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# Towards Healthy Urban Living – EU Green Infrastructure Strategy and Green Roof Implementation in Member States

**Master Thesis in Spatial Planning**

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# Abstract

Urban planning has long been known to affect the health of citizens and ecosystems of cities and surrounding areas. Since the 19th century, when numerous urban issues arose, the protection of health has been one of the priorities for city design and planning and has influenced the practice until this day. Nowadays, continuous excessive greenhouse gas production, physical inactivity and social, cultural and economic inequalities within cities are the main factors harming the health of urban populations in the west. Policymakers and scholars have been aware of these issues and attempt to find solutions to secure a healthy urban living. The recent development of green infrastructure, the incorporation of natural ecosystems within urban areas, which not only protects the environment, but also has positive effects on human health and well-being is an exemplary framework on this topic. The EU Green Infrastructure Strategy drawn up in 2013 is a supranational attempt to implement such strategies. This non-binding document, however, requires governance and cooperation on a number of levels in order for the initiatives to be put into practice. A popular example of green infrastructure in EU cities are green roofs which have multiple potential benefits for urban health, as shown by examples such as Hamburg or Rotterdam where the EU Biodiversity Strategy has been used as a background for environmental policies and where EU funds are used for green roof initiatives. The connection between the EU strategies and funds and national initiatives, however, is still weak, and the need for more promotion of EU frameworks as well as research on specific EU initiatives and their effect on healthy urban living is necessary.

# Table of Contents

# 1. Introduction

In an increasingly urbanized world more and more concerns arise regarding the effect of cities on natural environment and, consequently, human health. Healthy cities and a healthy urban living are being promoted by governments all over the world, especially due to numerous health hazards created within and by urban areas nowadays (Jackson, 2003; Northridge et al., 2003). The connection between health and cities is not a recent one. After the industrial revolution, in the quickly growing condensed urban areas of the 19th century, health issues, such as disease epidemics, poor sanitation and water quality as well as pollution from new factories situated in city centers arose and needed to be taken care of with the help of a tool which first emerged around that time – city planning (Jackson, 2003).

## 1.1. Background

Rapidly growing urban areas of the twenty first century face problems which have evolved with the development of technology, industry and a resulting overall change in lifestyles (Jackson, 2003). The issue of urban health, which became more visible in the nineteenth century, nowadays no longer revolves around poor sanitation and urban factory emissions, at least in most cities of the Western world. Current urban health issues are caused mainly by vehicle exhaust, increased greenhouse gas emissions produced mainly by infrastructure and transportation, physical inactivity, social and cultural fragmentation of cities as well as huge economic disparities, even in the most developed cities (Davoudi, Crawford, & Mehmood, 2009; Jackson, 2003).

Amongst many other sectors, urban infrastructure is often mentioned as one which contributes significantly to one of the main proved threats to both human health and natural ecosystem balance – excessive greenhouse gas emissions (Houghton et al., 2001; Frumkin et al., 2008; UN, n.d.). Infrastructure such as roads, schools, power plants, transportation and communication systems, etc., is one of the basic building blocks of modern communities, its existence and development is therefore essential (Webster's New World College Dictionary, 2014; Ramaswami, 2013). Methods of adapting infrastructure and altering it so that it no longer contributes to excessive greenhouse gas emissions, while also promoting a balanced coexistence of the urban fabric, urban populations and the natural environment within and around cities, have been on numerous national and international agendas in the last couple of decades (Hoornweg, Sugar, & Trejos, 2011). One of the initiatives which has recently emerged

in research and practice is green infrastructure, a system or network of natural and semi-natural features incorporated into the urban fabric in order to deliver ecosystem services and protect biodiversity as well as ensure a healthy urban living (Benedict, & McMahon, 2012; European Commission, 2013). Green infrastructure can take on many different forms, such as natural waterways, reserves, larger and smaller parks, urban green space or city design features, such as green walls and green roofs etc. (Benedict, & McMahon, 2012).

Both national governments and international organizations try to combat urban issues and constantly emerging health threats and to adapt cities to the changing climate through the implementation of green infrastructure policies (Davies et al., 2006; Mell, 2011). Measures such as frameworks and guidelines for green infrastructure design and implementation featured in official policies, as well as funds specifically developed to subsidize such initiatives are some of the main ways in which green infrastructure is promoted. In the EU, for example, the Green Infrastructure Strategy was developed in 2013 based on the objectives of the Biodiversity Strategy agreed on by the EU and its member states (European Commission, 2013).

The implementation of EU guidelines and funds is happening on various levels in member states and makes use of an important tool for such strategies – spatial planning (Neumann et al., 2011). Since the nineteenth century city planning has been attempting to address urban problems through the implementation of policies and city design elements which mitigate the negative impacts of climate change (Jackson, 2003). One of many examples of such a design element are green roofs, vegetated roof areas which have been proven to contribute positively to a healthy urban living (Dunnett, & Kingsbury, 2008).

## 1.2. Scope of Research: Objectives and Questions

The main question this research aims to answer is:

*To what extent do EU initiatives, such as the Green Infrastructure Strategy, affect the implementation of green infrastructure, specifically green roofs, in EU member states and contribute to EU's healthy urban living?*

Further answered sub-questions which lead to final conclusions consist mainly of the following queries:

- *How can spatial planning theory and practice contribute to a healthy urban living?*
- *What is green infrastructure and what benefits does it have for human and ecosystem health within urban areas?*

- *Which tools does the EU use and provide to promote the development of green infrastructure?*
- *How is the EU Green Infrastructure Strategy implemented on member state levels, what are its limitations?*
- *How are green roofs, a form of green infrastructure, beneficial to a healthy urban living?*
- *What connections between EU green infrastructure initiatives and a healthy urban living does the case study of green roofs in Hamburg and Rotterdam show?*

The research has two main foci and aims to connect the two. The first one is the EU Green Infrastructure Strategy, its objectives (chiefly human and ecosystem health) and how it is implemented in member states. The various levels of governance and decision-making, as well as spatial planning as a tool on many of those levels, is a chief theme of the first focus.

The second focus of the research is the effect of green infrastructure, and specifically green roofs on a healthy urban living, overall urban (human and ecosystem) health. The two together create a larger connection between the EU Green Infrastructure Strategy itself and how its implementation, in the form of green roofs, can affect human and ecosystem health in member states.

## 1.3. Relevance of Topic

Green infrastructure is a relatively recent topic. It appears more and more frequently in urban agendas and academic literature and its relevance is growing significantly with the increasing visible results of climate change and need for a sustainable urban growth. Because of the rapidly increasing urban growth, the importance of strategies for adaptation to the climate change and a need for a healthy urban living, a healthy relationship between the man-made and natural environment, have also increased (Benedict & McMahon, 2012). Apart from the fact that the theme falls within the scope of current urban agendas of many western cities, it is also important in relation to EU actions and policies. Despite there being many documents and reports conducted or funded by EU institutions (mainly by the Commission), there is still a gap in literature on the process of the implementation of specific green infrastructure measures, suggested and founded by the EU, in member states. Moreover, because green infrastructure developments are very recent, little is known from specific cases about how those initiatives affect healthy urban living in an area. The potential and expected benefits of green infrastructure are often mentioned in policies and project proposals, this research,

however, attempts at finding a more specific connection between EU funding and guidelines, green infrastructure implementation and health within EU cities. Filling a part of this research gap aims to promote further research in the field and promotion as well as investment in green infrastructure measures on a larger scale, as they have the potential to build a 'sustainable healthy future for EU cities' (Raynal, 2018).

## 1.4. Outline

This research will begin with a comprehensive theoretical framework and background of the topic. The theoretical framework is divided in two main parts: the first one, outlining the connection between cities and health, defining a healthy urban living, and the second one, making a connection between urban infrastructure and the health of citizens as well as ecosystems within cities. Furthermore, the second part of the theoretical framework mentions the aspect of the implementation of green infrastructure in national and international policies and guidelines and touches upon the example of green roofs: the way this kind of initiative works on a EU and EU member state level.

Secondly, the methodology of the research including document analysis, interviews and a case study will be described. The validity of such research will be assessed and the strengths and weaknesses of chosen methodology listed for a comprehensive understanding of benefits and limitations of the research.

The fourth section of the research includes the collected data and analysis of EU documents: the EU Green Infrastructure Strategy as well as supporting EU reports on the design and implementation of green infrastructure, as well as the roles of the EU institutions and member states in the process of the implementation of such initiatives. Furthermore, two case studies, of Hamburg, Germany and Rotterdam, the Netherlands, are described to illustrate the implementation of green infrastructure in the form of green roofs. Interviews with appropriate experts are interwoven throughout the analysis section, both in the description of the EU Green Infrastructure Strategy and the case studies. Concluding remarks as well as suggestions for further research are mentioned in the last, fifth section.

# 2. Theoretical Background

The theoretical framework of this research is based and builds on the topics of healthy urban living and the connection between the built environment and human health and well-being. A common thread in research discussing the positive effect of the environment on citizens' health is described, namely the access to green space as well as the presence of natural elements and ecosystems within urban areas.

The topic of green infrastructure in spatial planning, specifically the development and implementation of green roofs, will be brought up as a urban design feature which combines mitigation and adaptation to the changing climate. The connection between implemented green infrastructure and human and ecosystem health within cities will be identified as an important argument for the connection between urban infrastructure and health. A specific example, the EU Green Infrastructure Strategy, is introduced as a policy and framework suggestion for the implementation of such techniques in national documents and planning guides.

The theoretical framework combines, therefore, two main themes and relationships: that of cities and health and that of urban infrastructure and health. The aim is to show a connection between urban areas, healthy urban living and the contribution and effect urban infrastructure has on health.

## 2.1. Planning Healthy Cities

Urban planning and the health of citizens, as well as ecosystems within and around cities, have long been known to be interrelated (Northridge et al., 2003). Already in the 19th century, after the immense growth and industrialization of cities, health concerns were the main and "original impetus [...] for the profession of city planning" (Jackson, 2003, p.198). Nowadays, the issues of poor sanitation and urban factory emissions are not the most prominent problems of developed cities, yet the influence of early planning theory and practice is visible in urban areas till this day (Jackson, 2003). The current health problems of urban areas are caused chiefly by vehicle exhaust, increased greenhouse gas emissions produced mainly by infrastructure and transportation, physical inactivity, social and cultural fragmentation of cities and huge economic disparities, even in the most developed cities (Davoudi, Crawford, & Mehmood, 2009; Jackson, 2003). Since the early 1980s, numerous authors (e.g. Duhl et al., 1999; Lindheim, & Syme, 1983; Kunstler, 1998; Jackson, & Kochtitzky, 2001) have called for the practice of spatial planning to address these problems through the implementation of

policies and city design elements which would encourage physical activity and mitigate the negative impacts of climate change (Jackson, 2003).

The framework described in this section outlines a connection between urban areas and human as well as ecosystem health. Urban areas, in this case, are elements of the "physical environment made by people for people, including buildings, transportation systems, and open spaces" along with the modified natural environment within cities which has also been created, or at least modified, by people for their use (Northridge et al., 2003, p. 558). Regarding the human health aspect, the World Health Organization (WHO) definition will be used for the purpose of this research. The WHO describes human health as the "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1948). Ecosystem health is closely interrelated with human health, and natural environment is often considered to be a "fundamental determinant of health and well-being" (Northridge et al., 2003, p. 558). The definition of ecosystem health itself is, however, more contested and complex than the human aspect of well-being. Although described differently by numerous scholars, it is agreed that ecosystem health is "the occurrence of normal ecosystem processes and functions" (Tzoulas et al., 2007, p. 168). This definition will be expanded in section 2.1.2. and will include different aspects of ecosystem health.

### 2.1.1. The Development of the Healthy City

The 19th century brought upon numerous technological and industrial developments which had a significant effect on the course of human development. The increased industrialization created a need for larger concentrations in urban developments where thousands of workers lived in proximity to the factories they worked in (Lindheim, & Syme, 1983; Mumford, 1961). Their dwellings were highly concentrated, the living environments described as "savagely deteriorated, ugly, and debased" (Lindheim, & Syme, 1983, p.336). The mass housing and poor living conditions led to the development and quick spread of diseases, such as typhus, cholera, yellow fever and tuberculosis which all claimed many lives in the nineteenth century (Lindheim, & Syme, 1983). It became the main objective for reformers and sanitarians at the time to bring to the city fresh air, clean water, open green space and sunlight (Lindheim, & Syme, 1983). Beginning with Great Britain's 1848 Public Health Act based on the Chadwick Report, *On the Sanitary Condition of the Labouring Population of Great Britain*, by the end of the nineteenth century most major cities in the western world implicated policies on water management and improving the level of sanitation (Lindheim, & Syme, 1983).

Furthermore, theoretical frameworks and guidelines for city planning began to emerge, coined by the sanitary movement and scholars, starting with Benjamin Walter Richardson's idea of a utopian community (Hygeia, a City of Health) which suggested gardens for each house as a way of incorporating ventilation and sunlight into the city (Richardson, 1876). Following the late nineteenth century movements, more literature and theoretical frameworks of utopian cities emerged at the end of the nineteenth and beginning of twentieth century. In 1898, a city model, one of the most popular and influential in urban planning practice and theory, was brought up by Ebenezer Howard (Lindheim, & Syme, 1983). His 'Garden City' was a combination of the best attributes of an urban area and the countryside at once, a city surrounded by a belt of agriculture of which the centre contained commercial and recreational facilities and functions, such as living and schools separated on the outer rings of the city model (Howard, 1951). Howard's Garden City was used as a model for the 'new' ideal town as well as a template for suburban development (Lindheim, & Syme, 1983). The influence of the Garden City model was prominent in the field of planning throughout the whole twentieth century and is mentioned to this day as a significant contributor to the development of the idea of a healthy and green city (Corburn, 2009; Ward, 2005). Howard was one of the first theorists to highlight the importance of green space in urban areas and his utopia is often a point of reference for creating new urban policies, especially in the global north.

The beginning of the twentieth century showed a decrease in deadly disease epidemics and lower death rates which have often been contributed to large-scale planning, public health innovations and infrastructure projects such as clean water technologies, sanitation programs and safer food distribution (Corburn, 2009). Throughout the twentieth century, the field of urban planning was developing as cities throughout the world grew rapidly. Despite being much more sanitary than a hundred years before, cities in the global north have been facing the issues of inequality and the discrimination of the urban poor as well as environmental changes harmful to health of citizens and ecosystems (Corburn, 2009). The field of city planning and public health emerged at the same time and were closely connected at the beginning of the nineteenth century. Later, the two fields separated, as urban areas in the western world developed and different needs arose within them (Corburn, 2009). Following the two World Wars during which national and international policies prioritised different issues than urban health, towards the end of the twentieth and beginning of the twenty-first century, a more significant disconnection between environmental health and the field of urban planning has been observed (Barton et al., 2009; Corburn, 2009; Northridge et al., 2003). In the twenty-first century researchers, policymakers, activists and planning practitioners have been attempting to

re-focus city development on equal health within and around it (Barton et al., 2009; Corburn, 2009; Frumkin et al., 2004; Frumkin, 2005).

### 2.1.2. Modern Healthy Urban Living

The above described development in thinking and writing about healthy cities has led to the evolution of numerous frameworks and definitions of the 'healthy city' and ways to plan one, as well as of 'healthy urban living' in the context of the twenty-first century cities of the west. The main urban issues have dramatically changed since the nineteenth century, and with them the focus of national and international policies and planning techniques (Northridge et al., 2003). A connection between the natural environment, built environment and health of urban areas has often been underlined as a theoretical ground for healthy city planning and a guideline for policies and practice of urban planning (Northridge et al., 2003).

#### *Cities and Health Relationship*

Before describing the planning aspect of healthy cities, a conceptual framework illustrating the connection between the built environment and human health will be touched upon in order to set a background for recent developments in the fields of policy making and planning. Schulz and Northridge (2004) developed a conceptual model which shows various mechanisms and pathways through which social, political and economic processes interact with the physical aspect of cities and affect the health of urban populations (Schulz, & Northridge, 2004; Northridge et al., 2003). Summarized by Northridge et al. (2003) in a diagram (Figure 1) this framework mentions fundamental, intermediate and proximate factors affecting human health and well-being. The interconnections between them are complex, as the factors can influence each other, and all ultimately have an impact on the health of citizens.

The fundamental macro-level factors include the natural environment, historical, political and economic order of a city as well as the distribution of goods and opportunities. The intermediate factors consist of the built environment, the urban fabric aspect of the city and the social context such as policies, enforcement of ordinances, etc. Those components are the most important and familiar to planners and urban design practitioners, as they are direct results of policies, interventions, such as land use strategies and 'microscale design considerations', as well as overall decisions made about the development of land and buildings within cities (Barton, & Tsourou, 2013; Northridge et al., 2003). The proximate components include social, cultural and economic aspects as well as available resources, housing conditions, physical activity, crime rates and points further listed in Figure 1. Affected by the

elements mentioned previously, health and well-being can be measured on individual or population levels and include physical (e.g. diseases) as well as psychological (level of happiness, life satisfaction attributes) components (Schulz, & Northridge, 2004).

In this research, the main factors focused on will be the fundamental, natural environment as well as one of the intermediate factors – the built environment, specifically services such as transportation and other network systems, the building blocks of urban infrastructure. The natural environment and ecosystems of an area are considered by many as an 'exogenous domain', external to the influence of planners and human activities (Northridge et al., 2003). However, it is not fully outside of the influence of urban development. Nowadays, natural ecosystems are worked with and incorporated into the planning of cities. The balance within natural and man-made elements within urban areas is very important in maintaining the health of the environment and, closely interlinked with that, human health (Frumkin et al., 2008; Haines, & Patz, 2004).

