



# GREEN INFRASTRUCTURES IN AMSTERDAM

A Case Study on the Governance Challenges of  
Green Infrastructure Implementation



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## Abstract

Over the last few years, urban Green Infrastructures (GIs) have shown promise in improving urban resilience. As a result, GIs have become an essential component of cities' approaches to urban resilience and climate adaptation. However, despite growing interest in the potential of GIs to tackle urban issues and positively contribute to urban resilience, there are limitations and challenges for their implementation and mainstreaming in practice. This study focuses on the governance challenges and limitations of GI implementation in Amsterdam. The aim of this thesis is to examine how much Amsterdam's GI policy has learned from previous governance challenges regarding GI implementation and how they reflect on these challenges in their recent greening strategy. The empirical data collection for this study is undertaken by a combination of semi-structured interviews, observations and qualitative data analysis (policy documents and secondary data). Despite Amsterdam's active promotion of GIs in the past, Amsterdam struggled with many governance challenges of GI implementation prior to the introduction of the Green Vision. Based on how Amsterdam has previously reflected on GI governance challenges in new GI policy, it is reasonable to conclude that Amsterdam has made significant progress in their greening strategy and has learned a lot from previous GI governance challenges. However, future GI policy in Amsterdam could still solve a significant number of governance challenges.

**Key Words:** Urban Green Infrastructures, Urban Resilience, Climate Adaptation, Amsterdam

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## 1. Introduction

*“If we do not take the right decision now and get our feet wet, our feet will get wet...”*

(Interview 6, 2021).

Over the last decades, cities and their inhabitants around the world have become more vulnerable as a consequence of rapid urbanisation combined with climate change impact (Staddon et al., 2017; Zuniga-Teran et al., 2020). With 70% of the world’s population likely to be living in urban areas by 2050 and as climate change impacts threaten urban infrastructures in cities through different internal and external hazards, reducing risks and enhancing urban resilience becomes a priority (Staddon et al., 2017). Hereby, cities are considered not only as key engines for economic growth, but also as a major contributor to environmental problems (Merk, 2012).

The transition to green cities is essential and the most straightforward process in becoming more resilient for urban areas (Merk, 2012). Both citizens and city planners have increasingly promoted greening initiatives as a way to effectively respond to issues of urban liveability, public health and climate change (Goossens & Van Gorp, 2017). Recently, greening initiatives are progressively including both natural and semi-natural solutions, as well as green and blue constructions, and therefore being referred to as Green Infrastructures (GIs): *“The creative combination of natural and artificial (green + grey) structures intended to achieve specific resilience goals (e.g. flood impact mitigation, public health protection and enhancement, etc.) with broad public support and attention to the principles of appropriate technology”* (Staddon et al., 2018, p. 330). Over the last few years, urban GIs are among the most widely applicable, economically viable and effective tools to combat the impact of climate change and help people adapt to the adverse of climate change (Staddon et al., 2017). GIs show promise in enhancing urban resilience, through promoting and enhancing ecosystem services linked to the reduction of flood risks, urban heat islands, energy consumption in buildings, as well as improving air quality, carbon storage and the well-being of urban residents (Zuniga-Teran et al., 2020). Hence, GIs have become a critical part of cities’ approaches towards urban resilience and climate adaptation (Staddon et al., 2017).

However, despite growing interest in the potential of GIs to tackle urban issues and positively contribute to urban resilience, there are limitations and challenges for their implementation and mainstreaming in practice. Evidence suggests that poorly planned GIs can in fact lead to greater social inequality in cities, with people from disadvantaged backgrounds forced to relocate or being otherwise excluded from enjoying the benefits of improved greening initiatives (Staddon et al., 2018; Goossens et al., 2020). Also, GIs can have their limitations regarding physical characteristics of urban areas, or may increase health risks by the spread of diseases (Staddon et al., 2018). So, although GIs provide multiple benefits for urban areas to become more resilient, there is a growing recognition that there are considerable challenges and trade-off’s associated with the implementation of urban GIs (Staddon et al., 2018). This study will contribute to the rising societal issue of how to effectively implement GIs’ by examining several governance challenges and trade-offs.

