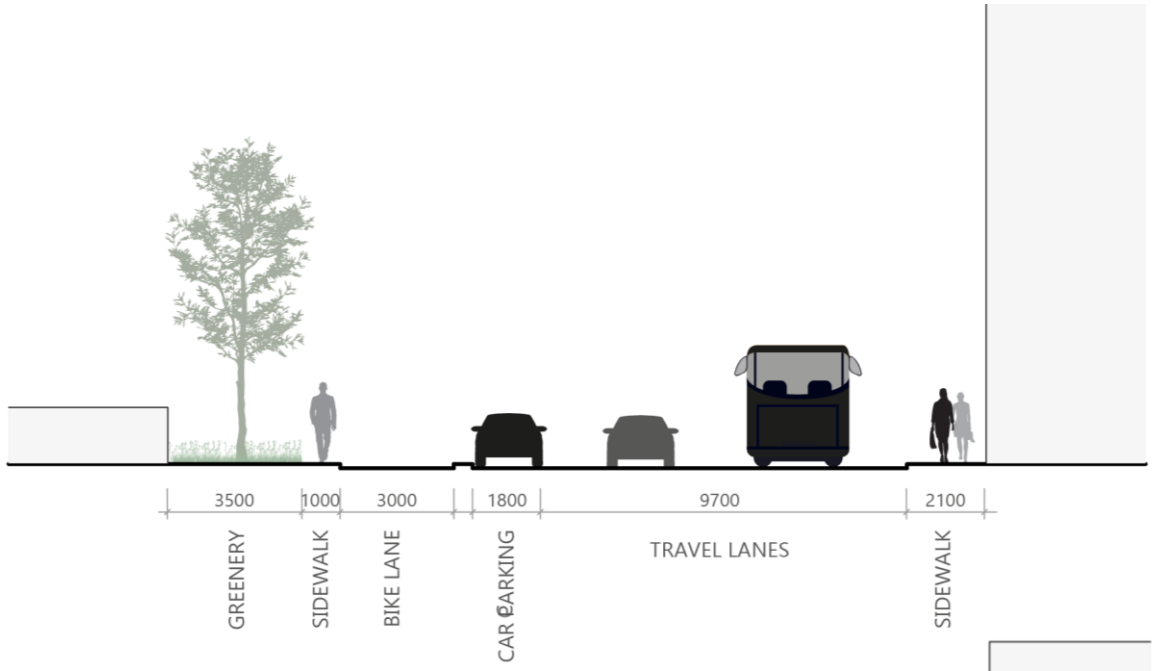


Figure 47: Gilbratargatan existing profile.