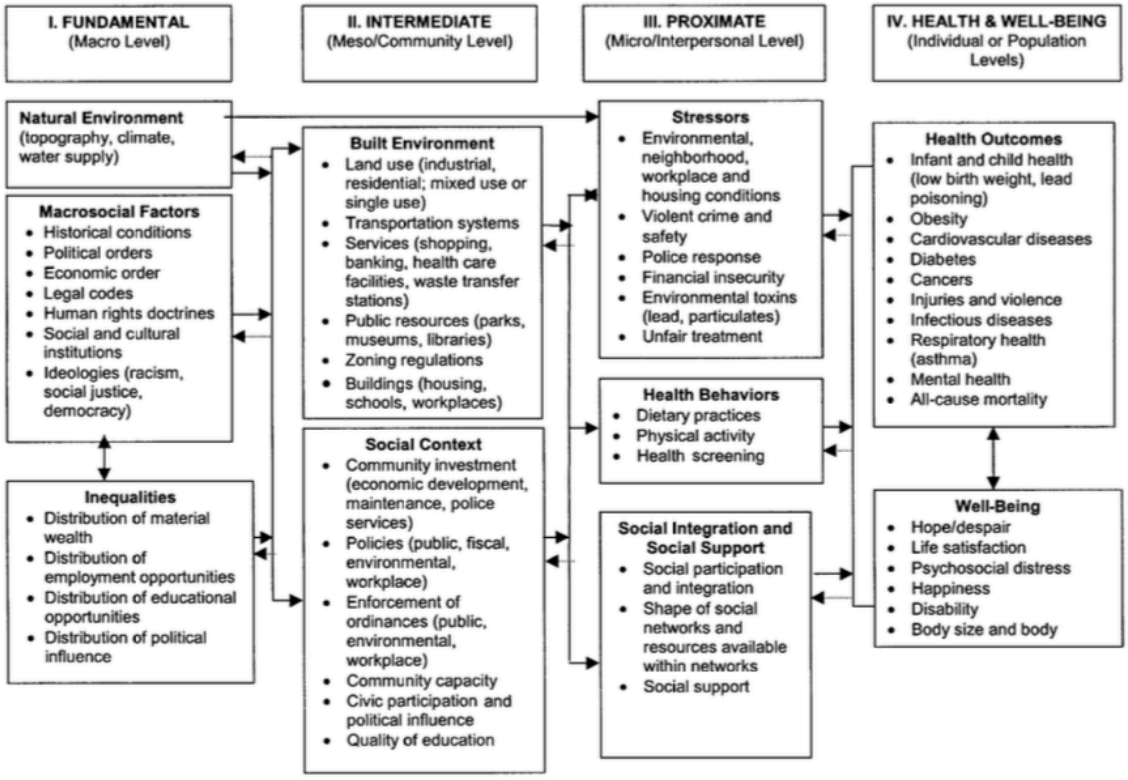


**FIGURE 1.** Social determinants of health and environmental health promotion. The model was developed for an article by AJ Schultz and ME Northridge.[5]

Figure 1. Social determinants of health and environmental health promotion. Model developed for an article by AJ Schultz and ME Northridge (Northridge et al., 2003, p.559).

### *Reconnecting Health and Planning*

All the multiplex connections between the natural and built environment should be considered when drafting policies and executing them in planning practice. Numerous frameworks describing modern healthy urban living have been developed in the current century and are being continuously built on in an ongoing discourse on healthy cities. Various key determinants of urban populations' health are highlighted in multiple researches, the main ones including processes governing land use, housing, transportation, job opportunities, social services, the quality of the urban environment and opportunities for public participation in local decision-making processes (Corburn, 2009).

Existing frameworks illustrate conditions under which cities can be considered as healthy and ways in which, with the help of policies and urban planning, the health of citizens can be improved in urban areas. Of course, the guidelines are contextual and differ greatly between developed areas, like Europe, where the main urban threats consist of heavy traffic, pollution, noise, violence as well as social isolation, and numerous developing countries, where

sanitation, water and waste management, and disease epidemics are yet to be fully taken care of (WHO, n.d.).

Definitions of healthy urban living and planning healthy cities in the western context vary throughout literature and policy documents. According to the WHO, a healthy city is "continually creating and improving 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 developing to their maximum potential." (WHO, 1998, p.13). This definition reflects the dynamic and complex process that is the development of cities and the maintenance of their physical and social environments. More often than through a short definition, research describes healthy urban living by explaining the methods in which it can be achieved and provides a framework for planners and decision makers to follow in order to develop healthy cities in the west (e.g. Barton, & Tsourou, 2013; De Leeuw, 2009; Ison, 2009; Jackson, 2003; Nieuwenhuijsen, & Khreis, 2016; Northridge et al., 2003; Ward, 2005).

Early twenty-first century frameworks on healthy cities call for a reintegration of public health and urban planning professionals as the only way to appeal for "essential planning and policy changes to improve the health and lives of urban populations" (Northridge et al., 2003, p.566). The connection between the two and the acknowledgment of both professions is a potentially good source for a framework in which healthy cities can be executed – a 'healthy governance' of urban areas (Dye, 2008). In order for this interconnection to be successful, the need for a "regulated land ownership, probity in financial investment, social cohesion, the empowerment of civil society, and foresight in planning the physical environment" is recognized, however no clear execution guidelines or concrete assessment measures exist to this day and a call to fill this gap in literature is often made (Corburn, 2004; 2009; Dye, 2008, p.769; Northridge et al., 2003).

### *Reduction of Greenhouse Gases for a Healthy Urban Living*

Although there is no one specific framework or measurement for the guidance and assessment of healthy urban living, researches most often describe a healthy city by explaining methods and successful ways in which western cities have already addressed the issue of health in urban areas. One example, and the main framework used for the purpose of this research, is related to the reduction of greenhouse gas emissions and air pollutants known to have adverse effects on human and environmental health (Beatley, 2012; Nieuwenhuijsen, & Khreis, 2016).

The threat created by increased greenhouse gas emissions is continuously highlighted, not only in academic literature, but also in sources directed to a wider audience: movies,

commercials, books, political campaigns and many others. The implications of greenhouse gas induced global warming range from economic to social and environmental (UN, n.d.). Increasing global temperature, changing weather (e.g. an increased number of severe storms and earthquakes), higher sea levels, the worsening of air quality and many more effects of excessive greenhouse gas production upset the ecosystem and natural balance ('health') of the environment, causing, for example, earlier break-up of ice on rivers and lakes or movements of some plants and animals to higher altitudes (Houghton et al., 2001; Frumkin et al., 2008; UN, n.d.). The change of climate is harmful not only to environmental balance, but also to human health and well-being, and the two are inherently interconnected (Frumkin et al., 2008; Haines, & Patz, 2004). The effects of climate change on human health have been extensively studied and include primarily "injuries and fatalities related to severe weather events and heat waves; infectious diseases related to changes in vector biology, water, and food contamination; allergic symptoms related to increased allergen production; respiratory and cardiovascular disease related to worsening air pollution; and nutritional shortages related to changes in food production" (Frumkin et al., 2008, p. 435). Further negative consequences include, for example, mental health issues (such as anxiety and depression), population dislocation and civil conflicts, often caused by resource scarcity and changes in livestock, agriculture, forests and marine life (Epstein, 2005; Frumkin et al., 2008; Haines, & Patz, 2004).

As the process of urbanization and climate change induced by excessive greenhouse gas emissions are inherently interlinked, healthy city planning aims to address the issue through various methods, such as a reduction of the use of cars, an increase in urban green areas and an incorporation of natural ecosystems into city networks (Dodman, 2009; Hoornweg, Sugar, & Trejos Gómez, 2011). Public urban sectors, especially the infrastructure one, i.e., roads, schools, power plants, transportation and communication systems, require a lot of energy and are therefore amongst the biggest contributors of greenhouse gas emissions within cities (Webster's New World College Dictionary, 2014; Ramaswami, 2013). The practice of healthy city planning in the western context aims to work on these particular sectors to improve not only human but, also ecosystem health in urban areas.

Amongst many other measures, an overall shift in mobility solutions away from the private car towards a promotion of public transportation, cycling, and pedestrianization is promoted in numerous countries as a way to ensure a healthy urban living (De Nazelle et al., 2011; Nieuwenhuijsen, & Khreis, 2016). Cars emit a lot of CO2 and other greenhouse gases as well as air pollutants related to harmful environmental effects, such as increased heat and noise levels (Nieuwenhuijsen et al., 2016). Apart from air pollution and harmful noise, the use of

cars is another example of sedentary behavior associated with a reduced level of physical activity which causes further harm to human health. Moreover, car accidents contribute to a large amount of deaths and injuries, especially in urban areas, and are linked to externalities, such as social inequalities, congestion, and oil dependence (Mueller et al., 2017; Nieuwenhuijsen, & Khreis, 2016; Nieuwenhuijsen et al., 2016). Planning practice and city design which aim for a healthier environment and population take into consideration the listed harmful effects of the use of cars and develop plans for a less car-dependent urban areas. One of the first theoretical designs of this kind was proposed in 1996 by J.H. Crawford, who described a car free city for one million people, illustrated in his books *Car free Cities* (Crawford, 2000) and *Car free Design Manual* (Crawford, 2009). Contemporary plans for healthy, car free cities have already been adopted in European capitals such as Brussels, Oslo, Barcelona, Madrid, Helsinki and many others. Banning cars from city centers, the pedestrianization of urban cores, car-free days, public transport facilities and cycling infrastructure availability have proven to be successful measures in cutting the use of cars and have shown positive health results amongst the populations and environments of cities (Heinen et al., 2010; Nieuwenhuijsen, & Khreis, 2016).

### *Contact with Natural Environment and Health*

The presence and promotion of green space is another important topic in describing healthy cities of the west. Natural light, ventilation, a better air quality and views of greenery are just a few of the aspects positively affecting human as well as ecosystem health within urban areas (Jones, 2003). In order to answer the main question of this research, the main framework used will be the one that supports a connection between urban green space and health (of both people and the environment they live in).

The frameworks for the planning of healthy urban areas often include the incorporation and preservation of urban green space, as natural areas have long been known to be beneficial for human health in a multiplicity of ways (e.g. Beatley, 2012; Corburn, 2009; Dye, 2008; Jackson, 2003; Ward, 2005). Already in the 19th century Frederick Law Olmsted observed that "experiencing and simply viewing nature reduces the stress of daily urban life" (Jackson, 2003, p.192). Parks, gardens and other green areas, both public and private, within cities not only protect the natural environment of an area, but also have restorative effects on mental and physical health (Jackson, 2003; Schulz, & Northridge, 2004). Numerous studies support the beneficial effects of green space on health and prove that both the physical and mental health of people living in greener areas, or at least close to them, tend to be better than of people living

in ‘grey’ urban neighborhoods, high rise buildings, etc. (e.g. De Vries et al., 2003; Groenewegen et al., 2006; Maas, 2006; Stigsdotter et al., 2010). The presence of green natural environments within urban areas ameliorates the quality of air, contributes to the cooling of the atmosphere and creates opportunity for physical activity promoting a healthy lifestyle and decreasing obesity levels and number of pollution-related lung diseases (Demeuzere et al., 2014). Furthermore, green space availability has been proven to promote social cohesion, social capital and sense of community, reduce stress and mental health issues related to it, supporting the well-being of citizens (Groenewegen et al., 2006; Stigsdotter et al., 2010; Van den Berg et al., 2010).

In planning practice and urban planning policies in the west, promoting healthy cities through the incorporation of green space in urban areas has been prominent and executed in a number of techniques (Beatley, 2012; Wolch et al., 2014). Private gardens, neighborhood parks and green squares are some of the small-scale initiatives, important on a local level. They are being incorporated by planners more and more often in neighborhood proposals and blueprints, despite an overall trend of city condensation and utilizing available space in the most practical and economical way possible (Groenewegen et al., 2006; Van den Berg et al., 2010). The access to larger green areas, sometimes further from urban centers, has also been noted as important, especially for reflective and restorative purposes as well as for the promotion of physical activity and preservation of natural ecosystems (Van den Berg et al., 2010). Those large-scale strategies often consist of gardens, big parks and forests surrounding a city and preventing its sprawl and excessive growth, a form which is often described as ‘greenbelts’ (Beatley, 2012). Such initiatives are supported not only by municipal and national policies, but also by those adapted on a larger scale, such as EU documents and frameworks (Beatley, 2012). The planning of such green space within and around cities may get complicated at times because, for example, green spaces need to be evenly distributed throughout the urban area to avoid social inequality issues due to disparate access to green space (Wolch et al., 2014).

### 2.1.3. Healthy Cities in the European Context

In Europe, disease epidemics and poor sanitation have not been a major issue since the nineteenth century. In fact, the development of sanitation, water and waste management has occurred at a fast pace in many European countries (Beatley, 2012a). Some of these developments have been compromised by the two world wars throughout the twentieth century, however, since the late 1990s, there have been considerable advancements on reconnecting the

health and city planning practices and healthy, sustainable city planning (Beatley, 2012a). This research focuses on the European geographical area and, specifically, the EU because of the advanced policies and practice of healthy city planning that has been and still is being implemented in the member states. The European frameworks and initiatives can be used as guidelines for other such projects adapted, of course, to different contexts, needs and realities.

The modern movement of the European Healthy City is often said to have been initiated and highly encouraged by the WHO and its healthy urban planning (HUP) initiative, the foundations of which were laid in the late 1990s (Barton et al., 2009). According to the WHO, over two thirds of population in Europe live in cities nowadays and experience many urban issues such as heavy traffic, pollution, noise, violence and social isolation to which the response has been proposed through a healthy city planning approach (WHO, n.d.) In 1998, the WHO, in collaboration with planners and academics from all over Europe, published its *Healthy Urban Planning—A WHO Guide to Planning for People* which argued and suggested a framework for the incorporation of health as a "central goal of urban planning policy and practice" (Barton et al., 2009, p. 94; Barton, & Tsourou, 2013). The book discusses the Healthy City movement and its relevance for planners, moreover lists 12 key health objectives which show similarities to the 12 goals of sustainable development:

"(i) promoting healthy lifestyles (especially regular exercise);

- (ii) facilitating social cohesion and supportive social networks;
- (iii) promoting access to good-quality housing;
- (iv) promoting access to employment opportunities;
- (v) promoting accessibility to good-quality facilities (educational, cultural, leisure, retail and health care);
- (vi) encouraging local food production and outlets for healthy food;
- (vii) promoting safety and a sense of security;
- (viii) promoting equity and the development of social capital;
- (ix) promoting an attractive environment with acceptable noise levels and good air quality;
- (x) ensuring good water quality and healthy sanitation;
- (xi) promoting the conservation and quality of land and mineral resources; and
- (xii) reducing emissions that threaten climate stability." (Barton et al., 2009, p. 94)

Many of these goals, especially (i), (v), (viii), (ix), (x), (xi) and (xii) are related to the focus of this research because, as previously mentioned, they can be achieved, i.e., through the incorporation and availability of green space in urban areas.

The WHO initiatives sparked a debate and action within planners, policymakers, and academics in Europe who pursued the focus on health. The WHO City Action Group (CAG) on Healthy Urban Planning was created in 2001 and initially included 11 cities from different parts of the continent: Gothenburg (Sweden), Horsens (Denmark), Sandnes (Norway), Belfast and Sheffield (United Kingdom), Milan (Italy), Seixal (Portugal), Vienna (Austria), Geneva (Switzerland), Zagreb (Croatia) and Pecs (Hungary) and by 2005 counted already 52 cities (Barton et al., 2009). Furthermore, the WHO European Healthy City Network, which is celebrating its 30th anniversary this year (2018), connects 100 cities and 30 national networks in a national and international level initiative to support healthy city planning and discussion. The WHO provides political, strategic and technical support as well as capacity-building in this network whose shared goal is to "engage local governments in political commitment, institutional change, capacity-building, partnership-based planning and innovation" (WHO, n.d.ii).

The WHO plans and frameworks agreed on and set in theory needed to be assessed in practice, according to their implementation and effects. Therefore, in 2003 the Health Impact Assessment (HIA) mechanism was introduced as one of the first instruments of this kind to evaluate healthy cities in Europe (WHO, 2003). Health Impact Assessment is often described as a methodology in itself and has "(i) developed logically from a social model of health that underpins an intersectoral approach to intervention, (ii) applies evidence from a variety of secondary sources to the subject and (iii) acknowledges the political and professional context of the undertaking" (Ison, 2009, p.i64). HIA has been applied in numerous European cities to assess different projects, and despite difficulties found during the introduction of a new methodology into municipalities, it has been found helpful in improving health in European urban areas (Ison, 2009).

Apart from the WHO, the European Union has also contributed considerably to healthy city planning within its borders. In the past two decades, the need for healthier cities has been recognized by most EU member states, and decision making bodies, mainly the European Commission, have been proposing and implementing initiatives and frameworks as well as offering funds to promote and ensure a healthy urban living in the EU (Fischer, & Sykes, 2009). Important documents for the spatial planning and development of EU cities include, for example, the 1999 European Spatial Development Perspective (ESDP) which first introduced

the focus on "growth, social equity and environmental protection" (Fischer, & Sykes, 2009, p. 60). A more recent EU initiative which, amongst numerous objectives, aims to improve human and ecosystem health within its borders by incorporating the natural environment into urban areas, is the EU Green Infrastructure Strategy, analyzed in detail in section 4.1. (Naumann et al., 2011b).

The focus of this research on European countries, especially the Northern and Northwestern part of the continent, comes from the keen interest in healthy, sustainable cities in most of the area and the availability of documents, frameworks, policies, plans and planning practice measures, already applied, in ensuring a healthy urban living (Beatley, 2012a). European cities can serve as examples for American ones or for new, developing cities of the South, as the methods for healthier urban areas are tested there. These can be transferable, of course, when adapted to the appropriate context (Beatley, 2012b).