Furthermore, because there is a gap in existing research on the limitations and challenges of GIs in the Netherlands, this study will have a contribution to academic literature. Several cities in Europe and the United States have recently been subjected to studies into the implications of urban GIs: New York (Curran & Hamilton, 2012), Barcelona (Anguelovski et al., 2018), Ghent (Goossens et al., 2020), Tartu & Faro (De Sousa Silva et al., 2018). For the Netherlands these studies are limited, or in some cases even non-existent. Therefore, this study focusses on the governance challenges and limitations of GI implementation in a Dutch city. Amsterdam recently stated that it desires to make the city significantly greener. More greenery is necessary because it serves as a meeting point, for biodiversity, a healthy living environment, and a more resilient city to global warming (Van Zoelen, 2020). According to former alderman Ivens, “greenery makes people happy” (Van Zoelen, 2020). Amsterdam has published an ambitious policy document regarding the implementation of GIs between 2020 and 2050, to make the city more resilient and liveable for all Amsterdammers (Gemeente Amsterdam; 2020). Amsterdam's ambitions to green the city, combined with the publishing of a new green strategy, inspired this study to select Amsterdam as a case study.

### 1.1 Research questions

This study takes a broader look into the effectiveness of Amsterdam’s urban GI policy. The aim of this thesis is to examine how much Amsterdam's GI policy has learned from previous governance challenges regarding GI implementation and how they reflect on these challenges in their recent greening strategy. The research question in this thesis is as follows: *How does Amsterdam's recent greening strategy learn from previous governance challenges in promoting green infrastructures?*

To answer the research question, this study will analyse several sub-questions. The first sub-question provides an overview on how Amsterdam approached the promotion of GIs throughout the history and what outcomes this has had on their greening strategy. Second, this thesis examines to what extent Amsterdam has experienced any governance challenges regarding the implementation of GI policy in the past. By analysing the governance challenges of GI implementation in the past, this study is able to discuss to what extent these governance challenges are reflected in current GI policy. This will be done in the third sub-question. Finally, this thesis will discuss how Amsterdam could improve its greening strategy and overcome its shortcomings by examining the governance challenges that Amsterdam did not reflect on effectively in new GI policy. The sub-questions are represented below:

- *How does the city of Amsterdam promote Green Infrastructures?*
- *What have been the governance challenges of Green Infrastructure policy until today?*
- *To what extent are these governance challenges reflected in the current Green Infrastructure policy?*
- *How could Amsterdam improve its greening strategy and overcome its shortcomings in promoting Green Infrastructures?*

This thesis is structured as follows. In the Theoretical Framework, a comprehensive literature review will be presented to show what research has been done on urban climate resilience and urban GIs. The third chapter will explain the methodology used during this study in more detail. Subsequently, in the Results and Discussion the empirical findings of this thesis will be presented and the outcomes of the governance challenges of GI implementation will be discussed. Finally, in the Conclusion, the research (sub-) questions will be answered and reflected on. Furthermore, a recommendation on planning practise will be made based on the findings of this study, and a reflection on the limitations of this thesis and suggestions for further research will be done.

## 2. Theoretical framework

This chapter will elaborate on, and stress the relation between, relevant theories and approaches related to this study. First, a general overview on the concept of urban resilience will be given. Second, the concept of urban resilience will be highlighted from the perspective of climate adaptation. Subsequently, the concept of urban Green Infrastructures will be introduced. In this section, the understanding of the GI concept for this study will be emphasized and the origins of the GI concept will be explained. Finally, insights on the role of urban planning in promoting urban GIs will be given. This section will present a framework on the eight governance challenges of GI implementation.

### 2.1 Urban resilience

The notion of resilience is gaining increasing prominence across a diverse set of literatures on cities and climate change (Leichenko, 2011). However, urban resilience is still a highly contested and broad concept. Several authors have described the varied and contradictory definitions of resilience and the absence of a framework for operationalising and measuring the concept (Ahern, 2011; Leichenko, 2011; Tyler & Moench, 2012).