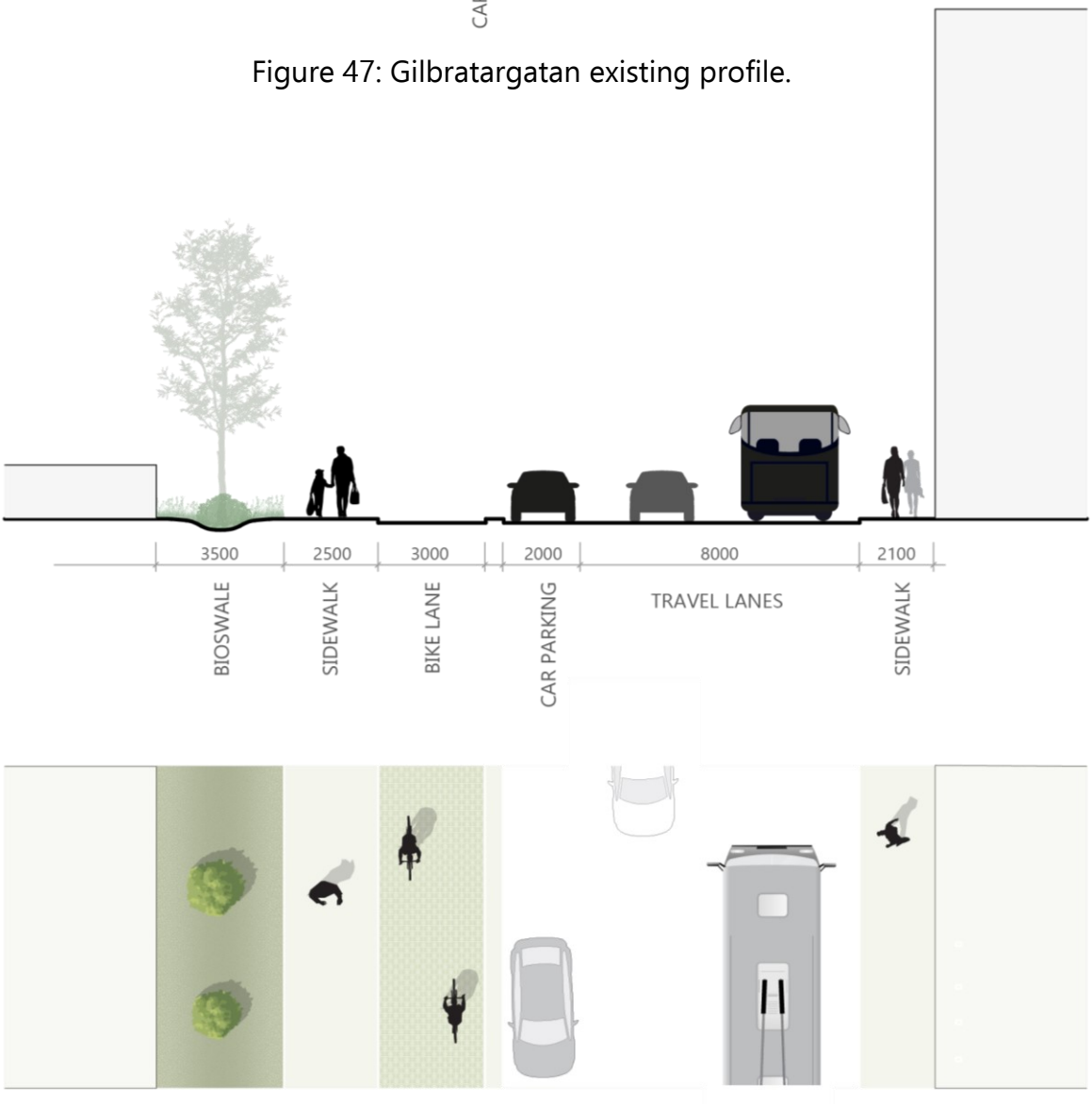


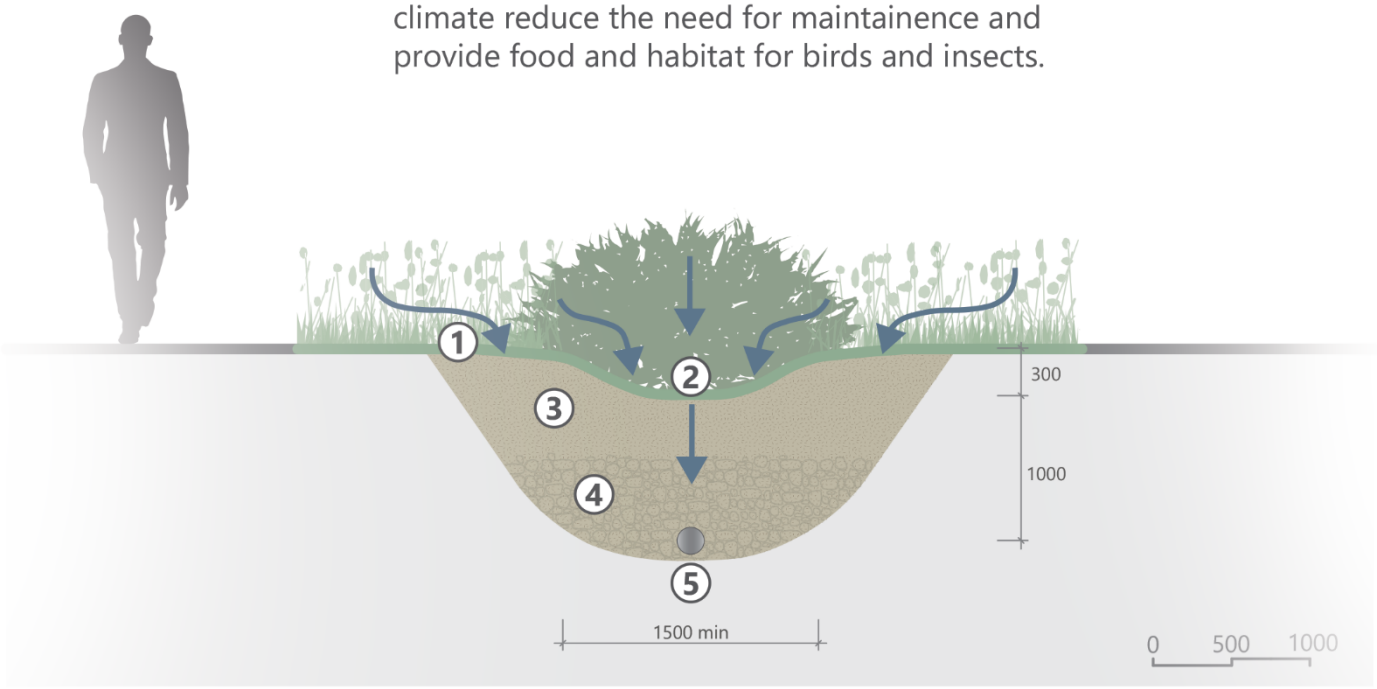
Figure 48: Gilbratargatan intervention proposal.

① **Bioswale**

A bioswale drainage course with gently sloped sides (max that filtrates the rain water removing debris and pollution from it.

② **Wetland Flora**

Local wetland vegetation lines the bioswale to create wildlife habitats and revent slope erosion. The use of native plants that are adapted to the climate reduce the need for maintainence and provide food and habitat for birds and insects.



③ **Soil bed**

Roots and soil remove majority of pollutants

④ **Gravel**

Secondary filtration and then moves to local aquafer

⑤ **Perforated Pipe**

Connected to catch basin for grey water recycling

Figure 49: Bioswale detail.

Figure 50: Föreningsgatan existing profile.