## 2.2. Urban Green Infrastructure

A feature often mentioned to affect, directly and indirectly, human and ecosystem health within cities is urban infrastructure. For the purpose of this research, infrastructure will be understood as "the substructure or underlying foundation, especially the basic installations and facilities on which the continuance and growth of a community depends, such as roads, schools, power plants, transportation and communication systems, etc." (Webster's New World College Dictionary, 2014). Because infrastructure systems mediate most resource flows in cities, they shape environmental issues and discourses within urban areas nowadays and "constitute one of the most important interfaces between nature and society" (Monstadt, 2009, p. 1926).

As most urban infrastructures require vast amounts of energy, they constitute an important contributor to high greenhouse gas emissions which affect the earth's climate (Davis, Caldeira, & Matthews, 2010; Ramaswami, 2013). Infrastructure has furthermore been known to have negative human and ecosystem health effects ever since the post-industrial cities of the 19th century, when the main factories were situated in urban centers (Davis, Caldeira, & Matthews, 2010; Ramaswami, 2013). Davis, Caldeira, & Matthews (2010) estimate that the combustion of fossil fuels by existing infrastructure in the world will emit an astonishing amount – 496 gigatonnes of CO2 between 2010 and 2060 – if no more fossil fuel powered infrastructure were to be built, which is an unlikely scenario (Davis, Caldeira, & Matthews, 2010).

With the increasingly urbanizing global population, infrastructure systems are growing and developing, and the question of their sustainability in relation to the sustainability of cities has been an important one in recent decades (Marvin, Graham, & Guy, 1999; Monstad, 2009). Techniques of achieving more 'environmentally friendly' infrastructure are an important topic of research as well as policy guidelines. They involve a multiplicity of measures, one of them being the 'green infrastructure' initiative (Norton et al., 2015).

### 2.2.1. Green vs. Grey Infrastructure

The study of urban infrastructure has been developing along with technological advances and the ever-changing systems of transportation, utilities and communication (Müller et al., 2013). The goal to make infrastructure more sustainable has been one of the leading topics in national and international agendas, especially in the Global North, after many proofs have shown the negative environmental and human health impacts of anthropogenic climate change caused by excessive greenhouse gas emissions, often from infrastructure (Hoornweg, Sugar, & Trejos, 2011).

A common association with infrastructure most often concerns its 'grey' form: bridges, roads, service buildings (such as schools, hospitals, etc.) and other man-made urban elements (Benedict & McMahon, 2012). The notion of 'grey' infrastructure came from the association with its main building components: concrete and steel, the base of human-engineered solutions (Talberth, & Hanson, 2012). Infrastructure systems are directly connected to the urban form and their presence frequently determines the existence and location of modern settlements, both in developed and developing countries (Hall, 1993; Seto et al., 2014).

Grey infrastructure is an essential part of the urban fabric and of most societies. It is also, however, highly energy-dependent: electricity and the heating of infrastructure buildings are the main sources of greenhouse gas emissions within a great majority of cities in the Global North (Davoudi, Crawford, & Mehmood, 2009; Müller et al., 2013). These emissions first occur during the construction phase of a given infrastructure, then during the use and later on (sometimes to a lesser extent in the end-of-life phase, e.g. waste management) (Müller et al., 2013; Seto et al., 2014). As an example, the manufacturing of steel and cement (most common infrastructure materials) "contributed to nearly 9 % and 7 %, respectively, of global carbon emissions in 2006" (Seto et al., 2014, p. 951). Furthermore, several studies show that the trans-boundary (outside of the city borders) infrastructure which is used within the city can have high greenhouse gas emissions levels, or higher, adding to the ones from direct urban

infrastructure. This contributes significantly to the total environmental impact of grey infrastructure (Chavez, & Ramaswami, 2012; Ramaswami, 2013; Seto et al., 2014). The need for a solution to the negative environmental effects of urban infrastructure has been acknowledged by environmentalists, scholars and policymakers, particularly in the Global North. Multiple solutions aimed at mitigating the climate change and adapting to this phenomenon have been drafted, one of them being green infrastructure (Benedict, & McMahon, 2012).

When thinking of infrastructure, as described above, rarely do forests, rivers, coral reefs and other natural ecosystems come to mind. Those, however, are important networks and systems which can be regarded as forms of infrastructure, seeing that they are essential for the development of societies and the determination of the urban form (Talberth, & Hanson, 2012). As an example, forests "can prevent silt and pollutants from entering streams that supply freshwater to downstream cities and businesses" therefore act as "natural water filtration plants" – forms of green infrastructure (Talberth, & Hanson, 2012, p. 1). Green infrastructure "can be broadly defined as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (European Commission, 2013). It is, therefore, a synthesis of natural environment systems and man-made green spaces or alterations which, using natural energy sources, help provide infrastructural services for societies without compromising the biodiversity of urban and rural areas. Examples of green infrastructure include technological practices and the implementation of additional green space into urban areas, including green, blue and white roofs, urban forestry, parks and wetlands, building adaptation for coping with changing weather conditions (floods, coastal storms, etc.) or rain gardens which capture rainwater, just to name a few practices (Foster, Lowe, & Winkelman, 2011; Vineyard et al., 2015). Green infrastructure also "encompasses a wide variety of natural and restored native ecosystems and landscape features that make up a system of 'hubs' and 'links'." (Benedict, & McMahon, 2012, p. 7). Those are most often found outside of urban centers, but are being incorporated, in an increasing degree, into cities. Hubs protect green infrastructure networks and provide a destination for wildlife and ecological processes to move through. Examples of hubs include reserves, large protected areas like national parks, smaller community parks and natural areas, urban green space etc. (Benedict, & McMahon, 2012). Links are "the connections that tie the system together and enable green infrastructure networks to work." (Benedict, & McMahon, 2012, p. 8). Those can

include conservation corridors, greenways, greenbelts and many other protected natural lands which serve as biological conducts for wildlife and protect ecosystem diversity.

With the rapidly changing climate and an increasing percentage of the world population living in cities, urban green space is gradually becoming more significant (Gill et al., 2007). Incorporating natural elements into infrastructure is gaining popularity amongst policymakers, as it is often found to be a cost-effective, long term, sustainable solution to excessive greenhouse gas emissions from grey infrastructure (Tiwary, & Kumar, 2014). The additional value of green infrastructure, in comparison to the grey one, is calculated by the cost of both types of initiatives (grey infrastructure is usually more expensive to build and maintain), the value of avoided damages thanks to green infrastructure prevention measures, as well as property value which frequently increases due to green infrastructure initiatives (Foster, Lowe, & Winkelman, 2011). Many studies prove the positive impacts of green infrastructure compared to the conventional – grey. Vineyard and colleagues (2015) measured and compared the green and grey infrastructure impacts using the case study of rain gardens in Cincinnati, Ohio. Their findings showed that rain gardens, as a way of dealing with wastewater, were more economically friendly (around 42% cost reduction) as well as environmentally beneficial (62-98% climate change impact reduction) than typical wastewater 'detain and treat' infrastructure systems (Vineyard et al., 2015). Moreover, green infrastructure is intended to work on different scales, from 'macro' centralized public projects to 'micro' applications on private property, connecting urban centers and the surrounding countryside (Foster, Lowe, & Winkelman, 2011; Gill et al., 2007). Another important benefit of green infrastructure which cannot be provided by the grey one is situated in the social sphere: green infrastructure benefits societies as it provides a safe way of coping with climate change and the feeling of protection for low economic costs (Demuzere et al., 2014).

### 2.2.2. Green Infrastructure and a Healthy Urban Living

Additionally to the benefits of green infrastructure mentioned in the previous section, this strategy is found to contribute positively to human and environmental health and well-being, adding overall to a healthy urban living (Tzoulas et al., 2007). The decreased health hazards and reduced negative implications of excessive greenhouse gas emissions are connected to the environmental and ecosystem based focus of green infrastructure (Naumann et al., 2011).

*Human Health*

Human health, as defined by The World Health Organization (WHO), is the "state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity" (WHO, 1948). This definition indicates a complexity in the idea of health and its dependence on a variety of factors including biological, psychological and social circumstances (Tzoulas et al., 2007). The social benefits provided by green infrastructure are often connected to communities where such strategies are implemented, their use of green space as well as the aesthetic and cultural values and backgrounds of their users (James et al., 2009). Urban green space contributes to social interaction and creates an environment which brings people together, furthermore, giving them a sense of place which is important for overall social cohesion (James et al., 2009; Newton, 2007). Researchers have shown that "the proximity of urban ecosystems provides a range of recreational and psychological benefits, as well as opportunities for community bonding and education to adapt to climate change" (Demuzere et al., 2014, p. 11; Jackson, 2003). Urban greenspaces provided by green infrastructure plans give citizens more contact with nature, which has further psychological benefits (James, et al., 2009; Tzoulas et al., 2007). As mentioned in section 2.1.2. proximity to nature is said to reduce stress, restore attention, reduce criminal and anti-social behavior, positively affect self-regulation and restorative experiences and increase one's enjoyment and aesthetic appreciation of the urban area they inhabit (Beatley, 2012; Corburn, 2009; Kaplan, & Kaplan, 1989; Korpela et al., 2001; Tzoulas et al., 2007; Ulrich et al., 1991).

Green infrastructure initiatives can improve mental health and social relations, they were moreover proven to have beneficial effects on one's physical health (Benedict, & McMahon, 2012; Coutts, & Hahn, 2015; Demuzere et al., 2014; James et al., 2009; Tzoulas et al., 2007). The amelioration of one's psychological and social state is already one factor connected to an increased physical well-being (James et al., 2009). Green urban infrastructure many a times encourages and increases citizens' participation in physical activities (walking, cycling) which leads to relaxation, comfort, satisfaction and an improved physical state (Demuzere et al., 2014; Mansor et al., 2012). Easy access to green space and increased activity decreases one's risk of becoming obese and, consequently, suffering from disease related to this state, such as heart problems, diabetes and many more (Coombes et al., 2010). The previously mentioned benefits of green infrastructure: a greenhouse gas reduction which leads to the improvement of air quality, water purification and overall temperature cooling all are advantageous to human health (Demuzere et al., 2014). Air quality, frequently improved by green infrastructure, reduces potential onset of lung diseases (for example chronic obstructive

pulmonary disease) and asthmatic problems caused by air pollution (Brunekreef, & Holgate, 2002; Demuzere et al., 2014; Pugh et al., 2012). Water purification and cooler temperatures further contribute to better human physical health, helping to avoid water-borne diseases and damages done by heat waves, for example dehydration (Demuzere et al., 2014).

### *Ecosystem Health*

The concept of ecosystem health is a complex and hotly debated topic, variously defined by numerous scholars (Tzoulas et al., 2007). Put very simply, ecosystem health is "the occurrence of normal ecosystem processes and functions" (Tzoulas et al., 2007, p. 168). There are, however, more aspects to the definition: "an ecosystem can be considered as healthy when it is free from, or resilient to, stress and degradation, and maintains its organization, productivity and autonomy over time" (Costanza, 1992; Tzoulas et al., 2007, p. 169). It is also often noted that these definitions imply that ecosystems work like organisms, and the need to regard them as more open systems with 'dynamic interrelationships' has been increasingly underlined (Tzoulas et al., 2007).

Despite the definition debate related to ecosystem health, it is commonly agreed that green infrastructure provides benefits to natural environments and protects as well as improves their 'health' (Tzoulas et al., 2007). One of those benefits is that urban and peri-urban habitats increase vegetation cover which contributes to the conservation of biological diversity (Costanza, 1992). Additionally, green infrastructure maintains the coherence of ecosystems and provides a basis for ecological networks, which prevents habitat separation and maintains an overall sustainable landscape (Opdam et al., 2006; Tzoulas et al., 2007). Different elements of green infrastructure can also preserve and enhance ecosystem diversity, one of the most important aspect of ecosystem health (Rapport et al., 1998). Species-rich ecosystems are found to maintain better organization and be more productive, vigorous than less diverse (Tzoulas et al., 2007). The improved quality of air and water is another benefit of green infrastructure which positively affects both ecosystem and human health. The two are, in fact, closely related: it is often found that rich ecosystem services and functions acquired from a Green Infrastructure contribute both to ecosystem and human health and well-being, and thus to a healthy urban living (Tzoulas et al., 2007).

### 2.2.3. Green Infrastructure Planning

Green infrastructure strategies are increasingly popular and progressively incorporated into urban and spatial planning policies (Benedict, & McMahon, 2012; Davies et al., 2006; Mell, 2011). The need for more sustainable and resilient planning is clearly visible in most urban areas due to rapid urbanization that is spilling into rural areas and as a result of quick disappearance of green space and natural ecosystems, degradation of water resources, decreased ability for nature to adapt to change, increased costs of public services, worse public health, and many more factors (Benedict, & McMahon, 2012). Sustainability and the 'greening' of cities is, however, only one of the priorities amongst other, sometime conflicting, important goals of urban agendas, such as commercial development, economic needs and goals and political ideologies (Mell, 2011). During the last decade, green infrastructure strategies have been developing as an approach which connects the different urban needs and priorities and, at the same time, is a middle ground in the fragmented thinking about spatial planning (Mell, 2011). As worded by Mell (2011) "the green infrastructure planning agenda brought together planners, ecologists, architects and developers and proposed a holistic, and functional understanding of the ecology of urban environments." (Mell, 2011, p. 29-30).

Green infrastructure is a fairly new initiative and, despite developing in varying ways spatially and geographically, it has a common goal of climate change mitigation and adaptation as well as maintaining a healthy ecosystem balance and increasing cities' sustainability and resilience (Benedict, & McMahon; Mell, 2011; Tiwary, & Kumar, 2014). The planning of green infrastructure strategies and their role in landscape management is highly dependent on location, the area's government structures (policies and funding) and available resources, which means that it is a process involving multiple actors and approaches (Mell, 2011). In order to draft a spatial and innovative frame of green infrastructure, the understanding of ecological networks, connectivity, multi-functionality as well as the sustainable agenda need to be taken into account (Madureira et al., 2011; Mell, 2011). As a common middle ground, the field of spatial planning plays an important role in the implementation and utilization of green infrastructure, for example for cities' adaptation to climate change (Matthews et al., 2015).

Numerous scholarly articles as well as international and regional documents provide guidelines for the planning and incorporation of green infrastructure into urban areas and existing ecosystems. As an example, Benedict, & McMahon (2011) discuss the planning of green infrastructure, specifically from a US perspective, yet with an international focus, and

provide recommendations of what approaches green infrastructure strategies should use. The authors mention a holistic design as one of the important aspects which allow green infrastructure to link green elements into the urban system (Benedict, & McMahon, 2011). Furthermore, the need for comprehensive planning and strategic lay out are listed as principal features of green infrastructure planning. Public involvement and input – the participation of citizens from all different groups of the population – is yet another key criterion for good green infrastructure planning mentioned by the authors (Benedict, & McMahon, 2011). Finally, the previously described combination of practices and principles from different professions is essential for these kinds of initiatives and so is the need for funding as a primary public investment (Benedict, & McMahon, 2011). Mell (2011) mentions that a balance between planners' and developers' awareness of green infrastructure's benefits as well as the recognition of the connective nature of ecological resources and impacts of development on natural, social and economic systems, is essential for green infrastructure development creating high quality and environmentally stable cities (Mell, 2010; 2011).

An important aspect of achieving all the objectives mentioned above is the existence of specific funding, on a national or international level, promoting green infrastructure strategies (Mell, 2011). Documents, such as the Green Infrastructure Fund linked to Economic Action Plans in Canada or the Green Investment Bank in the UK focus on establishing a greener economy nationally (Mell, 2011). On the EU scale, the Cohesion Fund or the European Regional Development Fund, among others, also promote a green infrastructure development (European Commission, 2013). These, although advocating for a greener, more sustainable urban development, do most often have economic growth in mind, which might sometimes be contradictory as "ecological viability and economic growth have been described as being somewhat incompatible" (Mell, 2011, p. 35; Tyrväinen, 2001). Governments are beginning to attribute more value to urban green infrastructure, although the need for policies to provide an assessment of the value of green infrastructure as well as a framework for its development has been acknowledged (Mell, 2010; 2011). An example of a well-established framework for green infrastructure development on the EU level is the EU Green Infrastructure Strategy, discussed further in section 4.1., which, despite not being a binding document, provides an in-depth description of the objectives and potential benefits of green infrastructure.

The planning of green infrastructure has only been developing on a larger scale in the last decade. Nevertheless, the need for such strategies is acknowledged nationally and internationally and is being slowly incorporated into frameworks and policy documents for spatial planners to work with and improve the sustainability and resilience of cities.

*Multi-level Governance in Green Infrastructure Planning*

The policy-making, design and implementation of green infrastructure strategies in the EU happens on different international, national and regional levels. It can, therefore, be considered as multi-level governance of spatial planning (Mell, 2011; Raynal, 2018). This type of governance has been previously described by numerous researchers, specifically in relation to spatial planning theory and practice, often in reference to climate change mitigation and adaptation (e.g. Bulkeley & Betsill, 2005; Corfee-Morlot et al., 2009; Keskitalo, 2010; Liesbet, & Gary, 2003). The concept of multi-level governance can be overall explained as dividing competences between local, national and supranational institutions with the use of traditional methods, such as public regulation by the state, but also public-private partnerships, non-state actors involved in the decision-making process etc. (Kern & Bulkeley, 2009). In the case of the EU a "system with multiple levels or spheres of governance, including European, national and sub-national policy arenas" has been developed in the past couple of decades (Kern & Bulkeley, 2009, p.311). In Europe specifically, many national governments have dispersed authority across territorial levels among both private and public actors – from a national to a sub-national level (Rosamond, 2007; Pierre and Peters, 2000). The resulting governance landscape involves blurred boundaries between different arenas of politics and many policy actors are becoming "active at different levels and pursue multi-level strategies such as venue shopping" (Kern & Bulkeley, 2009; p.312; Rosamond, 2007).