#### 2.1.1 Theoretical debate of resilience: from ecological resilience to resilience in urban planning

A simple understanding of resilience is the ability of a city to absorb or buffer disturbance while remaining functional (Holling, 1973). The concept of resilience is often associated with the ability to learn, primarily in order to become more robust to change (Newman et al., 2009). The issue of change, or disturbance, is a central dimension of resilience, both in terms of resistance to disturbances and recovery from it. Therefore, resilience is related to both preparations to minimise disturbances (mitigation) and actions to deal with disturbances once they have occurred (adaptation) (Lu & Stead, 2013). As such, according to Lu & Stead (2013), resilience represents an on-going process of reshaping, reorganising and developing new adaptive strategies for cities. Similarly to Lu & Stead's (2013) view on urban resilience as a capacity to minimise and deal with disturbances, Huck (2020) understands urban resilience as a bundle of urban capacities in better coping with shocks and stresses. Huck (2020) argues there are three main strains of thought that highlight distinct resilience capacities which are relevant for cities and their infrastructure systems: (1) capacities of a city and urban stakeholders to *resist* shocks and stresses; (2) capacities to *absorb* and *recover* from these shocks; (3) and capacities to *adapt* to changing circumstances and to *transform* by stimulating learning processes over time (Huck, 2020).

Some of the early literature on resilience originates from studies of ecological equilibrium in the 1970s (Lu & Stead, 2013). Most empirical studies of resilience around this time focused on the management of large-scale ecological disturbances that can completely transform an ecological system for a certain period, before gradually restoring its original balance or a new stable state (Lu & Stead, 2013; Taşan-Kok et al., 2013). Timmerman (1981) was one of the first scholars to make the link between resilience of society and climate change (Taşan-Kok et al., 2013). In the 1980's, the increasing frequency of disasters around the world enhanced the necessity of engaging with the resilience concept in social studies. From this point of view, resilience is commonly understood as the capacity of a social system to absorb disturbance and reorganise while retaining the same function, structure, identity and feedbacks (Timmerman, 1981; Taşan-Kok et al., 2013). In the 1990s, the notion of resilience appeared in urban planning for the first time (Miletti, 1999). Urban resilience began to be addressed in urban planning in the search for solutions of how functions under extreme stress in disasters could be maintained in resilient communities and later, resilient cities (Taşan-Kok et al., 2013).

## 2.2 Urban climate resilience

The concept of urban resilience has become increasingly important in facing environmental uncertainties and climate mitigation and adaptation strategies (Lu & Stead, 2013). There is widespread recognition that spatial structure of cities, and the way in which land is developed, has significant implications for both the adaptation of adverse impacts of climate change and the reduction, or mitigation, of emissions that cause the change and damage (Taşan-Kok et al., 2013). Many academics agree that planning should be concerned with both adaptation and mitigation strategies to deal with climate change impacts. However, different preferences can be found in academic literature. Fleisschauer (2008) shows that some academics argue that mitigation is a principle task in planning, by preventing and reducing damage to people, property, and resources before a disaster occurs. Others argue that the key role for urban planning is in promoting adaptation: *“while planning had something to contribute to the mitigation of climate change, the main challenge for planning is to help prepare for the impacts of climate change”* (De Vries, 2006, p.225). Similarly, Biesbroek (2009) sees a prominent role for urban planning in adaptive measures, such as water or green management. Even though adaptation and mitigation strategies are both important for dealing with the impacts of climate change, studies of urban climate resilience often overlook the multidisciplinary and complex nature of the notion of resilience and use the term with limited understanding (Jabareen, 2013).