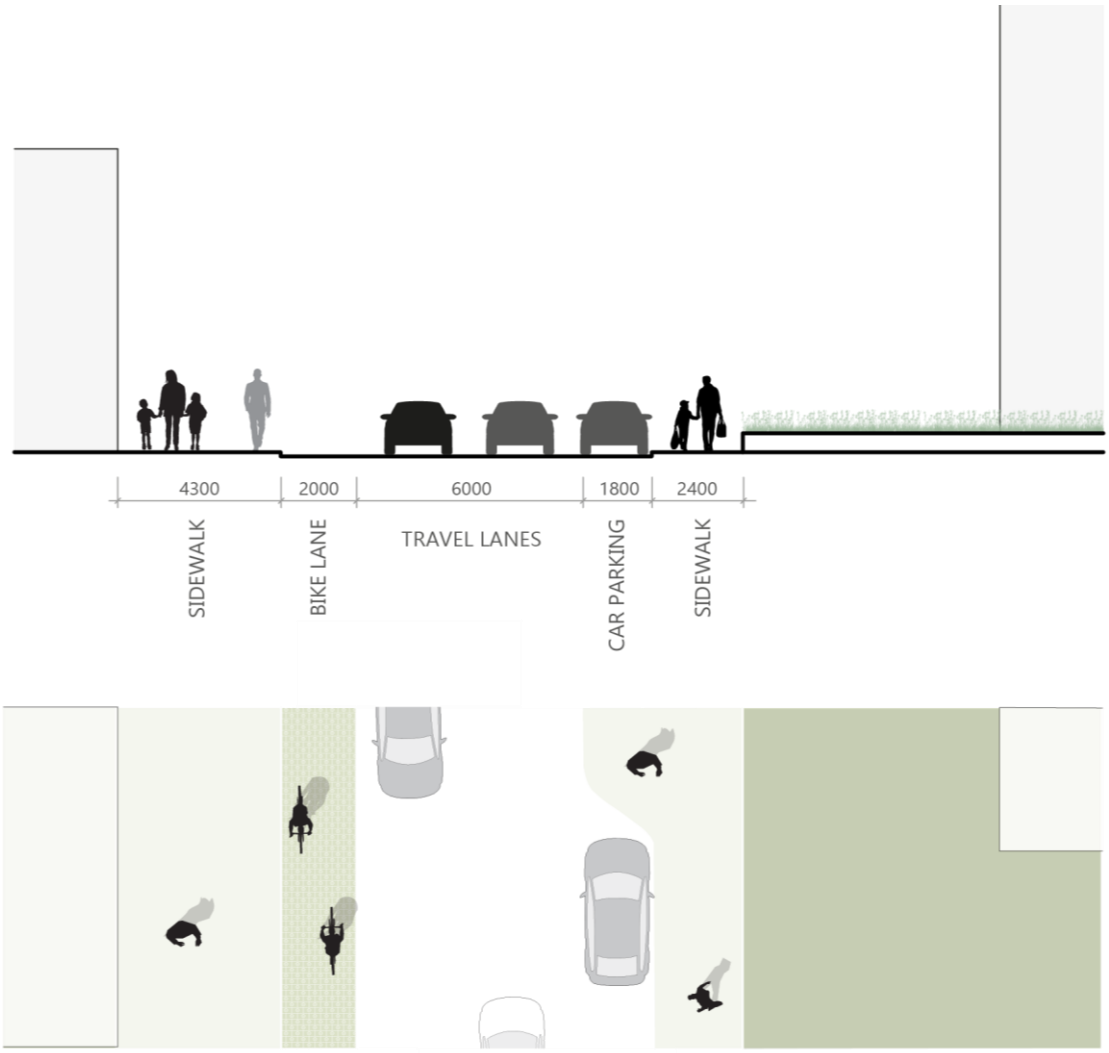


Figure 51: Föreningsgatan intervention proposal.

For Johanneberg additional improvements have been identified applying the guidelines seem on chapter 3 regarding health cities and the strategies for the post-pandemic city on chapter 4. The idea is promoting a more inclusive city, that has more to offer:

- Stockholm 1-minute city: apply the same concept used on the country capital, Stockholm, in Gothenburg, creating the sense of a coherent one-unit-model all over the country. This includes creating small spaces that can fit on parking spaces in different points of the city, that can work as social hubs, a place to relax and also park shared Scooters, as right now it does not have a proper place and occurs to be parked on sidewalks disturbing the pedestrian's flow. These 1-minute spaces also create environmental benefits being constructed with Swedish timber, and transform a street making it more alive and safer.
- Introduce Wi-fi spots along green areas: following the principal of digitalization, public outdoors Wi-fi spots welcome social interactions as well as general outdoors activities.
- *Gymnasium* in the southern part of Johanneberg: located close to the other schools, avoid the need for teenagers to travel far from home to continues their studies.
- Develop local Workstations: provided with a proper place to sit and work. The stations will be equipped with Wi-Fi and solar panels that generate renewable energy for workstation use (such has charging computers, tablets, and smartphones). Compatible with the 1-minute model, the workstations are sustainable structures which create environmental benefits being constructed with wood or recycled materials. Locally and relevantly placed stations would contribute to the neighborhoods contact with nature and social interaction. The workstations would experience a lot of use from students from the nearby school Chalmers as well as residents living in the multiple apartments in the surrounding area.
- Restructure Chalmers parking area: Gibratargatan has a lot of parking spots and the big Chalmers parking that is never completely used could be transformed into a pocket park with green space, to sit and relax, increase contact with nature. The green area is an ideal place for the previously proposed workstations that can be used by the students. Furthermore, the great amount existing parking spots will be reduced in order create better sidewalks. The east sidewalk will also become wider, in order to create more space for pedestrians, a now this sidewalk is used for outdoor tables of the restaurants there present. A speed table will be added to the pedestrian cross to reduce vehicles speed and guarantee the pedestrians safety. The proposal for the are also includes the construction of a bioswale as already mentioned on the first proposal for

Gilbratargatan, which will be install on the existing space for greenery between the different parking areas. Parts of the pavement in the parking spots will be removed to give space for more greenery, which creates more space to absorb and evaporate rain water and create biodiversity. All the asphalt removed from the parking to create the park can be reused for the roadbed of the speed table and new sidewalk additions

Figure 52: Chalmers parking.

Figure 53: Public green area to implement workstations.