In the context of green infrastructure initiatives in the EU, a collaboration between different levels of governance is necessary and practiced between EU institutions, member states and local, regional scales (European Commission, 2013). The different actions undertaken on various levels of the green infrastructure decision-making process is further described in section 4.2.1.

### 2.2.4. Green Roofs – a Green Infrastructure Example

Despite green and grey infrastructure having contrasting effects and commonly being on two opposite ends of the environmental spectrum, green infrastructure initiatives are found to be most efficient when combined with modifications to the existing grey infrastructure (Foster, Lowe, & Winkelman, 2011; Gill et al., 2007; Svendsen, Northridge, & Metcalf, 2012; Vineyard et al., 2015). Governments apply green infrastructure strategies in combination with grey infrastructure on local levels, which allows for 'best practices' on an individual case basis (Foster, Lowe, & Winkelman, 2011). One of numerous diverse examples of such a method is

the implication of eco-roofs: adapting existing infrastructure buildings to respond to extreme temperature and precipitation – primary climate drivers (Foster, Lowe, & Winkelman, 2011). There are three types of eco-roofs: green, vegetated ones, white roofs meant for cooling buildings, and blue roofs which provide water management. All three types have "distinct and overlapping benefits compared to typical "black" roofs meant solely to provide shelter" (Foster, Lowe, & Winkelman, 2011, p. 5). Not only are they financially an affordable way of climate adaptation, they also aim to achieve sustainability goals such as water conservation, local and regional cooling, electricity saving, habitat provision for wildlife and carbon absorption (Foster, Lowe, & Winkelman, 2011). Roofs are, during the day, some of the hottest surfaces in cities, therefore adapting, 'greening', them can make a significant contribution to urban surface temperature mitigation as well as to the reduction of the need to cool buildings on the inside (Chudnovsky et al., 2004; Norton et al., 2015). This research will mainly focus on the 'green' roofs in relation to previously mentioned benefit of urban green space and natural environments on human and ecosystem health. Most frameworks related to green roofs rely more on the description of their implementation and results than on a purely theoretical explanation, therefore the explanation given below of this green infrastructure strategy is mostly practical and descriptive.

### *Intensive and Extensive Green Roofs*

The roots (pun intended) of green roofs go back to ancient times, when the earlier form of this initiative – rooftop gardens were commonly used. The oldest documented roof garden were the hanging gardens of Semiramis (nowadays Syria), also known as the hanging gardens of Babylon, one of the seven wonders of the ancient world (Oberndorfer et al., 2007). Nowadays, similar green roofs are designed for many building and have various purposes, for example a mainly aesthetic one in exclusive hotels, business centers and private homes. Those are known as 'intensive' green roofs and are characterized by a great variety of plants. They also promote the active use of the rooftop space (Figure 2) (Oberndorfer et al., 2007). The name 'intensive' comes from the intense maintenance needs of such roofs due to their 'parklike' quality (Oberndorfer et al., 2007; Getter, & Rowe, 2006).

Figure 2. An intensive green roof garden in Linz, Austria (source: https://livingroofs.org/intensive-green-roofs/)

A more recent modification of green roofs are 'extensive' ones which 'have shallower substrates, require less maintenance, and are more strictly functional in purpose than intensive living roofs or roof gardens' (Figure 3) (Oberndorfer et al., 2007, p.824; Dunnett, & Kingsbury, 2008). Figure 4 shows the comparison of intensive and extensive green roofs (Figure 4). Extensive green roofs can be classified as semi-artificial ecosystems, thus the processes occurring in the vegetation on such roofs require little to no upkeep (Getter, & Rowe, 2006; Van Mechelen et al., 2015). Because they have a shallow media depth plants, extensive green roofs consist mostly of herbs, grasses, mosses and succulents. Thanks to their nature, such roofs can be built on sloped surfaces (Getter, & Rowe, 2006; Van Mechelen et al., 2015). Most green roofs have a similar structure which often includes a water retention, a drainage level as well as a growing medium underneath the vegetation (Figure 5). The design of these layers depends on the purpose of the green roof project and on the building's load capacity (Getter, & Rowe, 2006).

The extensive green roof design has been used as a way of mitigating negative effects of solar radiation and rising temperatures caused by greenhouse gas emissions, starting at the

end of the 20th century and first applied in Europe (Dunnett, & Kingsbury, 2008; Oberndorfer et al., 2007). This type of green infrastructure has numerous benefits discussed in many studies as well as websites offering and promoting green roof implementation (e.g. Dunnett, & Kingsbury, 2008; Getter, & Rowe, 2006; Oberndorfer et al., 2007; Van Mechelen et al., 2015). One of the main positive effects of green roofs is a reduction of storm water, and thus a reduction of the volume of rainwater in storm water infrastructure and urban waterways (Getter, & Rowe, 2006; Oberndorfer et al., 2007). Other advantages of this green infrastructure initiative include a reduced energy consumption of the buildings with a green roof. The vegetation cools the buildings in the summertime and can even provide insulation in the winter, therefore, less energy is needed to heat up and cool down the urban structures (Getter, & Rowe, 2006; Oberndorfer et al., 2007). Furthermore, green roofs are known to protect and sustain natural ecosystems, maintain and even increase the biodiversity of urban areas as well as provide habitat for different plant types, insects, birds and other small animals (Getter, & Rowe, 2006; Van Mechelen et al., 2015). On top of the listed positive aspects, both intensive and extensive green roofs are beneficial for human health and well-being: their cooling and air purifying effect as well as aesthetic values can result in reduced stress and blood pressure levels, increased physical activity amongst citizens living near such green infrastructure, decreased respiratory problems and increased work productivity (Getter, & Rowe, 2006).

Figure 3. An extensive green roof covering 7,000 square meters in Düsseldorf, Germany (source: http://www.greenroofs.com/content/guest_features006.htm )

*Table 1. A comparison of extensive and intensive green roofs.*

| Characteristic | Extensive roof | Intensive roof |
|---|---|---|
| Purpose | Functional; storm-water management, thermal insulation, fireproofing | Functional and aesthetic; increased living space |
| Structural requirements | Typically within standard roof weight-bearing parameters; additional 70 to 170 kg per $m^2$ (Dunnett and Kingsbury 2004) | Planning required in design phase or structural improvements necessary; additional 290 to 970 kg per $m^2$ |
| Substrate type | Lightweight; high porosity, low organic matter | Lightweight to heavy; high porosity, low organic matter |
| Average substrate depth | 2 to 20 cm | 20 or more cm |
| Plant communities | Low-growing communities of plants and mosses selected for stress-tolerance qualities (e.g., *Sedum* spp., *Sempervivum* spp.) | No restrictions other than those imposed by substrate depth, climate, building height and exposure, and irrigation facilities |
| Irrigation | Most require little or no irrigation | Often require irrigation |
| Maintenance | Little or no maintenance required; some weeding or mowing as necessary | Same maintenance requirements as similar garden at ground level |
| Cost (above waterproofing membrane) | \$10 to \$30 per $ft^2$ (\$100 to \$300 per $m^2$) | \$20 or more per $ft^2$ (\$200 per $m^2$) |
| Accessibility | Generally functional rather than accessible; will need basic accessibility for maintenance | Typically accessible; bylaw considerations |

Figure 4. Comparison of Extensive and Intensive Green Roofs (source: Oberndorfer et al., 2007, p.825)

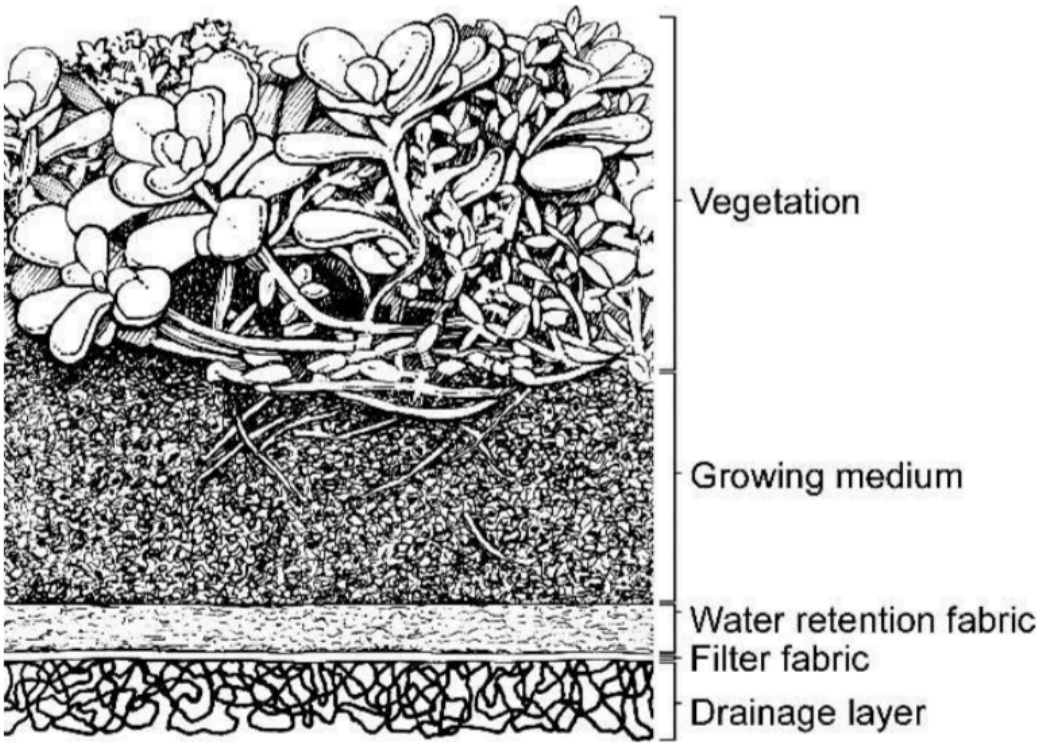


Figure 5. “Cross-section of a representative extensive green roof system including typically used layers. The drainage layer is place over a root barrier that covers the roofing membrane. The water retention fabric is optional and the media depth and plant material vary depending on design specifications.” (source: Getter, & Rowe, 2006, p.1278).

# 3. Methodology

This research will utilize a variety of qualitative methods to answer the main research question. The main approach of this research design is, therefore, a mixed-method one, within the qualitative investigation field. Firstly, a document analysis of the EU Green Infrastructure Strategy will be conducted (see section 3.2.) in order to determine what its stance is on green infrastructure, implementation and benefits. This document analysis will be supported by referencing other EU documents and interviews with EU officials. Interviewing is the second data gathering method used in this research as a supporting primary source. Two case studies, those of Hamburg and Rotterdam, will be provided to showcase an example of green infrastructure – green roofs and their implementation as well as their effect on a healthy urban living.

The main purpose of a mixed-method approach in this study is to obtain a detailed overview of not only the official objectives and framework of the EU Green Infrastructure Strategy from its original document, but also to look into the implementation of this initiative in national policies of EU member states. Additionally, a more empirical aspect – interviews and case studies aim to illustrate the planning and policymaking of green infrastructure on local levels.

The use of multiple sources, both primary and secondary, is made to 'triangulate' the obtained data and, as a result, to increase the validity of the research: support the weaknesses of one method by the benefits of another (Shenton, 2004).

## 3.1. Document Analysis – Background of the Research

As one of the background sources for this research the EU Green Infrastructure Strategy document will be used and its brief qualitative analysis will be conducted. This strategy, as a non-binding document, does not impose any legal obligations on EU Member States, it is merely a suggestion or framework to be included in national policies. Therefore, a successful implementation of the guidelines provided in the EU Green Infrastructure Strategy requires the integration of green infrastructure plans into different policies and sectors within Europe as well as into member states' policies (Neumann et al., 2011). The main document used for analysis will be the Green Infrastructure Strategy summary and a communication of its main points published in 2013 by the Commission for the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. This document

is mainly descriptive, provides information on the benefits of green infrastructure in several fields (e.g. environment, health, etc.) and the need to implement such strategies in the increasingly urbanizing Europe. A qualitative analysis of the communication document will be conducted chiefly based on the guidelines provided by Wesley (2010) and Bowen (2009), using open-coding and later a description and an interpretation of the main topics found in the document (Bowen, 2009; Wesley, 2010).

Because the Commission's communication does not provide a comprehensive insight into the specific design and implementation of green infrastructure in member states, the document analysis will be enriched with the use of the *Design, Implementation and Cost Elements of Green Infrastructure* projects report prepared for the Commission prior to the green infrastructure strategy itself by Naumann et al., (2011) as well as an in-depth report on the Multifunctionality of Green Infrastructure and some impact assessment documents provided by the Institute for European Environmental Policy prepared in collaboration with national environmental bodies and universities such as the University of Antwerp (IEEP, 2011).

The short green infrastructure strategy communication document is analyzed by using a number of codes in order to select the main themes recurring in the strategy and develop the major objective of the Commission's communication, as well as the principal benefits of green infrastructure and means in which the EU can facilitate and promote the implementation of such strategies among member states.

The codes used to analyze the document consisted of recurring topics in the communication as well as more specific relations between green infrastructure and health, based on some key-terms from the theoretical framework rooted in Northridge et al.'s (2003) concepts provided previously in section 2.1.2. Potential benefits of green infrastructure and references to other EU policies providing guidelines and funds for green infrastructure strategies are an example of a recurring theme. Codes based on the framework of healthy urban cities and the connection between health and urban areas, specifically urban infrastructure, have also been used, for example some of the fundamental, intermediate and proximate factors affecting human health, such as environmental stressors, natural environment overall, physical and psychological health effects of green infrastructure, etc. (Northridge et al., 2003).

Furthermore, the document analysis will be supported by interviews with two EU officials (section 4.1.3.): Julie Raynal from the European Commission and Gabor Toth from the Council, as a way of showing how the EU Green Infrastructure Strategy is perceived in practice throughout different departments of the EU. To demonstrate the implementation of

green infrastructure in the form of green roofs, the case studies of Hamburg and Rotterdam will be provided in section 4.3.

## 3.2. Case Studies

The case study method has been utilized to illustrate the implementation of green infrastructure in exemplary EU member states. The use of the case study method has been chosen to establish whether and on what level of significance EU guidelines, frameworks and funds affect member states' implementation and policies on green infrastructure and their effects on a healthy urban living. Case studies have proven to be useful in determining correlations between different phenomena or statistical data in social science research (Bennett & Elman, 2006). Moreover, a qualitative case study approach has been chosen because it can help build theories and search for patterns in a specific social science field, in the case of this research – spatial planning (Eisenhardt, 1989).

Out of many types of green infrastructure one has been chosen to make the example even more specific. Green roofs as a green infrastructure initiative are described because they present an interesting depiction of the incorporation of green infrastructure into the existing urban structures (buildings' roofs). As these are amongst the earliest green urban infrastructure solutions, a substantial amount of data and knowledge is available about them (Foster, Lowe, & Winkelman, 2011). The choice of two EU cities, Hamburg and Rotterdam, has been made based on prior research of advanced green roof strategies in the EU. Hamburg has been active in the field of green roof establishment for almost a decade now and a connection between the city's policies and EU guidelines has been found, adding to the strength of this case study in the context of the main research question of this thesis (Bornholdt, 2018). Rotterdam has also proved to have a developed green roof strategy, and further connections with EU funding make it a valuable case study. The choice of two case studies instead of one in-depth analysis has been made to show the variety and the level in which the EU can affect national green infrastructure policy making as well as to increase the overall validity of the research (Eisenhardt, 1989). Although the two case studies are not thoroughly compared, conclusions have been made based on the resemblances and differences between the green roof strategies in Hamburg and Rotterdam. The data for the case studies consist of secondary sources: policies, documents, available project proposals, funds and reports, as well as of primary data in the form of expert documents described in the following section and a combination of the two sources as another way of making the research more comprehensive (Eisenhardt, 1989).

## 3.3. Interviews

Interviewing constitutes a data gathering method weaved into the analysis of this research. Utilizing both secondary sources in the form of documents, fact sheets, project plans and results, official publications and other academic sources, as well as primary sources in the form of interviews, allows for a broader perspective and enables using a variety of information available to answer the main research question (McCoyd & Kerson, 2006)

The interviews conducted were mostly semi-structured expert ones. Two of the interviews were carried out in person: the first one with Julie Raynal (on 14 June 2018), the main EU official who, in the European Commission, works on drafting, promoting and adapting the EU Green Infrastructure Strategy. The second in-person interview was conducted with Jovelyn Lecomte (on 22 May 2018), the director of Plaisir Vert, an organization which offers services of designing and setting up green roofs and walls in Brussels. One interview was a telephone conversation conducted with Marloes Gout (on 17 July 2018) who works in the Urban Development department of the Municipality of Rotterdam and, specifically, focuses on green roof policies, initiatives, promotion, etc. The other five interviews were conducted via email since most of the chosen experts were occupied and were only able to find time to answer the questions in a written form. Studies have shown an advantage of in-person interviews over telephone or email ones, however, the clearness and easiness of data collection as well as the ability to obtain feedback from important officials have proven to be beneficial in the case of this research (de Leeuw & van der Zouwen, 1999; Jordan et al., 1980; Knox & Burkard, 2009). The advantages of email interviews have also been described by McCoyd & Kerson (2006) and include a possibility of having a geographically spread out sample in a relatively short amount of time and a possibility for respondents to answer questions on their own terms and in their own time (McCoyd & Kerson, 2006).

The email interviews were made by sending questionnaires, adapted to the role and position of the respondent, on the topic of EU green infrastructure policies, green roofs specifically, and the connection between those and a healthy urban living (see: Appendixes). The interviewed officials include Gabor Toth, who is the Environmental Coordinator at the Council of the European Union; Nathalie Bauman, a lecturer and researcher in the field of urban greening who works at the Institute of Environment and Natural Resources in Basel, Switzerland; Dr. Hanna Bornholdt, a scientific consultant and landscape architect working in the Ministry of Environment and Energy Directorate General of Nature Conservation, Landscape Architecture and Energy Department of Landscape Planning and Urban Green

Infrastructure in the city of Hamburg, Germany; Wolfgang Ansel, the director of the International Green Roof Association (IGRA) based in Stuttgart, Germany; and Eveline Bronsdijk from the Urban Development department of the Municipality of Rotterdam.