### 2.2.1 The climate adaptation approach in urban resilience

In the case of urban climate adaptation, an approach based on resilience encourages practitioners and policymakers to consider innovation and change to support recovery from stresses and shocks that may or may not be predictable (Tyler & Moench, 2012). The aim of this adaptive way of resilience-building as a strategic approach is to prepare for climate change events under high uncertainties (Tyler & Moench, 2012). More recently, urban professionals and city leaders are progressively adopting the notion of resilience within this new adaptive approach (Zuniga-Teran et al., 2020). Resilience is increasingly understood as a fundamentally dynamic property of complex socio-technical systems: *“the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience”* (100 Resilient Cities, 2018). This approach of urban resilience in the light of climate adaptation has strong similarities to the three capacities of urban resilience (Huck, 2020), as described in the previous section. First, the capacity of a city to survive shocks is related to the capacity to *resist* shocks and stresses (Huck, 2020). Second, the capacity of a city to adapt to shocks is similar to the capacity to *absorb* and *recover* from these shocks (Huck, 2020). Finally, the capacity of a city to grow no matter what kinds of chronic stresses and shocks they experience is comparable to the capacity to *transform* by stimulating learning processes over time (Huck, 2020).

Since this type of resilience clearly depends on natural and semi-natural solutions, city managers and policymakers need to consider how they may improve resilience through Green Infrastructure's (GIs) that optimize the ecosystem services potentially available to a greater or lesser degree in all cities (Zuniga-Teran et al., 2020). This represents a multistranded and intersectional endeavour that therefore requires interdisciplinary and transdisciplinary approaches (Ahern, 2011; Portman, 2018). In the context of urban climate impacts and vulnerabilities, strengthening resilience therefore constitutes planned adaptation strategies, which reduces the vulnerabilities and risk of increased climate hazards for cities (Staddon et al., 2017). Over the last years, GIs are among the most widely applicable, economically viable and effective tools to combat the impact of climate change and help people adapt to the adverse of climate change. Hence, GIs are becoming a critical part of cities' approaches towards urban resilience and climate adaptation (Staddon et al., 2017).

## 2.3 Urban Green Infrastructures

Though often explored for its contributions to urban aesthetics and public health, urban Green Infrastructures also show promise in enhancing urban resilience, through promoting and enhancing ecosystem services linked to the reduction of flood risks, urban heat islands, and energy consumption in buildings, as well as improving air quality, carbon storage, and the well-being of urban residents (Zuniga-Teran et al., 2020). The notion of GI has evolved extensively since the end of last century. GIs have developed from a number of green space planning activities into a defined and flexible approach of urban planning (Mell, 2017). However, there is still no consensus regarding the concept, principles and implementation measures of GIs among researchers, political actors and practitioners (Monteiro et al., 2020).

This study will merge the definitions from the European Commission (2013) and Staddon et al. (2018) on GI into its own definition, which defines GI as follows: *Green Infrastructure is a strategically planned network of natural and semi-natural (artificial) structures designed and managed to achieve specific resilience goals with broad public support.* Greening initiatives related to this study on GI include trees, forests, parks, rain gardens, green roofs, wetlands, retention ponds (temporary storage), detention basins (permanent storage), rainwater storage tanks, permeable paving, urban farming and other pervious outdoor surface coverings in public and private spaces (Staddon et al., 2018; de Sousa Silva et al., 2018; Goossens et al., 2020).

### 2.3.1 The origins of the Green Infrastructure concept

GI is a term that has received great attention in land conservation, landscape design and land development since the end of last century (Monteiro et al., 2020). Still, there is no clear time and place on the origin of GI components (de Sousa Silva et al., 2018; Grădinaru & Hersperger, 2019). The roots of the idea of a network of multi-functional green and open spaces in planning and nature conservation efforts started in the early 19<sup>th</sup> century (Benedict & McMahon, 2012; Grădinaru & Hersperger, 2019). In the end of 19<sup>th</sup> and early 20<sup>th</sup> century, the landscape architect Frederick Law Olmsted stated that all urban green areas, independent of their characteristics, should provide people with benefits from nature. For this reason, he considered that parks should be connected to each other and to surrounding residential areas (Benedict & McMahon, 2012; De Sousa Silva et al., 2018). The concept of GI is based on this idea, and originated from the early concepts of parkways, greenbelts and garden cities in the UK in the 1850s (Mell, 2017; Grădinaru & Hersperger, 2019; Chatzimentor et al., 2020; Monteiro et al., 2020).