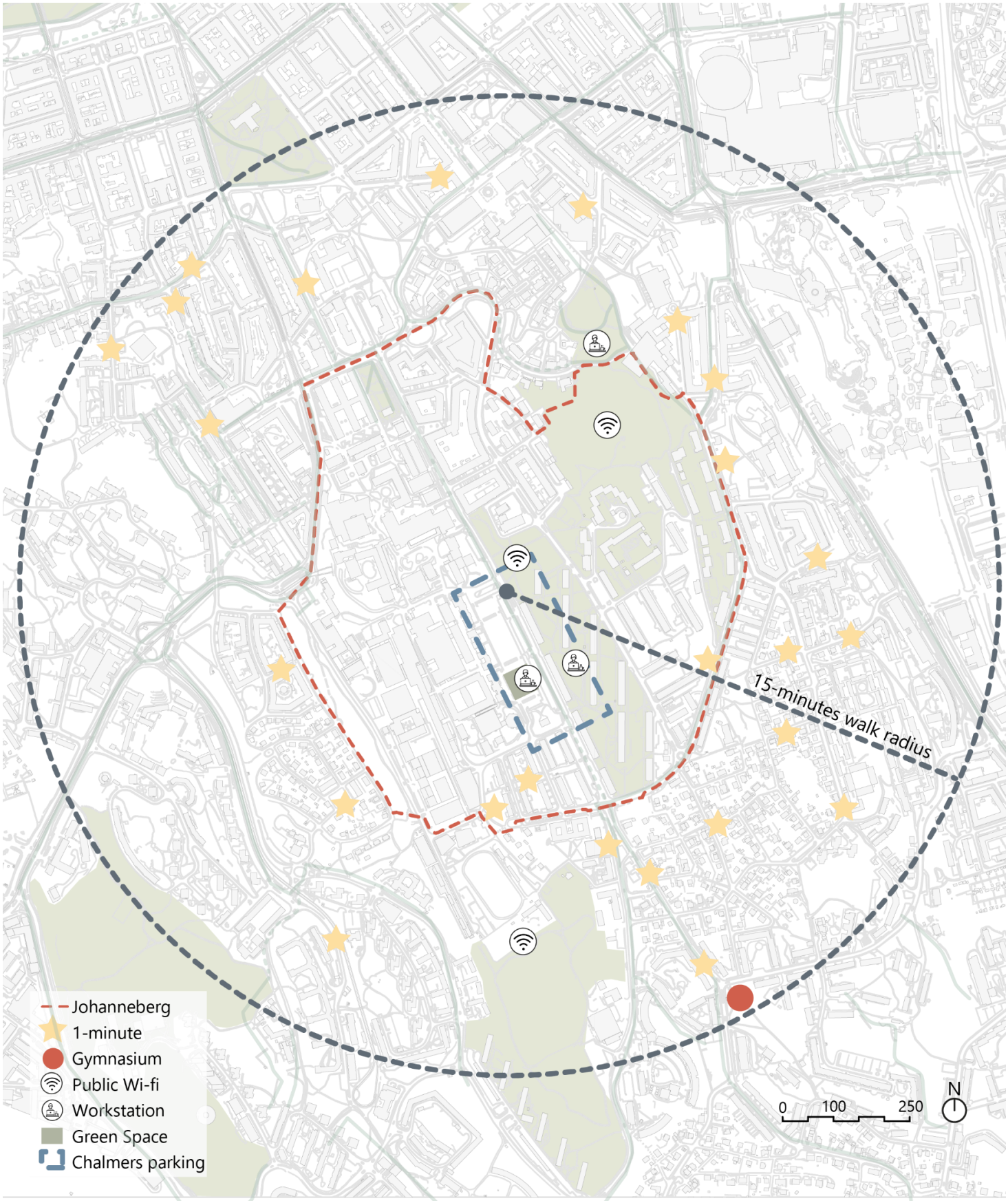


Figure 54: Johanneberg Masterplan proposal.

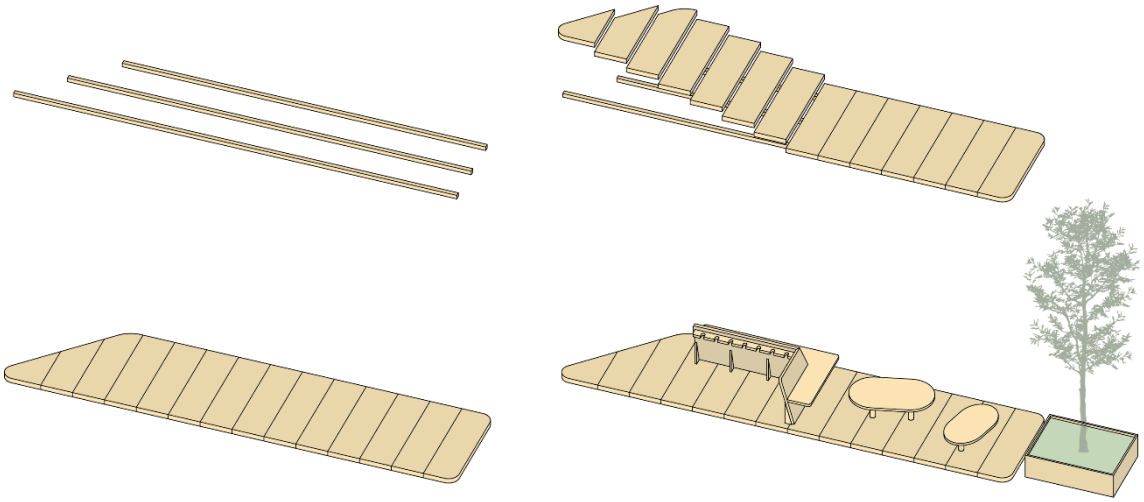


Figure 55: 1-minute city building step.