An important limitation of this research method has been a low response rate amongst contacted individuals in the fields of EU policy making and implementation, national green infrastructure specialists and policy makers, green roof specialists and companies which offer green roof services to private and public parties. Out of close to 40 contacted individuals or companies (via email or telephone) only one fifth have responded at all and even fewer – positively, offering to answer questions for the purpose of the research.

## 3.4. Validity of Research

According to Guba (1981), for a qualitative study to be trustworthy the researcher must address and take into consideration four main criteria: credibility, transferability, dependability and confirmability (Guba, 1981; Shenton, 2004). Credibility, or internal validity, is "one of most important factors in establishing trustworthiness" and in this research has been increased mainly through data triangulation (Shenton, 2004, p.64). Triangulation through the use of different research methods allows for one method to compensate for the limitations of another (Guba, 1981; Shenton, 2004). In the case of this research, the EU Green Infrastructure Strategy document is supported by interviews with EU officials drafting and promoting the strategy, as well as case studies and interviews with other experts working with the implementation of green infrastructure in specific member states. This makes it possible to show different points of view and reality perspectives, not just the from the level of the EU. Furthermore, internal validity of the research has also been increased by complimenting the main background document (EU Green Infrastructure Strategy) with other reports, policies and green infrastructure implementation descriptions in order to support and build on the brief strategy communication.

The second criterion, transferability, or external validity, "is concerned with the extent to which the findings of one study can be applied to other situations" (Merriam, 1998, p.31). This study, in order to increase the external validity, shows a number of examples of green infrastructure implementation and its impact on a healthy urban living and refers to official EU documents as ones aiming to affect all member states. The findings can, therefore, be applied to other member states and overall EU-level policymakers, however, the case studies are also contextual and, as many naturalistic inquiries believe, "in practice, even conventional

generalizability is never possible as all observations are defined by the specific contexts in which they occur" (Shenton, 2004, p.69). Hence, the number of examples in this research serves to increase the transferability of the research, taking into account the differences that may occur in varying contexts.

Dependability, also known as reliability of a research project, refers to the "techniques to show that, if the work were repeated in the same context with the same methods and with the same participants, similar results would be obtained" (Shenton, 2004, p.71). Incorporated into this research is a thorough description of its methodology to increase its dependability. Some of the questionnaires used (found as Appendixes) and information on interviewed experts are also included, along with references to all the documents utilized for the analysis and case study information. Nonetheless, in qualitative research, due to ever-changing phenomena and methods, such as personal interviews which can never be repeated in the same way, dependability can be problematic and hardly ever fully attainable (Shenton, 2004).

Finally, the aspect of confirmability, as described by Guba, refers mainly to the triangulation of data, the admission of researcher's beliefs and assumptions and the recognition of shortcomings of a study's methods and their potential effects (Guba, 1981; Shenton, 2004). This research, as described previously in sections 3.1., 3.2., and 3.3., utilizes a number of data gathering methods which provide both primary and secondary sources in order to triangulate the data. It is understandable, however, that the analysis comes with the researcher's point of view, and both for document analysis as well as interviews and case studies the perspective and decisions undertaken highly depend on the discretion of the researcher (Shenton, 2004). The recognition of the research methods' limitation as well as their benefits are also taken into account and described in the following section.

## 3.5. Strengths and Weaknesses of Applied Methodology

As is the case with many studies, the utilized method, even if it seems like the best one to support the hypothesis, can have its downsides. In the case of this research, the main weakness of the chosen methodology is its majorly qualitative nature and, therefore, a lack of 'hard' data evidence to support the research question. Furthermore, the case study approach and specific examples, although serving to show a variety of possible green infrastructure implementation and funding possibilities, make it difficult to generalize the results for a larger sample (Dandekar, 1986; Verschuren et al., 2010).

Another downside of the research is that it is largely based on secondary document, report and research analysis with an addition of primary data in the form of several interviews. Due to a short time span of the research as well as the low response rate from the contacted experts, the amount of primary data is not high enough to support the arguments of this study. It is, therefore, the secondary sources that constitute the foundation for answering the research questions. The documents and reports utilized come mainly from one source – the EU institutions and EU-funded researchers, which also creates a disadvantage for the research (Dandekar, 1986). However, the bias is taken into account and critically analyzed in section 4. of the study.

A strength of the chosen methodology is the number of utilized documents and a variety of secondary sources: official EU documents, reports, governmental websites and project proposals. Another advantage is the fact that several experts, who occupy important positions related to green infrastructure and green roofs in the EU or member states, have been interviewed, and the obtained information as well as official documents are a valuable and reliable source for analysis.

# 4. Findings and Analysis

The findings of this research will be provided in two main sections. Firstly, section 4.1. provides a qualitative analysis of the EU Green Infrastructure Strategy main document with the description of its aim and contents. In relation to this document, several other sources (in-depth reports, other studies, interviews) will be referred to in section 4.2. in order to illustrate how the EU framework and guidelines can be designed and implemented on local scales in member states.

Secondly, case studies be discussed as one of many examples of the implementation of green infrastructure in the form of green roofs in EU member states. Hamburg and Rotterdam have been chosen as examples illustrating the connection between local decisions and policy making and EU guidelines and funds. The case study analysis will include references to researches and information websites on those cases as well as primary data in the form of email interviews. The case studies provide a comprehensive image of the connection between EU frameworks, local policy making and practice, as well as of how green infrastructure, specifically green roofs can affect human and ecosystem health in EU member states. Additionally, other examples are brought upon to discuss the connection between EU policies and guidelines, green roof implementation on a local level and how those affect healthy urban living in given area.

## 4.1. EU Green Infrastructure Strategy

The EU Green Infrastructure Strategy is an example of a non-binding document which sets a framework and provides some basic guidelines for the implementation of green infrastructure initiatives within EU member states. Released in 2013 by the European Commission, the Strategy communication document describes the benefits of implementation of green infrastructure in EU cities and refers to many other EU policies which provide further guidelines as well as funding opportunities for green infrastructure.

### 4.1.1. Background Information

In the past almost two decades, the EU member states with the support of the decision-making bodies, mainly the European Commission, have been raising awareness about the changing climate and its harmful effects on ecosystem and human health as well as drafting

and implementing policies and documents to mitigate and adapt urban areas to climate change (Fischer, & Sykes, 2009). Important documents for the spatial planning and development of EU cities include, for example, the 1999 European Spatial Development Perspective (ESDP) which first introduced the focus on "growth, social equity and environmental protection" (Fischer, & Sykes, 2009, p. 60). Criticisms of this documents were often based on the previously mentioned in section 2.4.5. inherent contradiction between environmental protection and economic development (Fischer, & Sykes, 2009). Nevertheless, mitigation and adaptation to climate change has had a prominent role in the EU agenda, and specific focus on green infrastructure was mentioned in 2011 in the EU 2020 Biodiversity strategy (EU Biodiversity Strategy, n.d.).

The EU Strategy on Green Infrastructure has been drafted as a key step of the EU 2020 Biodiversity Strategy (Naumann et al., 2011b). The Strategy's Target 2, more specifically, states that "by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems" and aims to address the "increasingly fragmented nature of European habitats as a result of human-induced land cover change and land use intensification while also providing recreational, economic and health benefits to society" (European Commission, 2011, p. 5; Naumann et al., 2011b, p. 1). Green Infrastructure projects would further contribute to all 6 targets of the Biodiversity Strategy such as "the full implementation of the Birds and Habitats Directive (target 1) and to maintaining and enhancing biodiversity in the wider countryside and the marine environment (targets 3 and 4)" (The EU Strategy on Green Infrastructure, n.d.).

The EU Green Infrastructure Strategy only promotes investment in green infrastructure and the development of a Trans-European Network for Green Infrastructure and does not have definitive legislative power. Therefore, efficient implementation of the EU Green Infrastructure Strategy requires the integration of green infrastructure plans into different policies and sectors within Europe as well as into member state policies (Neumann et al., 2011). A more in-depth analysis of this document will be provided in section 4.1.3. and two case studies from EU member states implementing green infrastructure strategies will be found in section 4.3.

### 4.1.2. EU Green Infrastructure Strategy Communication Summary

The main document of the Green Infrastructure Strategy is its summary and a communication of its main points published in 2013 by the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The document is written in an uncomplicated language, understandable not only to specialists from the field. This communication is descriptive in nature and starts with a paragraph including background information on the importance of protecting Europe's natural capital as well as a working definition of Green Infrastructure (section 1.2.) which states that green infrastructure is

> "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings." (European Commission, 2013, p.3).

The EU Green Infrastructure Strategy mentions a variety of developed definitions of green infrastructure and only provides its own working one used throughout the rest of the document as well as in any other references to it in other Commission documents and communications. Section 2 of the document argues that green infrastructure can make a contribution to the effective implementation of EU policies of which the objectives can be achieved through nature-based solutions (European Commission, 2013). The importance of green infrastructure in regional policies is highlighted as an essential part of sustainable urban development in the EU, where 60% of the population nowadays lives in cities (European Commission, 2013). Section 2.2. of the communication already mentions the health benefits which can be achieved thanks to green infrastructure initiatives. Clean air and a better water quality as well as healthy ecosystems and a decrease in vector-borne diseases are some of the physical health benefits listed by the Commission and supplied by positive mental health aspects, such as a feeling of community, empowerment of individuals and societies as well as the creation of appealing places to work and live in (European Commission, 2013). Some examples of the usage of green infrastructure as a method to mitigate the urban heat island effect and using land instead of air conditioning are provided in Box 2 of the document and consist of biodiversity-rich parks,

green spaces and fresh air corridors, amongst others. Reference to different EU documents and regulations, more specific and decisive ones than the green infrastructure strategy, is made to show a connection between several issues and guidelines and the use of green infrastructure as a solution. As an example, the Directive on energy performance of buildings is mentioned because it promotes different materials and design features which, if adopted in the construction of the building, can reduce levels of greenhouse gas emissions from this sector. Green infrastructure makes use of such innovative materials and, if incorporated into the design of buildings, can make them more energy efficient as well as have other benefits, such as risk management, maintaining 'sustainable livelihoods' and 'fostering green growth' (European Commission, 2013). In section 2 of the document another reference is made to the Commission's proposal for an Environmental Action Programme to 2020 which tackles the issue of natural capital. The EU Green Infrastructure Strategy demonstrates how green infrastructure is important in maintaining Europe's natural capital, specifically the soil, water, air and biodiversity and natural ecosystem conservation. Section 3 of the communication describes what actions can be taken by the EU to encourage the development and implementation of green infrastructure in member states. Those actions include facilitating integration of projects into funding mechanisms, such as the Common Agricultural Policy, Cohesion Fund, European Regional Development Fund, Horizon 2020 and many others. Moreover, the need for 'consistent' and 'reliable' data on ecosystems, their services and the potential value they provide in order to promote green infrastructure solutions in spatial planning and decision-making processes is considered as important and mentioned in the Strategy document.

Improving knowledge and the development of more research into biodiversity and its relation to the conditions of an ecosystem and related green infrastructure benefits are also highlighted as important in the third section of the Commission's communication. EU-level green infrastructure, an international coordination and a 'pan-European vision' for projects which, because they are based on geographical natural systems like rivers or mountain ranges, often surpass national boundaries, is yet another point of section 3, and tools, such as macro-regional strategies and European territorial cooperation programs (such as the EU Strategy for the Baltic Sea Region) are mentioned (European Commission, 2013). Section 4 of the communication document tackles the theme of promoting green infrastructure initiatives in policy areas, such as regional cohesion, agricultural policies, consumer and health policies associated with funding mechanisms for green infrastructure in member states. The green infrastructure strategy is concluded in section 5 by highlighting the potential benefits of such initiatives and

the important role of the Commission in promoting and facilitating green infrastructure within member states (European Commission, 2013).

### 4.1.3. EU Green Infrastructure Strategy Communication Analysis

The Green Infrastructure Strategy communication analysis includes the main themes found within the document along with its aims and the ways in which the EU can facilitate and promote the implementation of such strategies among member states.

*Green Infrastructure Implementation Benefits*

The theme that most often re-appears in the EU Green Infrastructure Strategy communication document relates to the benefits that can be achieved through the implementation of green infrastructure in EU cities. Knowing that the document has been prepared by the Commission itself, it is understandable that the strategy described in it is highly promoted and shown as favorable in many different aspects. The benefits of green infrastructure mentioned throughout the communication document can be divided into economic, social, political and environmental ones (Figure 6). These categories correspond to the processes which interact with the physical aspect of cities and affect the health of urban population (Schulz, & Northridge, 2004; Northridge et al., 2003). The economic benefits of green infrastructure highlighted in the document consist, for example, of potential ecosystem services, reduction of vulnerability to disasters, therefore lowered costs of building up cities' resilience, cost-effective options for the implementation of multiple EU directives, such as the Drinking Water Directive, cutting costs of heavy grey infrastructure, etc. (European Commission, 2013). The document itself does not provide any specific examples of green infrastructure which has proven to be economically beneficial to member states or any precise guidelines for the implementation of such strategies. The lack of specific cost information and potential saving opportunities adds to skepticism evoked when reading about the economic benefits of green infrastructure. Potential readers of this documents who work for national and regional municipalities might want to know how exactly green infrastructure can be economically friendly. As mentioned in section 2.2.3., national and international agendas often struggle to balance economic development and environmental protection, therefore, detailed information on how green infrastructure can in fact add to economic development would be beneficial and would make the document more convincing (Mell, 201).

The social and political benefits of green infrastructure described in the communication include a greater sense of community in an area, combating social exclusion and isolation,

individual benefits to one's psychological and physical health as well as further potential positive effects of the implementation of green infrastructure into national policies. Once again, not many concrete examples are provided in the document itself of how green infrastructure strategies can benefit human health, except for a basic description. However, a reference to an in-depth report of the Multifunctionality of Green Infrastructure is made as a source of additional information and a proof of green infrastructure's benefits (European Commission, 2012; 2013). There are numerous environmental advantages of the implementation of green infrastructure described in the communication document and these include mainly the protection, conservation and enhancement of EU's 'natural capital' as well as an improvement of the quality of air and water and overall ecosystem health (European Commission, 2013). The link between a healthy environment and healthy citizens is made and proves the importance of natural environment as a fundamental factor affecting urban health.

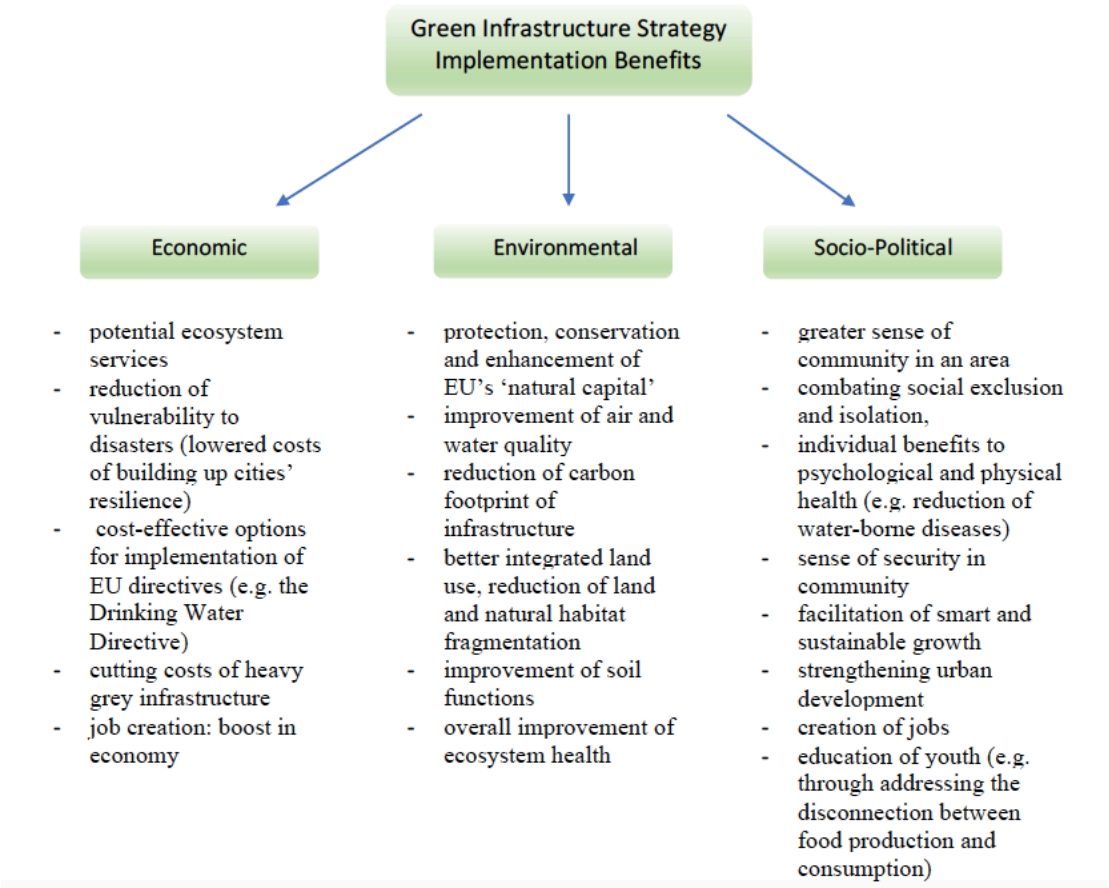


Figure 6. Green Infrastructure Benefits described in the Green Infrastructure Strategy Communication.