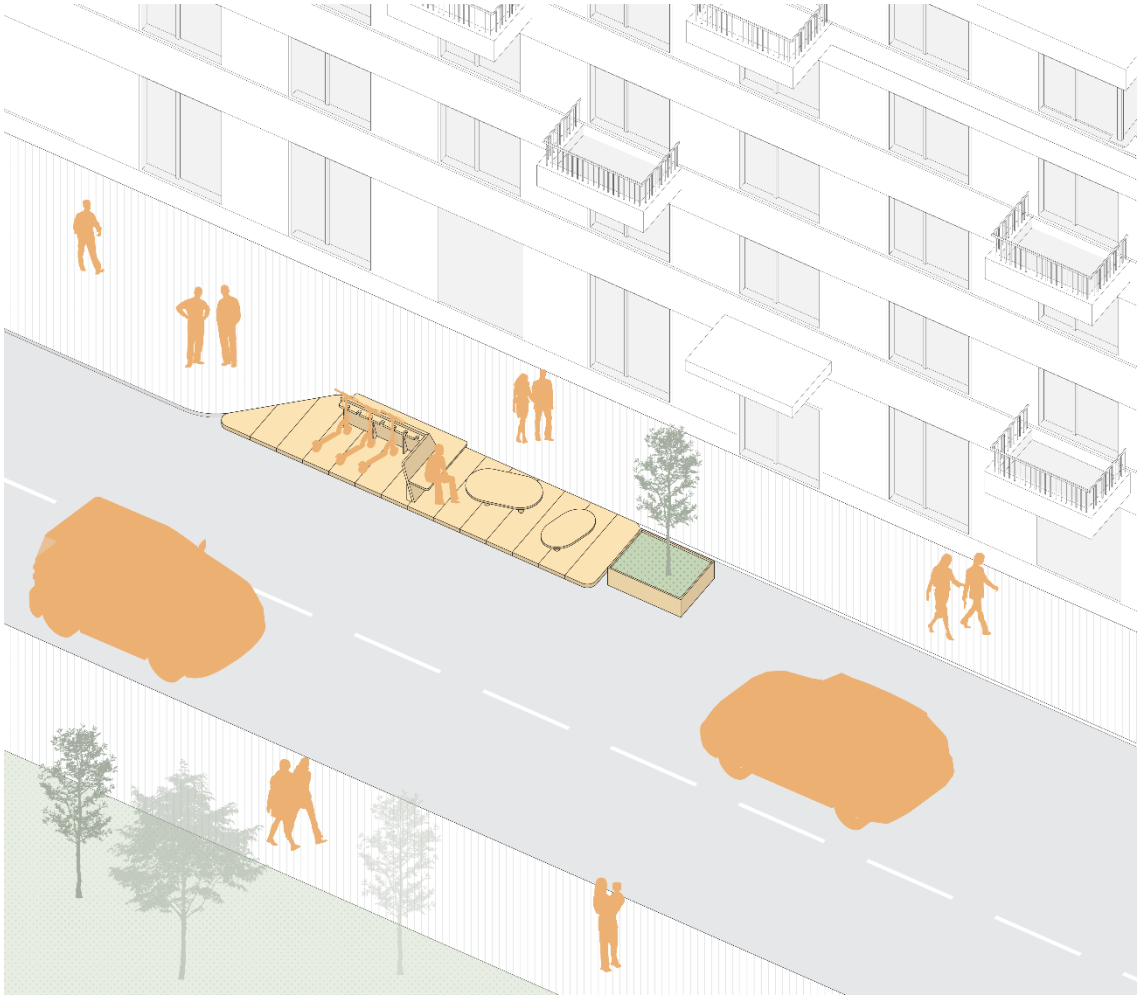


Figure 56: 1-minute city model.

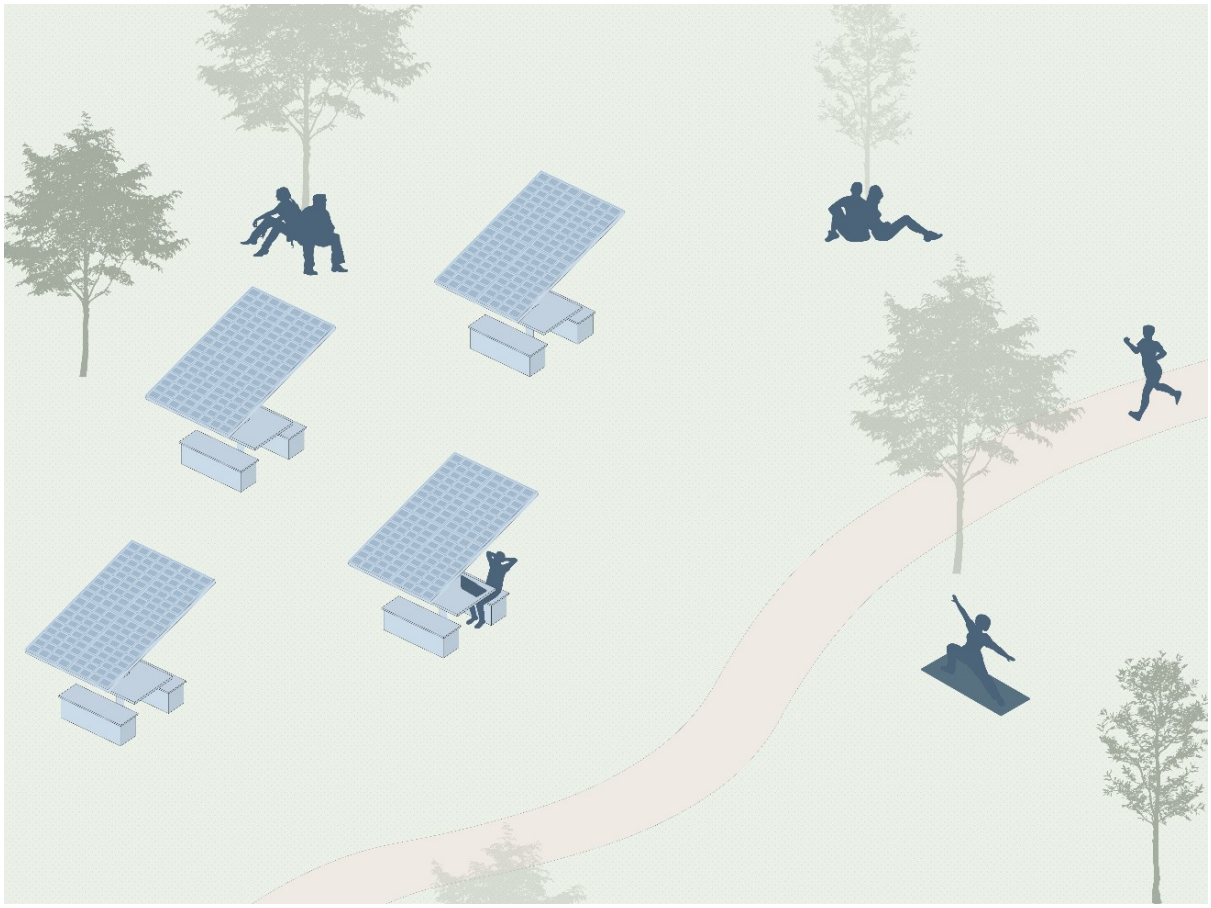


Figure 57: Work stations insert on public green areas.

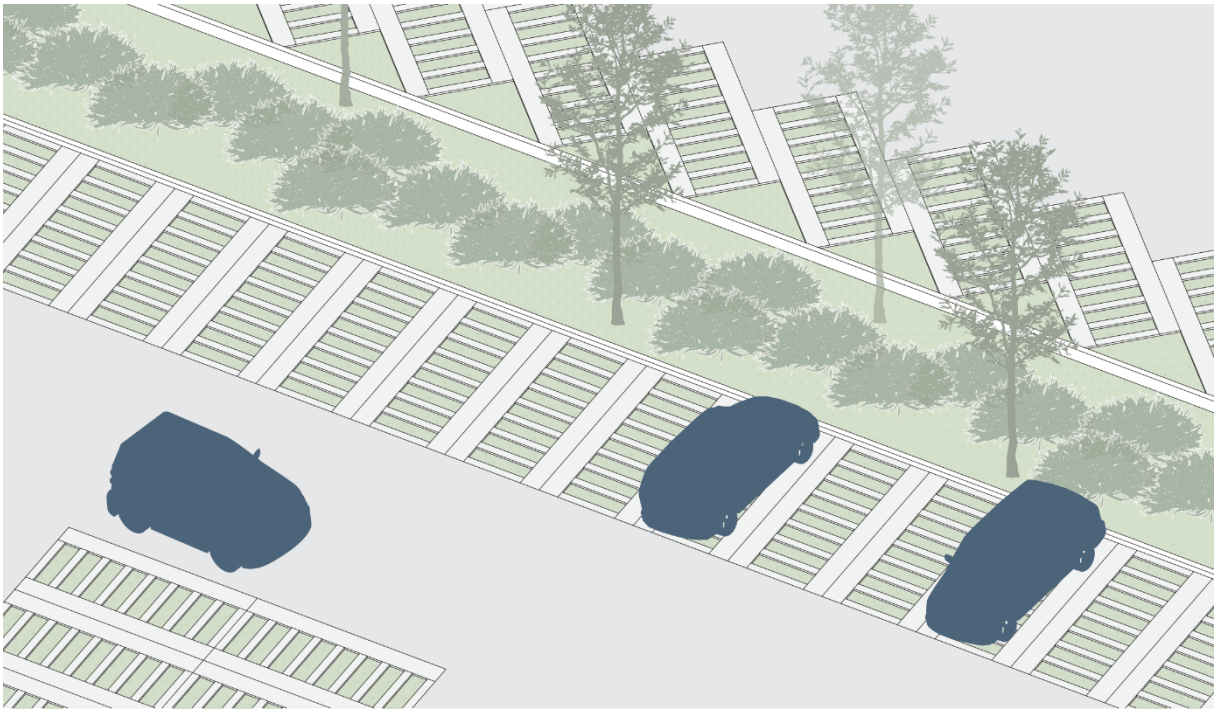


Figure 58: Chalmers parking with new Bioswale and more green areas.

Figure 59: Chalmers parking intervention.

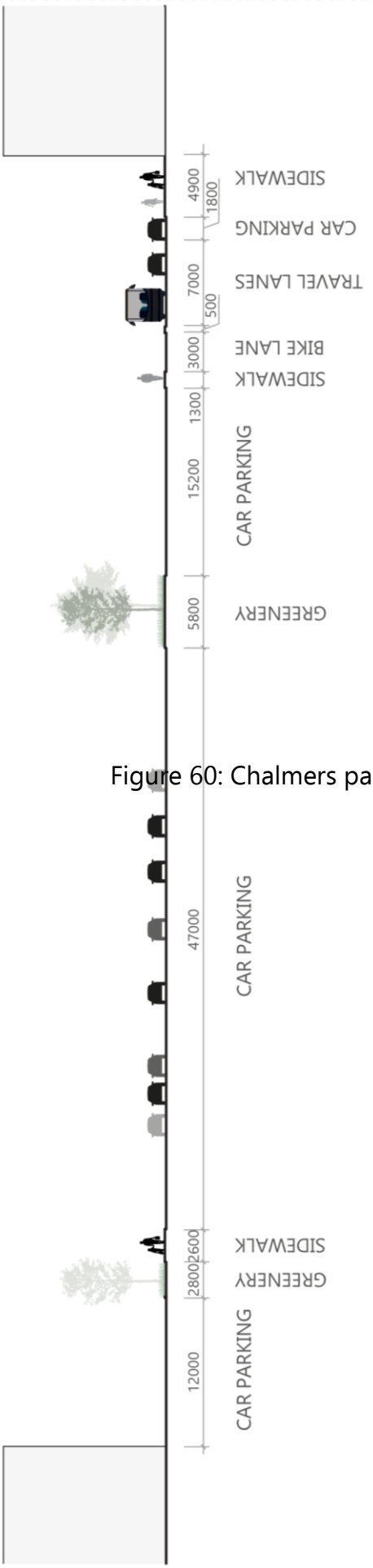


Figure 60: Chalmers parking current layout.