*Implementation of Green Infrastructure on National and EU Levels*

The second main theme of the EU Green Infrastructure Strategy is the implementation of green infrastructure in national and EU-level policies and the promotion of such initiatives. Once again, due to the source (Commission) and targeted audience (mainly other EU bodies as well as member state governments) of the communication, it is comprehensible that the sources of guidelines and possibilities of funding green infrastructure strategies as well as references to further information on the design, implementation and detailed scientific studies of benefits of such initiatives are provided. The need to integrate public and private sector funding of each member state with EU funds is stated as the optimal technique for green infrastructure implementation. The different scales of green infrastructure should be "interconnected and interdependent" and work beyond country boundaries (European Commission, 2013, p.7). This is mentioned without citing any specific national policy which implements the green infrastructure strategy, as suggested by the EU. Some of the documents mentioned include EU-level funding opportunities for research and innovation in green infrastructure, for example Horizon 2020 and the European Regional Development Fund (European Commission, 2013). The reference to Europe's 2020 objectives is made multiple times and green infrastructure initiatives as well as their implementation in policies is described as one of the means to achieve those objectives, especially ones related to nature conservation and improvement of environmental urban health in EU cities.

Overall, the EU Green Infrastructure Strategy communication of the Commission is not a binding document and does not provide clear step-by-step instructions on how to implement green infrastructure policies in EU member states. The potential benefits of this strategy are listed as important push factors to implement it on national and supranational levels. References to more specific policies and plans, such as the 2020 strategy, the Regional Cohesion Policy, the Common Agricultural Policy, etc., help in specifying techniques of green infrastructure implementation, different types and designs of such initiatives and sources of potential funding for the strategy. Basing national policies and plans for green infrastructure initiatives solely on the one communication document seems unachievable, therefore, a more detailed framework with specific data on potential green infrastructure benefits would be of better use for member states. Details concerning the design and implementation of the green infrastructure strategy can be found in numerous other documents, however, gathering the essential data to determine whether such initiatives are favorable for an area is a highly time consuming process and could be facilitated by the creation of one comprehensive EU green infrastructure framework. To make this analysis more inclusive, green infrastructure

implementation and design are be further described in the following section, making use of additional documents and interviews with EU officials.

## 4.2. Planning and Implementation of Green Infrastructure in the EU

The EU Green Infrastructure Strategy, as concluded in the previous section, does not consist of one specific guideline document, and its implementation and design as well as the use of funds for green infrastructure initiatives most often depend on a specific member state's policies and plans. After its first mention in the 2020 Biodiversity Strategy released in 2011, green infrastructure solutions have been investigated and studies indicating their benefits and specific design and implementation have been supported by the European Commission. Documents, such as the In-depth report on Green Infrastructure (2012), the Green Infrastructure Implementation and Efficiency (2012), or the Design, Implementation and Cost Elements of Green Infrastructure Projects (2011), just to mention a few, are referenced in the Green Infrastructure Strategy as additional sources of information on green infrastructure in the EU.

As mentioned by Julie Raynal in an interview conducted for the purpose of this research, the main and virtually only EU official working directly with the Green Infrastructure Strategy, one of the most important base policies with the goal of green infrastructure implementation is the EU Biodiversity 2020 Strategy in which all parties involved (member states) committed to fulfill the Europe 2020 goals (Raynal, 2018). Previously described in section 4.1.1. goal 2, action 6 of that document specifically aims to "set priorities to restore and promote the use of green infrastructure" (European Commission, 2011, p.15). The EU Green Infrastructure Strategy is considered as one of the tools which aim to achieve the bigger objective of the Biodiversity 2020 Strategy, therefore, it takes part in achieving a larger goal of "halting the loss of biodiversity and ecosystem services in the EU and helping stop global biodiversity loss by 2020" (European Commission, n.d.; Raynal, 2018). The achievement, even partial, of the 2020 goals will positively affect not only the environment, but also citizens of EU member states and can add to ensuring a healthy urban living (Raynal, 2018)

### 4.2.1. EU Institutions' and Member States' Roles in Green Infrastructure Implementation

A number of key drivers and bodies are found to be of importance in the implementation of green infrastructure project among member states. The main drivers are "policy and spatial planning requirements, strategies and action plans, and local/regional needs and stakeholder interests and motivations" which are dependent on EU institutional decisions on a larger scale, and national or, even more specifically, city policies on a local scale (Neumann et al., 2011, p.2). Figure 7. shows a summary of the roles and actions taken by different parties in the process of planning, designing and implementing green infrastructure strategies in EU member states.

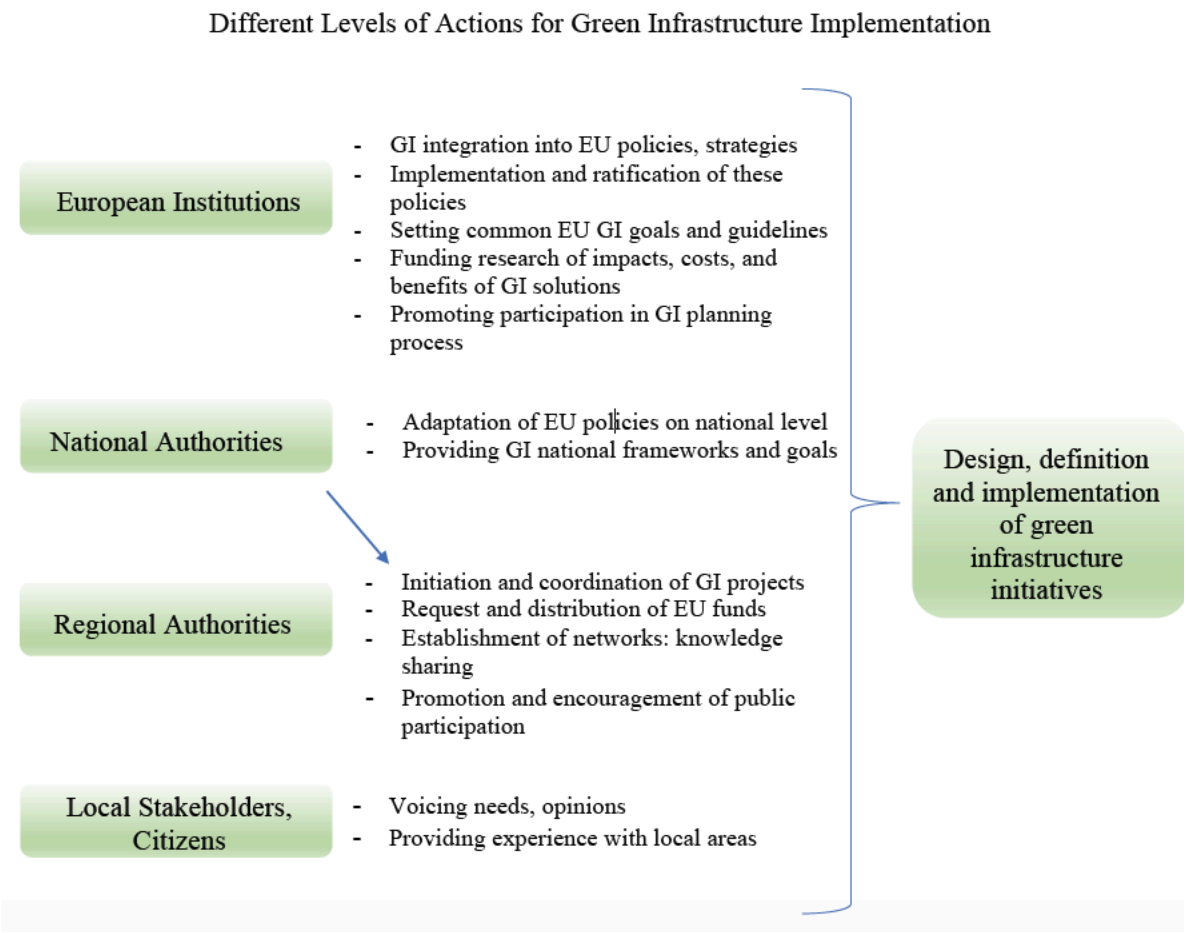


Figure 7. Different Levels of Actions for Green Infrastructure Implementation. Adapted from Novakova (2013).

*EU Institutions' Role*

EU institutions play an important role in the process of green infrastructure promotion and establishment of EU-level guidelines and funds. In particular the Commission takes care of drafting documents and plans, such as the Green Infrastructure Strategy, and later communicating them to other EU bodies and promoting them throughout member states (Raynal, 2018). Further EU-level tasks and policy actions, suggested in the report by Naumann et al., (2011) include: creating a legislative framework and setting "clear targets for protecting, maintain and creating green infrastructure (measurable in quantitative and qualitative terms)" as well as increasing policy coherence at EU level by "integrating green infrastructure into all relevant policies as one objective, highlighting the link and potential benefits received" (Naumann et al., 2011, p.5). Furthermore, EU institutions should increase awareness and facilitate knowledge sharing between experts, stakeholders, decision makers, spatial planners and citizens across EU member states. The actions aiming to increase awareness and promote green infrastructure initiatives are also described in the Green Infrastructure Strategy communication and can take on many forms. Ms. Raynal mentioned a few of those, such as the European Green Urban Green Infrastructure Conference, funded by the EU, which took place in Budapest, Hungary in 2017, and amongst its main themes focused on green roofs and their health benefits for European urban areas (EUGIC 2017; Raynal, 2018).

The Commission and other EU institutions have no executive powers in deciding on specific cases of green infrastructure implementation and national distribution of EU funds for particular green infrastructure initiatives, as stated by Julie Raynal "in the commission we do not decide on implementation of gI measures, it's for national authorities, for spatial planners, so the EU level has no legal competence on spatial planning and on use [...]" (Raynal, 2018). Nevertheless, there have been multiple financing instruments set to facilitate and support green infrastructure projects, for example the LIFE+ fund and its Natural Capital Financing Facility which offers green infrastructure funding opportunities to public and private entities, e.g. public authorities, land owners, NGOs and many more (European Commission, 2018). One example of a LIFE+ supported project (further described in section 4.3.3.) are Urban Roofs in Rotterdam, initiated by the municipality of Rotterdam and subsidized, along with a number of other partners, by the EU through a contribution of over 3 million euros for the application of multifunctional and green roofs on three buildings: the Peperklip, the Robert Fruinstraat and the De Heuvel building (European Commission, n.d.; Gemeente Rotterdam, 2017a).

The spatial planning of green infrastructure initiatives often finds its basis in EU guidelines and policies, such as the Strategic Environment Assessment (SEA), Environmental

Impact Assessment (EIA) and Environmental Liability Directive (ELD) which are considered as "the most important legal instruments of horizontal European environmental policy" (Naumann et al., 2011, p.26). The SEA, EIA and ELD include environmental legislations on water, biodiversity, climate, air and landscape, and, due to the broad focus of green infrastructure, many of these acts can be made use of for green infrastructure initiatives (Naumann et al., 2011).

Apart from the Commission, other European institutions, such as the Council of the European Union, the European Parliament, and the European Committee of Regions also play a role in the promotion of such initiatives. Firstly, by adopting the Green Infrastructure Strategy communication and integrating it into policies and funding tools and later by co-working with the Commission on the promotion of green infrastructure (Novakova, 2013). Moreover, green infrastructure is implemented in the headquarters of European institutions themselves: plans for three green roofs have, for example, been made for the newly open European Parliament Wilfried Maertens building in Brussels (Toth, 2018).

### *Member States' Role*

On the member state level, the coordination of projects, requests for and distribution of EU funds is the main task, apart from establishing the chief needs of a particular area and inviting local residents and stakeholders to green infrastructure planning process (Novakova, 2013; Raynal, 2018). Creating overarching and supporting frameworks on a national level is another important task of EU member states' governments (Naumann et al., 2011). Oftentimes member states establish special national initiatives and plans which receive EU funds, like the previously mentioned Urban Roofs in Rotterdam or Green4Grey, which also benefits from LIFE+ financing and aims to develop green and blue infrastructure in the 'Flemish belt' around Brussels (Ouvinen, n.d.). Furthermore, many EU countries have established national ecological networks to facilitate and promote green infrastructure development within national borders, but also to encourage international initiatives, exchange of knowledge and cooperation (CIRABC, 2017). These ecological networks include, for example, The Flemish Ecological Network in Belgium, The National Ecological Network of Bulgaria, The Territorial System of Ecological Stability of the Landscape, Czech Republic, The French 'green and blue trail' (trame verte et bleue), The German National Ecological Network (Biotopverbund), and many more (CIRABC, 2017).

The spatial planning aspect of green infrastructure plays an important role not only on the EU level, but also on the national level, as it has to be clearly defined, overlooked and

provided with national or regional legislations and instruments (Naumann et al., 2011). Spatial planning is a measure which allows for a combination of actors (planners, stakeholders, researchers) to study existing infrastructure and natural environment of an area and assess which specific types of green infrastructure can be developed there (Naumann et al., 2011). Spatial plans across the EU vary and include initiatives, such as the Shoreline Management Plans which aim to manage UK's coastal zones. The previously mentioned EU policies (SEA, EIA and ELD) on spatial planning are followed and adapted at local levels by each member state. The interests of private and social actors are further aspects affecting the design and implementation of green infrastructure initiatives: the needs opinions of stakeholders and civilians are more and more often taken into account when drafting spatial plans for such projects (Naumann et al., 2011; Raynal, 2018).

*Multi-level Governance of Green Infrastructure Initiatives*

From the gathered documents, interviews and reports on green infrastructure it can be concluded that decision-making processes happen on a multiplicity of levels in order for such initiatives to be designed and implemented. Both Ms. Raynal and Mr. Toth underlined the importance of cooperation between the different levels of governance. The success of green infrastructure initiatives often depends on a smooth and collaborative process of decision-making and planning of such strategies, which is underlined in most previously mentioned EU documents. Because multi-level governance involves the dispersion of authority between different various levels, it is important for all levels to contribute to both the decision and planning process for a comprehensive framework and practice of green infrastructure implementation (Kern & Bulkeley, 2009). In practice, some of the roles of the EU, national and regional governments and local stakeholders (or citizens) can be interchangeable (Raynal, 2018). For example, project proposals can come from private parties as well as member state governments or even can be suggested by EU institutions. The actions that contribute, on different governance levels, to green infrastructure projects in Hamburg and Rotterdam are further described in section 4.3. as examples of multi-level governance in practice.

### 4.2.2. Green Infrastructure and Healthy Urban Living in the EU

The beneficial effects of green infrastructure are highlighted in every official EU document and website as one of the main aspects promoting the development of green infrastructure initiatives. A special document published by the Commission in 2014 underlines the main public health benefits of green infrastructure strategy. Those are described to depend

on previously mentioned factors categorized by Northridge et al. (2003): the fundamental ones, mainly the natural environment, the intermediate factors, such as the built environment, and the proximate factors: social integration, financial situations, levels of physical activity amongst citizens, etc. (Northridge et al., 2003). The Commission report also distinguishes between physical health and wellbeing benefits of green infrastructure initiatives. The main positive outcomes derive from more access to green space which, as mentioned in section 2.2.2, encourages physical activity leading to relaxation, comfort and satisfaction as well as decreased chances of obesity and numerous heart diseases (Coombes et al., 2010; Demuzere et al., 2014; European Commission, 2014; Mansor et al., 2012). An example of England is provided, where "the benefits of urban greenspaces for physical and mental health have been estimated at 2-3 billion euros in averted health costs" and that of the Netherlands, where the "KPMG has estimated a gain of hundreds of millions of euros per year by greening neighborhoods. Reducing sick leave by only 1% would save billions of euros" (European Commission, 2014, p.2; 2012).

The Commission's factsheet uses as a reference a more detailed theoretical framework and research on the connection of green infrastructure and health benefits, the in-depth report on the multi-functionality of green infrastructure (European Commission, 2012). This report "describes the different functions that GI seeks to execute and explores the scientific evidence behind its ability to perform these functions, using case studies where available" (European Commission, 2012, p.ii). One of these functions is the improvement of ecosystem functioning (ecosystem health), and another – the promotion of societal wellbeing and health adding up to an overall aim for healthy urban (and rural) living (European Commission, 2012). Similarly to this research, the in-depth report provides a framework connecting ecosystem and human health with green infrastructure and provides case studies, for example one in Llieda, Spain, where green facades proved to mitigate the 'urban heat island' effect caused by the region's extreme climatic conditions (European Commission, 2012; Perez et al., 2011). The significant shading effect of these green facades lowered the temperature in buildings and helped to avoid heat strokes, burns, excessive energy use for cooling, thus affecting positively both human and ecosystem health in the area (European Commission, 2012; Perez et al., 2011).

Another extensive document released by the Institute for European Environmental Policy (IEEP) in 2010, prior to the Green Infrastructure Strategy, describes policy tools and instruments for green infrastructure implementation in the EU and outlines the impact these initiatives may have on a wide range of areas, including health and well-being (Mazza et al., 2011). Once again, the connection between green infrastructure, especially more green space

within cities and ecosystem and human health, is underlined as very strong and important in the report. The IEEP showed that a full implementation of green infrastructure solutions in EU policies and the development of a ‘comprehensive, dedicated EU legal instrument’ for green infrastructure implementation would have the most beneficial effect on citizens’ health and well-being as it would be most effective (Mazza et al., 2011).

A multiplicity of other EU documents, such as the Final Report of the Horizon 2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities' called Nature-Based Solutions & Re-Naturing Cities or the Final Report Supporting the Implementation of Green Infrastructure, underline the benefits that green infrastructure has for human and ecosystem health and an overall healthy urban living (European Commission, 2015; 2016). Because the EU green infrastructure strategy has been implemented so recently, specific effects of initiatives supported and financed by the EU have not yet been measured. An important report with such information is supposed to be released by the Commission in the late fall of 2018 (Raynal, 2018). Most of this type of research is financed and released by European institutions, which signifies a bias in the available documents and reports. Member states have established ways of measuring their own initiatives, however, most of the green infrastructure is very recent and has yet to prove its benefits for human and environmental health.

Some cost-benefit studies have also been cited in the previously mentioned documents, their conclusions are mostly positive and in favor of green infrastructure implementation as a healthy urban living promoting strategy. The beneficial health aspect of green infrastructure is often underlined and promoted by the EU. In practice, however, there are various priorities and issues addressed by green infrastructure solutions, health not always being the main consideration, yet always an important one. Specific examples of that will be cited in the following section.

## 4.3. Case Studies – Green Roofs in Hamburg and Rotterdam

The implementation of green infrastructure in EU member states takes on various forms. Described previously in section 2.2.5, green roofs are one of many examples mentioned in the Green Infrastructure Strategy, specifically in relation to urban green infrastructure and its health benefits: “in cities ‘intelligent’, resource-efficient buildings, incorporating green features, such as green roofs and walls and made with new materials, can deliver environmental, social and health benefits” (European Commission, 2013, p.9).

This section further describes green roofs as a green infrastructure example and brings up the case studies of Hamburg and Rotterdam, as well as other examples of green roof policies in the EU and how those are affected by overall EU guidelines and financing tools.

### 4.3.1. Hamburg, Germany

*Background Information*

Germany has had a long tradition of rapidly developing green infrastructure, specifically green roofs, and is often used as an example of good practice for other EU member states (IGRA, 2018). Most environmental policies in the country are taken on a local 'state' level, however, the most important legal basis for Germany's nature conservation including green infrastructure initiatives can be found in the Federal Nature Conservation Act (Ansel, 2018). This act includes the implementation of some European Nature Conservation Directives, for example the Habitats Directive and the Birds Directive, into national law (BISE, n.d.). A recent policy development related specifically to green infrastructure has been the The Federal Green Infrastructure Concept (BKGI), which integrates EU guidelines and points mentioned in the Biodiversity Strategy 2020, as well as the Green Infrastructure Strategy (BfN, 2017).

Although green infrastructure initiatives are present throughout the whole country, Hamburg is often cited as the main example of green roof implementation in a EU city. The Commission itself offers a case study of Hamburg's Green Roof Strategy to show a positive and successful green roof implementation and outlining its leading role in that field among major German and European cities (Climate-ADAPT, 2016). Located in the center of the northern German metropolitan region, the Free and Hanseatic City of Hamburg is a city-state – both a state and a municipality. The city, with its 1,8 million inhabitants, has a constantly growing population, hence an increasing need for apartments, which causes a stress to local green spaces and a need for sustainable and healthy city solutions (Bornholdt, 2018b). With prior development and promotion of it from Hamburg's mayor, Olaf Scholz, the city implemented its 'Green Roof Strategy' on 8 April 2014 (Bornholdt, 2018a). The goal of this strategy was to build 100 hectares of green roofs in a decade and to overall set green infrastructure as one of the city's priorities (Bornholdt, 2018a).

*Green Roof Strategy in Hamburg*

In an interview with Dr. Hanna Bornholdt, who works for the Directorate General of Nature Conservation, Landscape Architecture and Energy Department of Landscape Planning and Urban Green in the Ministry of Environment and Energy in Hamburg, more information on green roofs in Hamburg was obtained; she has also published a four-year report (2014-2018) of green roof initiatives in the city. The green roof strategy in Hamburg has been based on some objectives of the city's climate policy and climate-related urban development, aiming to establish green roofs as a preventive measure against climate change which would be cost-effective (Bornholdt, 2018b). Furthermore, green roof planning has been managed as one of the lead projects in the field of urban development in Hamburg.

Hamburg's green roof strategy is mostly controlled by the city's highest 'green' administration level: the Office for Nature Conservation, Green Planning and Energy with Dr. Hannah Bornholdt in the lead. The main task of this Office is the development and implementation of green roofs in the city as well as drafting specific projects (such as "More City in the City – Together for more Freedom of Quality in Hamburg", a part of Hamburg's new urban development concept) which are later validated by the mayor (Bornholdt, 2018b). A multi-agency project group, comprised of representatives of the Department of the Environment and Energy and the Department of Urban Development and Housing, meets on a regular basis and twice a year organizes a meeting with trade associations and institutions as well as architects to discuss green roof strategies. Later, scientific research and data supporting such projects are gathered in collaboration with the HafenCity University (HCU) which drafts its reports on the possibilities green roofs provide.

As for the funding for green roof initiatives in Hamburg, from 2015 until 2019 three million euros have been made available for greenfield subsidies. Since 2015, green roof subsidies directed only towards new buildings and conversions have been offered by the municipality. Around 30% to 60% of the production costs of green roofs are granted as a one-time subsidy throughout the city (Bornholdt, 2018b). Apart from the city of Hamburg, a number of bodies cooperated in the drafting of the green roof initiative as well as the financing of the strategy. The bodies include among others: the Hamburg Investment and Development Bank IFB, the Department of Urban Development and Housing BSW, HafenCity University Hamburg (HCU Hamburg), the Association of German Landscape Architects (BDLA) (Bornholdt, 2018b). Since the initiation of the program until December 2017, 127 applications for green roof funding were received in Hamburg and 86 of them got approved. The first green roof fully funded by the city was opened in July 2016 on the Streit's house on Jungfernstieg

(Figures 8, 9), where 500 square meters of the roof were covered in a species-rich garden and a wooden deck for recreational purposes (Bornholdt, 2018a; 2018b).

Figures 8, 9. Green Roof on the Streit's house on Jungfernstieg. (source: http://www.hamburg.de/gruendach-unternehmer/7954512/streits-haus/)

### *EU's Role in Hamburg's Green Roof Strategy*

Throughout the interview and the whole report provided by Dr. Bornholdt, there was little mention of EU frameworks, initiatives or guidelines which were taken into account when implementing green roofs in Hamburg. The main relationship between Hamburg's green roof strategy and the EU seems to be a financial one. The report on the green roof strategy in Hamburg mentions the EU as a source of funding for current and future programs (Bornholdt, 2018b).

As much as the Commission promotes its policies and guidelines and aims to develop and offer the perfect tools to finance and subsidize green roofs, even in a city like Hamburg, where the Green Roof Strategy has been active since 2014, EU finances have not reached any specific initiatives until 2018 (Bornholdt, 2018a). The first project in Hamburg which has successfully been granted the Horizon 2020 funding by the European Commission is Clever Cities. Dr. Bornholdt mentioned this recent initiative which has been approved in June 2018 and includes London and Milan, apart from Hamburg. Clever Cities includes projects that implement natural solutions into urban planning and aim to adapt Hamburg to climate change, green roofs being a prize example of such projects (Bornholdt 2018a). The total amount of funding is 15 million euros, with 2.6 euros for Hamburg specifically, available until the end of the project – May 2022 (Bornholdt, 2018b).

In the case of Hamburg, the EU Green Infrastructure Strategy seems to be indirectly applied, mainly in the financial aspect. Neither Dr. Bornhold nor Mr. Ansel, the director of the International Green Roof Association (IGRA), had any information about a more direct connection between EU initiatives or any specific examples of green roofs in Hamburg or Germany in general (Ansel, 2018; Bornholdt, 2018). Since the support and promotion of green roofs in Germany started early on, in the 1980s, EU initiatives and reports have been informed by practice in cities such as Hamburg, as opposed to local policies being inspired by EU frameworks (Ansel, 2018). Still, possibilities for financial support of projects like green roofs are now promoted robustly enough for initiatives such as Clever Cities to emerge and connect different cities across the EU with the aim of achieving sustainable urban development and within that, healthy urban living.

### *Hamburg's Green Roofs and Health*

The aspect of health benefits provided by green roofs has been underlined in Hamburg's Green Roof Strategy. In order to counter the common argument of green roofs' economic costs outweighing their health benefits, the city of Hamburg has developed an economic evaluation

of its green roofs which takes into account their development and life cycle costs (Bornholdt, 2018a). The costs of green roofs can potentially save 20 years of refurbishment in comparison to 'grey' roofs. However, as most of the benefits of green roofs are long-term ones, these are, therefore, difficult to measure this early in the process of green roof incorporation in Hamburg (Bornholdt, 2018a; 2014b).

Hamburg's green roof strategy is frequently promoted as a means to a healthier urban living. While a connection between increased green space and health within this city has been found, specific examples fail to provide hard evidence for this connection. Due to Hamburg's policy being in place until 2020, projects like Clever Cities – until 2022, their health benefits are not yet measurable. An overall EU report on the effects of green roofs on health is planned to be released towards the end of 2018 and will include case studies such as Hamburg (Raynal, 2018).

### 4.3.2. Rotterdam

*Background Information*

Green Infrastructure initiatives and policies in the Netherlands are amongst the most developed and longest-standing ones in the EU (BISE, n.d.). At the beginning of 2017, a new Nature Law was implemented in the country as an overarching framework and update of nature conservation law, flora and fauna law and forestry law (BISE, n.d.). This document takes some inspirations from the EU Biodiversity Strategy and includes green infrastructure initiatives as a method of nature conservation (BISE,n.d.). The responsibility for the implementation of the new nature law lies with the particular Dutch provinces and is incorporated in municipal policies and strategies. In relation to urban green infrastructure specifically, the Implementation Agenda Natural Capital (*Uitvoeringsagenda Natuurlijk Kapitaal: behoud en duurzaam gebruik van biodiversiteit, 2013*) was implemented in 2013 and includes 16 action points of which two are directly relevant to green infrastructure (BISE, n.d.; Ministerie van Economische Zaken, 2013). The Agenda calls for green infrastructure to be considered in the design of new infrastructure projects throughout the country (Ministerie van Economische Zaken, 2013).

An important and progressive Dutch government initiative is the Green Deal program which supports businesses, civil society and other governmental bodies in the implementation of policies on sustainability and overall 'green' societal changes (Gout, 2018; Government of the Netherlands, 2015). Green Deals cover a variety of themes and provide guidelines,

financing or networking possibilities for the development of green initiatives. Green roofs are one of the Deal initiatives which now has around forty partners across the Netherlands (Government of the Netherlands, 2015). The Green Roof Deal was set up in 2014 and aims, through 'national stimulation', to "make the most of the ecosystem-strengthening properties of vegetated roofs" (Greendeals, n.d.). The use of vegetated roofs is promoted by the Dutch government and has been shown as economically, socially and environmentally beneficial, underlining the health benefits it can provide in urban areas (Government of the Netherlands, 2015).

Within the already extensive Dutch green infrastructure and green roof initiatives, Rotterdam is known to have one of the most developed green roof policy in the EU (Gout, 2018; Rotterdam Climate Initiative, 2018). Along with Amsterdam and Groningen, Rotterdam was the first to implement a green roof program in the Netherlands already in 2008 (Bronsdijk, 2018).

### *Green Roof Strategy in Rotterdam*

Rotterdam's journey with the green roof implementation started in 2008. A program was created and subsidies provided for new green roofs which back then were mostly supposed to supply water storage and retain rainwater in the flood-prone city (Bronsdijk, 2018; Gout, 2018). The program is still running and provides a subsidy of around 25 euros per square meter for the green roof implementation (Gout, 2018). Although the main objectives of the green roof policy have shifted slightly, retaining rainwater is still important in Rotterdam, and numerous other benefits of green roofs are highlighted in the promotion of the initiative. The government, with an aim of implementing 1 square kilometer of multifunctional (including green) roofs by 2020, stimulates the development of this green infrastructure through the provision of subsidies and additional promotion of the strategy as beneficial for individuals, businesses and society overall (Bronsdijk, 2018). In a telephone interview, Ms. Marloes Gout (on 17 July 2018), who works in the Urban Development department of the Municipality of Rotterdam, in a jocular manner called the new approach to green roofs in the city 'Green Roofs 2.0'. By that she meant that the government now promotes this economically and environmentally friendly initiative, highlighting positive long term effects, including citizens' physical and mental health improvement (Gout, 2018).

At present, Rotterdam has 235,000 square meters of green roofs all around the city (Bronsdijk, 2018). Examples of public buildings which have implemented green roofs include parks, such as the Dakpark or Station Hofbogen, the Erasmus MC Hospital and the office

building of the city of Rotterdam – the Timmerhuis (Bronsdijk, 2018). The Dakpark (Figures 10, 11), funded in 2013, is the largest city roof garden in Europe, located on top of a shopping center and spreading across 1200 meters (Let It Grow, 2018). The Dakpark is an interesting example of a resident's initiative as it was funded, and is maintained, by local volunteer groups with the support of the government. The municipality promotes the Dakpark as a successful green roof and an example of effective green infrastructure implementation (Let It Grow, 2018). The promotion of green and multifunctional roofs in Rotterdam takes on many forms, including promotional events open to all public (Gout, 2018). In July 2018, the Rotterdamse Daken Dagen (Rotterdam's Rooftop Days) took place. Its aim was to stimulate the use of roofs – to show how their modification can contribute to a "healthy, attractive and future-proof city" (Rotterdamse Daken Dagen, 2018). The event was considered as successful: 56 rooftops were visited by around 20,000 people, and a Dakheld 2018 price was given out to Carleen Mesters and Anne-Marie Bor who work with the Green Roof Green Deal, mentioned in the previous section (Rotterdamse Daken Dagen, 2018).

Figures 10, 11. The Dakpark in Rotterdam. (source: www.dakparkrotterdam.nl)

*EU's Role in Rotterdam's Green Roof Program*

Rotterdam, along with Hamburg, is an excellent example of city and people-initiated projects and plans, such as the green roof program. Because green roof implementation and subsidies were introduced by the Dutch government long before the EU Green Infrastructure Strategy, they have not been heavily influenced by this document itself (Bronsdijk, 2018; Gout, 2018). Ms. Bronsdijk mentioned the importance of Waterplan 2 – a Dutch national initiative drafted in relation to the European Directive on the assessment and management of flood risks – for green roof implementation (Bronsdijk, 2018). The Waterplan indicates green roofs as one of the tools which can help increase the water storage capacity in cities (Bronsdijk, 2018).

Rotterdam's green roof program, specifically a recent project initiated by the municipality, like the Hamburg's strategy, is connected to the EU financially (Bronsdijk, 2018; Gout, 2018). With the approval from the EU and a budget of over 3 million euros from the LIFE+ fund, in July 2017 the LIFE@ Urban Roofs project was endorsed in Rotterdam (European Commission, n.d.; Gemeente Rotterdam, 2017a;2018). The main objectives of this project are the following: promoting private investment in the context of the adaptation to climate change, facilitating and encouraging the use of multifunctional (including green) roofs and boosting innovation and experimental technologies (Gout, 2018; European Commission, n.d.; Gemeente Rotterdam, 2017a). A design contest has been announced by the municipality

to create plans of multifunctional roofs for three selected demonstration sites: The Peperklip, a large, lower-income housing project; De Heuvel, a community building in the city center; and Robert Fruinstraat, a street with different property types which face a problem of flooding (Gout, 2018; European Commission, n.d.). LIFE@Urban Roofs, using EU funds, will also implement a social cost benefit analysis (SCBA) of the demonstration sites in order to determine the effect of multifunctional roofs. The EU itself will monitor the progress of this project mainly by sending some of its officials to Rotterdam on a regular basis (Gout, 2018). The collected data will be used to create a blueprint for such an approach which will then be used by other members of the LIFE project, beginning with the main partner, Vejle in Denmark (Gemeente Rotterdam, 2018).

The LIFE@ Urban Roofs project once again illustrates the different roles in the governance and implementation of green roofs in the EU. The municipality of Rotterdam, along with a few other private and public partners, was responsible for drafting the project and applying for the EU fund. The idea for the project was rooted in the city's tradition of innovative urban solutions and the need for rainwater retention which could bring further benefits (Gout, 2018). EU legislations and frameworks, specifically the Biodiversity 2020 Strategy and its objectives, were considered when the project was prepared, however, Rotterdam's previous experience, possibilities and needs were a priority for LIFE@ Urban Roofs (Bronsdijk, 2018). The LIFE+ fund, mentioned in the EU Green Infrastructure Strategy, has played the most important role in materializing the concept of green roofs in Rotterdam. The EU acts, therefore, as one of the actors practically facilitating the process of the green roof implementation in the Dutch city. In relation to framework and policies, Rotterdam is an inspiration for other EU countries and attracts many policymakers and planners who want to learn from best practices (Gout, 2018). Across the EU, national policies are often inspired by practice and examples of existing green roof strategies, rather than by EU documents and guidelines.

### *Rotterdam's Green Roofs and a Healthy Urban Living*

Although the implementation of green roofs in Rotterdam started because of the need for more rainwater retention, throughout time their multiple long-term benefits have also been acknowledged and promoted by the municipality (Gout, 2018). One of those benefits is the improvement of health for Rotterdam's population and environment. The LIFE@ Urban Roof project description refers to various studies proving the connection between green space and human health, highlighting the potential benefits of green roofs (Gemeente Rotterdam, 2018).

In section 3.2.7. of the LIFE @ Urban Roof project document a way of assessing green roof's health benefits is mentioned (Gemeente Rotterdam, 2018). Those advantages are separated into two main categories: avoided health care costs and prevented labor loss. The measurements have been made using the Economics of Ecosystems and Biodiversity (TEEB) city tool. In relation to the avoided health care costs it has been estimated that there are "0.835 fewer patients per 1000 inhabitants at 1% more green within a radius of 1 km around the home", which in summary means that the more green space there is in an area, the lower the incidence of diseases is around it (Gemeente Rotterdam, 2018, p.14). Furthermore, 868 euros is saved per patient. The prevented labor loss is estimated at the value of "6,341 euros per patient. Assuming 0.835 fewer patients per 1000 inhabitants at 1% more green, this amounts to 5,294.74 euros less loss of work per year" (Gemeente Rotterdam, 2018, p.14). Such measurements are possible only some time after the implementation of a green roof, therefore, they are estimated at this point of the process. The improvement of biodiversity, air quality, social cohesion and cultural history are further benefits mentioned in the LIFE@ Urban Roof project description, and all together add to a healthy urban living.