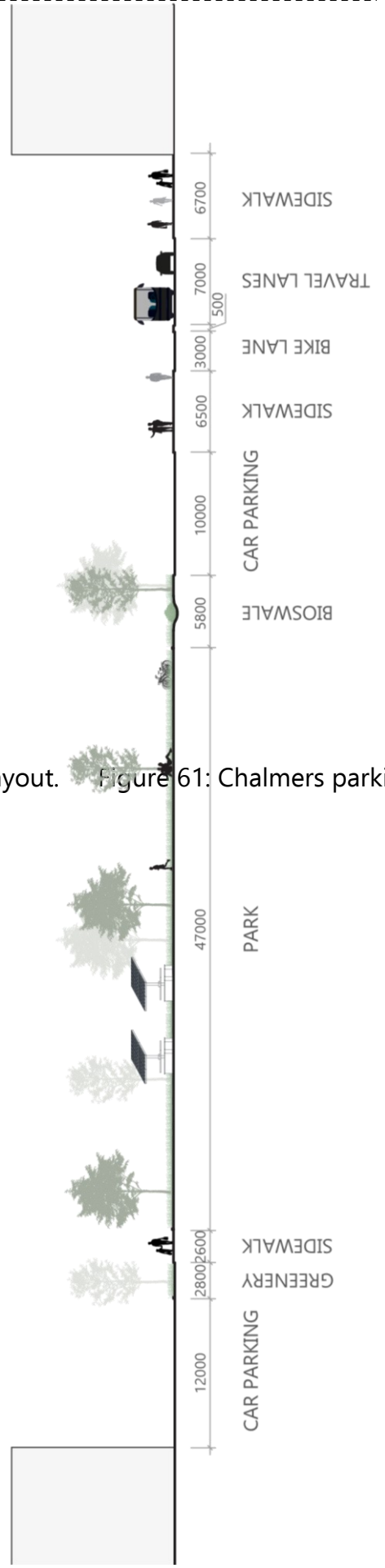


Figure 61: Chalmers parking intervent

5.4 Summary

Gothenburg is a really well-structured city, but there are still places for improvement especially if the country keeps not implementing any restrictions on future health emergencies. The city has bike lanes, numerous green spaces, bike-sharing stations, good availability of health centers and schools. Gothenburg has also already implemented Wi-Fi in strategic areas. To continue being a healthy city, Gothenburg need to keep improving. Although the abundance of green areas makes Gothenburg prepared for the post-pandemic life, the green areas need to be improved to combat future health emergencies: implementing strategies such as public Wi-Fi and solar-panel charged workstations improves the city for arising challenges. The contact with green areas and the increased interest for outdoor exercises would not be a problem, but the urban environment can contribute with people willing to keep in movement with better structure sidewalks that can also lead to the existent outdoor workout stations.

The intervention proposal has been developed in accordance with the health city parameters investigated on chapter 3 and the recovery proposals highlighted on chapter 4. Regarding the parameters for the health city, new water treatment system and sewer system were not considered for the present project due to the fat that the considered metropolitan area of the city is already well-provided by those.[261] The improvement regarding water and sewage, was the addition of Bioswale on Gilbratargatan to filter the rain water and relieve the load on the sewer system. and Public transportation in Gothenburg is easily accessible and well-connected, as it has a priority lane. In the present year half of the bus in Gothenburg run by electricity and it is expected that on next year the percent will increase to 75%. The city goal is to reduce all the public transport emissions in 95% by 2035.[262] This would be an improvement to several the health city parameters: pollution, urban mobility and sustainability.

Summarizing the interventions proposal in comparison with the health city parameters and the post-COVID-19 urban planning ideas (table 5 and 6) it is evident how those parameters defined before the pandemic are coherent with COVID-19 urban environment demand. Although this last health emergency has been a challenge, it does not highlight big changes from what was already recognized as an effective urban planning, but it evidences how urgent well-design cities should be developed.

[261] Gryaab, "Avloppsvattenrening". https://www.gryaab.se/vad-vi-gor/avloppsvattenrening/?fbclid=IwAR0B2eFiBLlddwg9XGmOu9N2Q1eolsrjLTPQWwhvCYgnzKkQ_V5gaAzv-CQ

[262] Adersjö, A. (2022). "Nu går hälften av bussarna på el i Göteborg". SVT. https://www.svt.se/nyheter/lokalt/vast/halften-av-bussarna-gar-pa-el-i-goteborg?fbclid=IwAR3vGwvJjQpQi0HyMLPaCeYzl54mrxUXUOqcpxYK4Np2D7PRdYTtVBBHBKo

Pollution	Water treatment system	Bioswale
	Sewer systems	Bioswale
	Decabornising the construction sector	Use of low-carbon material to build the Workstations and 1-minute space
	Circular economy	Reuse of resources - asphalt and Use of sustainable energy - solar panels
	Implement reuse policy	Reuse of resources - asphalt
	Recycling	Reuse of resources - asphalt
Urban mobility and space	Design neighborhoods for pedestrians	Improvement on sidewalks and bike lanes
	Well-designed neighbor-hoods for physical activity	Improvement on sidewalks and bike lanes
	Parks	Wi-fi spots on green areas; new park on Chalmers parking
	Trails and paths for walking and cycling	Improvement on sidewalks and bike lanes
	Traffic calming	New speed table on Gilbartragatan
	Investment on public transport	-
	Community participation	Västtrafik Hållplats survey
Sustainability	Circular Economy	Reuse of resources - asphalt and Use of sustainable energy - solar panels
	Reduce, reuse and recycle	Reuse of resources - asphalt
	Life Cycle Assessment (LCA)	Evaluate the intervention during its Life Cycle
	Use of renewable energy	Solar panels on Workstations
	Use of alternative vehicles fuel	Existing charging station for vehicles

Table 5: Intervention proposal in accordance with health city parameters.

Urban planning after COVID-19	Car sharing	Not applicable - population interest on walking and cycling
	Charging stations	Existent
	Decabornization of urban mobility	New bike lane and sidewalks - motivate use of non motorized vehicles
	1-minute City	Stockholm idea was applied in Gothenburg
	15-minute City	Concept used to analyse Johanneberg
	"Workation"	Inspiration for the workstations on green areas
	Bus priority lane	Existent
	New bike and walk paths	Applied in different strategic points of the study area

Table 6: Intervention proposal in accordance with urban planning ideas after COVID-19.