Another important connection between green roofs and health in Rotterdam can be observed in the Erasmus MC Hospital, where an intensive green roof was opened in 2018 (Figures 12, 13). One of the main aims of this rooftop garden is to help improve the health of patients. The slogan of this project is "You'll get better from green", which underlines the connection between green space and health (Gout, 2018; Erasmus MC, 2017; Erasmus MC TUIN, n.d.). The Erasmus MC Hospital's roof garden was constructed with the aid of public financing and private donations (Erasmus MC TUIN, n.d.). Due to the fact that the hospital's green roof has been opened very recently, it is difficult to establish and measure its benefits at this time. Nevertheless, it has proven to be a success amongst patients, visitors and the staff of the hospital (Erasmus MC TUIN, n.d.). One of the patients mentioned on the official website of the project called the green roof an "oasis where patients can forget about their illness for a while" (Erasmus MC TUIN, n.d.). Apart from creating a healthy and welcoming environment for the patients, the Erasmus MC Hospital's green roof provides environmental health benefits, such as air purification, a habitat for insect and birds and retainment of rain water (Gout, 2018).

Despite the fact that Rotterdam's green roofs aim primarily to retain rainwater and be an environmentally as well as economically friendly urban solution, their multiple benefits are promoted and made use of in the city. The municipality of Rotterdam encourages the implementation of this type of green infrastructure as it can help the city to fulfill its overall Resilience Strategy of being 'ready for the 21st century' (Bronsdijk, 2018). Rotterdam's

striving for resilience includes both human and environmental health as important aspects, and a healthy urban living is considered as crucial for the sustainable development of this urban area (Gemeente Rotterdam, 2017b).

Figure 12. Plan of the Erasmus MC Hospital building with green roofs. (source: https://www.nationaalgroenfonds.nl)

Figure 13. Artist's impression of the rooftop garden in Erasmus MC Hospital. (source: https://www.erasmusmctuin.nl/ )

### 4.3.3. Green Roofs in the EU and a Healthy Urban Living

Green roof strategies, initiatives, projects and policies, aside from the described cases of Hamburg and Rotterdam, can be found all over the EU. The implementation strategies and objectives of green roofs vary across different cities. In most EU member states, however, the benefits of this green infrastructure type are acknowledged, which leads to the creation of more and more green roofs across Europe (Raynal, 2018).

In the process of choosing case studies for this research, a number of EU cities, which have some sort of green roof strategy and are active in implementing this green infrastructure type, were looked into. Interviews with experts from Brussels and Basel have been conducted in order to determine whether there is an observable trend or pattern in the implementation of EU guidelines in green infrastructure initiatives. In Brussels, the capital of Belgium as well as the heart of the EU institutions, green roof projects are slowly being incorporated into city planning through the provision of subsidies and organisation of promotional conferences (Lecomte, 2018). The main issue with the implementation of this green infrastructure in Brussels seems to be the lack of knowledge on their benefits. Ms. Lecomte, the director of

Plaisir Vert, one of the few organizations in the city which offers green roof and wall services in Brussels, noted that most potential clients are discouraged by the costs of green roofs, especially the maintenance costs (Lecomte, 2018). Despite there being some city budget available for such initiatives, there is little promotion of green roofs in Brussels. Furthermore, Ms. Lecompte was unaware of any connection between EU policies, frameworks or funds and green roofs in Brussels. Although it is the role of the government to submit projects, such as green roofs, to receive EU funding, there still seems to be little connection between the guidelines of the Commission and practice in Brussels. This seems ironic, considering the fact that most of those decisions are made and policies drafted in this city. The Brussels Capital municipality provides a set of guidelines as well as a summary of the costs and benefits of green roofs, listing a healthy urban living as one of the advantages (Bruxelles Environnement, 2016). The knowledge of this type of green infrastructure and its health benefits is, however, still not widespread in the city. A need for a master plan and the implementation of green roofs on a larger scale, with the aid of the EU, is called for to promote green roofs in Brussels (Lecomte, 2018).

Another example of a successful green roof implementation can be observed in Basel, Switzerland. Although the country is not part of the EU, it is actively implementing the Biodiversity 2020 Strategy and uses practices which inspire other countries across Europe. Switzerland did not make use of any of the EU green infrastructure frameworks or guidelines as it started to implement green roofs long before those documents were created (Baumann, 2018). As far as the transfer of knowledge is concerned, it was the country's policies and practices that inspired EU frameworks, and not the other way around (Baumann, 2018). The city of Basel "has the largest area of green roofs per capita in the world", and initiatives, subsidies and a program for this green infrastructure implementation started as early as 1996 (Climate-ADAPT, 2015). Two major campaigns, the first one between 1996 and 1997 and the second one between 2005 and 2006, were held to promote green roofs in the city (Baumann, 2018; Climate-ADAPT, 2015). Their aims were to inform – through all possible media – the citizens, private house owners, building companies, etc., about the benefits of green roofs as well as to promote government subsidies (around 25-30 swiss francs per square meter of green roof was available) for a period of one year (Baumann, 2018). Since 2001, 30% of buildings with flat roofs in Basel (all types, public and private) have been greened (Baumann, 2018). In 2002, an amendment to the City of Basel's Building and Construction Law was passed and requires for all new and renovated flat roofs to be greened (Climate-ADAPT, 2015). In the last 20 years, green roofs in Basel have proved to benefit biodiversity and air quality (creating a

microclimate) and have added to a healthy urban living, which proves that this type of strategies, if applied on a large scale and promoted enough, can have enormous benefits for the health and well-being of citizens and urban environments (Baumann, 2018; Climate-ADAPT, 2015).

The Basel example demonstrates that anything is possible with enough funding, promotion and engagement of all levels of governance within a city: the citizens, stakeholders, local municipalities and national government. In the case of EU member states, this collaboration is also important, and EU Institutions can contribute to this process on various levels: by promoting such initiatives and informing on potential funding opportunities. Looking into the listed examples as well as other EU cities, such as Amsterdam, Copenhagen, Stuttgart, Milan, just to name a few, there still seems to be little connection between EU guidelines, initiatives and city policies. The different governance levels seem to work more independently and the cooperation needs to develop on a deeper level (Raynal, 2018).

# 5. Conclusions and Discussion

This section incorporates the theoretical and empirical findings of the study to answer the main research question and sub-questions, as well as to give an overall reflection on the topic of the research and suggestions for further investigation of the topic. The main research question of this thesis is:

*To what extent do EU initiatives, such as the Green Infrastructure Strategy, affect the implementation of green infrastructure, specifically green roofs, in EU member states and contribute to EU's healthy urban living?*

In order to conclude with the answer to the main research question, the responses to following sub-questions are mentioned in the following sections. Section 5.1. provides a summary of answers to the first three sub-questions:

- *How can spatial planning theory and practice contribute to a healthy urban living?*
- *What is green infrastructure and what benefits does it have for human and ecosystem health within urban areas?*
- *How are green roofs, a form of green infrastructure, beneficial to a healthy urban living?*

Section 5.2. concludes the issues tackled in the remaining sub-questions (as well as the main research question):

- *Which tools does the EU use and provide to promote the development of green infrastructure?*
- *How is the EU Green Infrastructure Strategy implemented on member state levels, what are its limitations?*
- *What connections between EU green infrastructure initiatives and a healthy urban living does the case study of green roofs in Hamburg and Rotterdam show?*

## 5.1. Planning Green Infrastructure for a Healthy Urban Living

A strong connection between cities, and later the practice of their planning, and the health of citizens and ecosystems within urban areas has been proven by numerous investigations and studies, beginning as early as the 19th century (Corburn, 2009; Jackson, 2003; Northridge et al., 2003; Ward, 2005). Initially, during and right after the industrial revolution in Western cities, the theory and practice of spatial planning dealt mainly with the issues of poor sanitation, high urban concentrations which led to quick spreading of diseases,

as well as air and water pollution from industries in the nineteenth century cities (Lindheim, & Syme, 1983). The development of technology and subsequent changes in urban areas over time created a need for city planning to adapt and find solutions to new health hazards in modern cities (Northridge et al., 2003). Nowadays, the main health threats in Western cities include excessive greenhouse gas emissions which cause pollution, thus posing a serious threat to the health of urban populations and ecosystems, contributing to social inequality and discrimination (Corburn, 2009).

The field of spatial planning has been aiming to adapt cities to the changing environment by drafting policies and making use of the newest technologies, as well as by incorporating and making use of the natural environment in urban areas (Dodman, 2009; Hoornweg, Sugar, & Trejos Gómez, 2011). One of these methods which has proven to be beneficial for human and ecosystem health is the alteration of urban infrastructure – roads, schools, power plants, transportation and communication systems – into green infrastructure. Studies show a relation between green space within cities and healthy urban living, therefore, green infrastructure often consists of the incorporation of urban green space wherever possible (Benedict, & McMahon, 2012). Incorporating more of the natural environment into cities in the form of parks, urban green space or city design features, such as green walls and roofs, has numerous health benefits (Benedict, & McMahon, 2012). Plants help purify air through CO2 absorption, furthermore green space provides natural light, ventilation and views of greenery positively affecting physical and mental health (Jones, 2003).

Green roofs, being one of the examples of green infrastructure, incorporate green space into condensed urban areas which often lack space for parks, gardens etc. Their benefits have been listed as: financial affordability (longer lifespan than ‘grey’ roofs), sustainability, water conservation, local and regional cooling, electricity saving, the provision of habitat for wildlife, carbon absorption and the beautification of urban space (Foster, Lowe, & Winkelman, 2011). With well-planned and well-designed projects, as well as with sufficient financing, green roofs can be amongst the most important contributors to healthy urban living in modern western cities.

## 5.2. Green Infrastructure Planning and Implementation in the EU

Green infrastructure and its potential benefits have been present on the EU environmental agenda since the establishment of the Biodiversity 2020 Strategy in 2011 (EU Biodiversity Strategy, n.d.). The Strategy’s second Target specifically refers to ‘maintaining

and enhancing ecosystems' by establishing green infrastructure in member states (European Commission, 2011; Naumann et al., 2011b). In 2013, the European Commission released a more specific green infrastructure document, the communication of the Green Infrastructure Strategy addressed to other EU institutions. This communication document defined green infrastructure, providing some examples as well as multiple benefits, including those affecting healthy urban living, as well as potential measures of implementation of green infrastructure in member states (European Commission, 2013).

The EU Green Infrastructure Strategy is not legally binding or detailed enough to stand alone as the main framework and guideline for green infrastructure design and implementation in EU member states. Reports on the benefits of green infrastructure as well as additional documents on specific design of green infrastructure are useful, and together create a strong basis for member states to implement green infrastructure into national policies and planning practice. An important aspect of green infrastructure implementation is also the governance of such projects. Ideas, plans, designs, policies and funding for green infrastructure can all come from different levels: the EU, national governments, regional authorities and local stakeholders or other private parties. The roles of these parties are interchangeable, as proven by the two case studies of green roof implementation in Hamburg and Rotterdam. National and regional policies do not always implement EU strategies directly. The knowledge transfer can happen both ways, and EU frameworks are often inspired by local practice, such as successful green roof projects in Basel, Switzerland (Baumann, 2018; Raynal, 2018). Cooperation in this multi-governance scheme is essential – even with plans and projects coming from member-state levels, EU financing is often essential for their realization. Spatial planning, as a theoretical and practical tool, is of great importance on all levels of green infrastructure governance.

Green roofs, a specific type of green infrastructure also mentioned in the EU Strategy, are now being increasingly incorporated into European urban areas. The case studies of Hamburg and Rotterdam show how regional and national policies incorporate green roofs through their promotion and provision of subsidies. The health benefits of green roofs are often underlined as significant in regional plans, however, in the case of Rotterdam they have been of secondary importance, after rain water retention. Despite the fact that healthy urban living is promoted as one of the main benefits of green roofs, most of the projects are too recent (or not even completed) to allow gathering data on their actual impact on the environment and population in the vicinity. A EU report on the effects of green infrastructure in member states, with specific case studies, is due to come out in Fall 2018 and will provide more scientific proof of the effects of green infrastructure (Raynal, 2018). Before that, the findings of previous

research serve as the main source of knowledge and proof of a connection between the incorporation of green space in urban areas and healthy urban living.

In summary, to answer the main research question: *To what extent do EU initiatives, such as the Green Infrastructure Strategy, affect the implementation of green infrastructure, specifically green roofs, in EU member states and contribute to EU's healthy urban living?* the EU guidelines and frameworks do not yet have a significant impact on national and regional policies and practice. Many local initiatives existed before the publication of the EU Green Infrastructure Strategy and now serve as a source of data and inspiration for EU policies. The available EU funding, however, is important, if not essential, for some projects which implement and promote green infrastructure (e.g. green roofs) in European cities. As for their contribution to healthy urban living, this is one of the main goals and benefits of green infrastructure mentioned both by the EU and in national plans. It has been proven that green infrastructure does have positive effects on human and ecosystem health, however, such long-term effects are yet to be measured in specific case studies across the EU.

## 5.3. Discussion

This research has shown an undeniable connection between green infrastructure and a healthy urban living. Due to the modern strive for urban sustainability, the implementation of green infrastructure with the use of new design and technologies is more and more visible across European cities. However, when it comes to the EU initiatives, there still seems to be little connection between the official EU frameworks and national policies. Of course, EU documents and member states' laws oftentimes have similar objectives of biodiversity enhancement and nature conservation, which results in a healthier environment. Nonetheless, many national policies have applied green infrastructure measures of the adaptation to climate change and reduction of greenhouse gas emissions before the publication of official EU goals. The EU Green Infrastructure Strategy does provide important information on potential financing of such projects, yet it cannot enforce projects in member states – the initiatives must come from a local level. Therefore, the promotion of green infrastructure strategies on different levels – amongst governments, local municipalities, but also citizens – is important and, as seen in Basel, can have beneficial effects. Organizing EU conferences and promotional campaigns coupled with more extensive promotion of available funding could increase the number of green infrastructure strategies across member states. Furthermore, future research into specific benefits of green infrastructure on human and ecosystem health could provide

additional data and proof encouraging nations to take action. Many cities in Europe have already developed strategies, such as green roof implementation, and can serve as examples for other urban areas in the EU. An open and accessible transfer of knowledge between all actors of the multi-level governance would be of great benefit for the development of green infrastructure and a resulting healthy urban living in the EU.

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# Appendixes

## Appendix A: Interview Guide for EU Officials

EU GI Strategy & Green Roofs

Semi-Structured Interview Questionnaire

EU Commission + Council staff

1. Can you tell me, in summary, about the EU GI Strategy framework, its aims and objectives?
2. How is this document is perceived by EU officials (is it well known, used as a reference and guideline in decision-making)?
3. In Commission's proposals for the Cohesion Fund and the European Regional Development Fund (ERDF), Green Infrastructure is specifically identified as one of the investment priorities.

- How does this funding work for GI initiatives throughout member states?

4. What is the process of implementation of Green Infrastructure (any kind, maybe focus on the specific example of green roofs) in EU member states (in policies, plans and practice)?
5. How does the Commission promote GI initiatives and solutions throughout member states (campaigns, funds, etc.)?
6. Have GI solutions (green roofs) proven to be beneficial to human and ecosystem health in the surrounding areas?

- If so, how?

7. How is the efficiency and success of GI initiatives measured/tested in member states?
8. Can you refer me to anyone else who works with, around the EU GI Strategy and knows some specific case studies, examples, ways of implementing this framework in national policies and projects?

# Appendix B: Interview Guide for National Government Experts for Green Roofs (example of the Netherlands)

EU GI Strategy & Green Roofs

Semi-Structured Interview Questionnaire

National Policymaker

1. What are, according to your knowledge and opinion, green infrastructure and within this umbrella term, green roofs?
2. What is the role of this organization in relation to green roof promotion, design and implementation in the Netherlands (or specifically Rotterdam)?
3. How are green roofs promoted in the Netherlands (Rotterdam)?
4. What are specific examples of buildings which have implemented green roofs in Rotterdam (private or public ones)?
5. Do EU initiatives, frameworks and promotional tools (e.g. the EU Green Infrastructure Strategy or the Biodiversity 2020 Strategy, specifically Target 2) influence policy making and implementation of green roofs in the Netherlands?

- If so, in what way?

6. Do you receive EU funding for green roof projects (e.g. LIFE NCFF funding)?
7. How do green roofs in the Netherlands (Rotterdam) aim to improve human and ecosystem health, an overall healthy urban living?
8. Have these initiatives been successful in promoting health, and perceived health within Dutch cities?

# Appendix C: Interview Guide for Organizations Implementing Green Roofs

EU GI Strategy & Green Roofs
Semi-Structured Interview Questionnaire
Green Roof Implementing Organization

1. In what does your company specialize?
2. When and how did you start putting green roofs into your services?
3. What was the reason for this?
4. (If there is any knowledge on this subject) Do you work mainly with intensive green roofs (deeper, more plant varieties, more aesthetic, more maintenance) or extensive (shallower, especially bushes, less maintenance, more convenient and environmentally friendly)?
5. With whom do you work in terms of green roof services? (Private companies, individuals, initiatives of the city)?
6. Do you know of any EU frameworks, guidelines for promoting green roofs?
7. Do you work with EU initiatives or funding from EU bodies supporting green roofs?
8. What are the benefits of green roofs?
9. Do green roofs, in any way, affect the physical and mental health of people in and around the building?

- If so, how?

10. Does the green roof affect the environment in any way?

- If so, how?

11. What does healthy urban living mean to you?
12. Do you think this green roof can contribute to a healthy urban life?