6. CONCLUSION

History has shown that pandemics can be a impetus for building safer environments. The layout of the contemporary city and the measures adopted to contain the spread of the COVID-19 virus emerged from the impact of previous epidemics and pandemics. As mentioned, one of New Zealand's public heath interventions against the virus spread was hotel managed isolation and quarantine (MIQ), which is correlated with the policies from the Black Death outbreak, when ships and trade caravans arriving from infected areas to submit to 30 days of isolation. Knowledge obtained from the Black Death, such as quarantine and isolation, was used to combat the COVID-19. The Cholera pandemic was a key historical moment for urban environments with the association between the disease and the need for sewage systems, which provide population healthier environments and protections from other diseases. In the Spanish Flu health emergency has the first to close public meeting places and implement restriction in schools, churches, cinemas and theaters, which was also adopted 100 years later by many countries during the COVID-19 outbreaks.

The Cerda's utopic urban planning for Barcelona proved to be effective and bring qualities to its habitants' life. Together with the superblock project, it provides people a safer neighborhood when it comes to traffic and public space. Its qualities had been noticeable and for this reason the superblocks will be extended to Madrid providing the city the ability of being more prepared in case of a new health emergency, as for now, the city had faced many mobility problems. Clarence Perry Neighborhood concept from 1929 can be compared with the new city concept develop by Carlos Moreno in 2006 that became a trend solution for recover cities after the COVID-19 emergency. These comparisons bring up the question of whether the pandemic could have been handled better if Perry's model had been applied before, instead of now using Moreno's concept as a reactionary response.

Well designed and well managed public spaces such as parks and gardens, urban forests, nature reserves, playgrounds, greenways, markets and streets make direct contributions to urban health and wellbeing, ensuring healthy living and longer life. When provided in adequate quantity across the urban divide, high quality of green, and public spaces support ecosystem services such as clean water, purifying air, enhancing and protecting biodiversity, cooling our cities, storing carbon, and protecting the earth natural features and processes.[263] The COVID-19 health emergency together with the predicted proportions of people living in urban areas by 2050 highlighted even more the need for well design cities. The increased visits to

[263] Chong, J., Rana, S., Ojal, M. (2020) "Public Spaces as an Invaluable Resource for Delivering Healthy and More Equitable Cities and Communities". The Journal of Public Space.
https://www.journalpublicspace.org/index.php/jps/article/view/1415

public spaces and green areas during the pandemic shows how people understood the importance of the city elements and how they should be more present in the environment and improved to attend all the needs of a neighbors and its respect habitants.

These findings provide evidence regarding Doxiadis science of human settlements, as its first principal was the maximization of man's potential contacts with the elements of nature, with other people, and with the works of man, such as buildings and roads. Furthermore, the concern with making road and sidewalks wider and providing cities with bike paths goes together with Kevin Lynch principle of access, that states that people should be able to have means to move in their own city.

Aiming a better urban environment after the COVID-19 pandemic, many countries developed their strategies. Although China did not present a higher amount of visits to public and green spaces during the emergency, the country has developed new standard green design ratio as they recognize it is a important element of the urban environment. China is also investing hospital, sanitation and in sustainability applying the smart cities concept, waste management policies and green energy to reduce the emission of GHG, all mentioned on the health cities parameters.

Denmark recovery plan also goes towards a more sustainably city, reduction of GHG emissions and improvements on cycle paths in order to motivate the population to use bicycles instead of cars. Although the country has no new strategies regarding water pollution and sewage, Denmark is still following with the UN's Sustainable Development Goal defined on 2015 that includes improvements of these areas. Sweden is adopting measures to become a more sustainable and resilient country. Even though the country did not adopt any kind of lockdowns, it suffered the consequences of the pandemic and understood the need to elaborate strategies for a better future. If it works as expected, the one-minute city implemented in Stockholm can bring lots of improvements for its population everyday life with the creation of spaces for the people instead of cars. This will provide the city more places where people can meet the neighbors and friends, and take some fresh air during breaks, especially in this moment with working and staying home all day has become so common.

Spain recovery strategy was elaborated with the involvement of the community, which enlists the perspectives, concerns and visions of community members to articulate the strategies to be apply, and as consequence increase the probability of a better results, heathier outcomes and more livable environments for residents. The strategies of the country include promoting higher sustainable, safe and connected urban and metropolitan environment. The government wants to promote the decarbonization of urban mobility in order to make it a less polluted and healthier environment, which is also New Zealand's goal. Furthermore, the latest projects approved by New Zealand's

Fast Track initiative will provide the country population new residential areas with adapted green spaces, as they were an important element of life when the restrictions were being used. Australia is investing on preserve its nature reserve and make then more attractive for the public, as well as more adapted to its workers.

Although each country has developed its own recovery plan, they all have in common the desire to build more sustainable environments and reduce the GHG emissions. One of the parameters to build a health city now a days is the community involvement on the project development and as for now only Italy and Spain have invested on it. Measures taken during the emergency, such as the increased amount of walk and cycle paths in cities as Milan and Spain, seems to be well accepted by its community and will continue to be developed for the future. It is important to recognize the common desire and concern to build better environments to the future according to each country needs.

The focused research on the city of Gothenburg, together with all the knowledge about previous pandemics, health city parameters and new design ideas conceptualized to create better urban environments after the COVID-19, allowed the development of strategies to improve different areas of the city center. The city is already having a well-developed infrastructure and the proposed ideas were thought to complement it by creating connected and safer bike lanes, wider sidewalks and structures for urban spaces use. The city center is well designed and embrace the urban mobility and space parameters of a health city, and the project proposed aims to enhance its characteristics and encourage further urban space use. These same proposals could be also applied in other neighborhoods: the 1-minute city and Work stations were specially developed with this purpose as they are small structures that can fit in existing parking places and green areas.

This research has contributed to understand the whole of urban planning on providing safer and healthier environments by highlighting how it changes during the history, contributed to combat the COVID-19 outbreak and can continue to improve in the future. For future research could be done to understand how the future projects, if already implemented, could have affected the spread of the COVID-19 virus.

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