Even though the historical roots of GIs go back to the 19<sup>th</sup> and 20<sup>th</sup> century, the concept of GI is widely considered new (Monteiro et al., 2020). It was the appearance of the 'greenway movement' in the 1990s in North America that the issue of GIs started to gain special attention, not only among urban planners, urbanists and landscape artists, but also among environmental groups, ecologists, and politicians (Mell, 2017; Grădinaru & Hersperger, 2019; Monteiro et al., 2020). Greenways were described as planning tools with the potential to serve both human and nature purposes (Searns, 1995). At that time, greenways started to be seen as an adaptive response to the physical and psychological pressures of urbanisation, along with cultural and social ones (Searns, 1995; Monteiro et al., 2020). Although the greenway movement was starting to spread around the globe, due to different geographical, political and academic systems, different definitions of this concept have risen (Ahern, 2004). In Europe, the term ecological networks was prevalent (Ahern, 2004; Jongman & Pungetti, 2004). A system of nature reserves and their interconnections that make a fragmented natural system

coherent, which is seen as a planning tool that contributed to improving urban aesthetics, as well as cultural identity, to create more sustainable and greener communities (Jongman & Pungetti, 2004; Ignatieva et al., 2011). In fact, the greenway movement contributed widely to the development of ecological networks in Europe and helped to provide inclusive urban GIs, along with greenbelts and green wedges (Ignatieva et al., 2011). However, in 2001 the concept of GI was first introduced in a paper by Benedict and McMahon (2012) as an *“interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations”* (Benedict & McMahon, 2012, p.5). From this point onwards research and practitioner reports started to be populated with the term GI. The initial uptake of GIs, the period of ‘exploration’ (1990s-2005), was seen to be steadily engaging European academics and practitioners (Mell, 2017).



Figure 1: Green Infrastructure in Amsterdam. Source: Own material.



Figure 2: Green Infrastructure in Amsterdam. Source: Own material.



Figure 3: Green Infrastructure in Amsterdam. Source: Own material.



Figure 4: Green Infrastructure in Amsterdam. Source: Own material.



Figure 5: Green Infrastructure in Amsterdam. Source: Own material.

## 2.4 The role of urban planning in promoting Green Infrastructures

In 2002, Sandström (2002) reinforced the idea of Benedict & McMahon (2012), emphasising the multifunctional role of GIs and its importance for urban planning, stating that GIs as a planning instrument was as important as any other technical infrastructure for people's life quality. GIs should, therefore, be seen as essential in every urban area, as opposed to something nice to have, and must be planned, designed and financed like other regular infrastructures (Monteiro et al., 2020).

Following the initial period of the 'exploration' of GIs (1990s-2005), development moved into its second phase, the 'expansion' of GIs (2005-2010) (Mell, 2017). The GI concept has, since its exploration phase, gained attractiveness among researchers, city-planners and decision-makers (Monteiro et al., 2020). This reflected in an increase in the number of academic, government agencies and practitioners working with GIs, and a significant increase in discussions, policy guidance and research projects looking at its benefits (Mell, 2017). This period of GI development saw an increase of GIs in regional development. Practitioner and policy literature developed by governments elaborated on how GIs were being planned through strategic plans, and where investments were taking place at a site, city and sub-regional scale (Mell, 2010). The number of GI strategies increased greatly in the UK and USA (Mell, 2014). Parallel to the discussions in the UK and USA was the rise of other GI examples across Europe, more explorations of GI utility occurred with slightly different approaches and contexts (Mell, 2017). Therefore, this period witnessed the beginnings of a more refined approach to GIs that examined its value as a planning process and was framed using more nuanced interpretations (Mell, 2017). Hence, this approach was more context related and differed from the early phase of GIs, as there was a greater level of consensus among GI advocates regarding its guiding principles (Mell, 2010). The shift towards a more refined approach of GIs in a context related planning process would gain momentum in the third phase of GIs: 'consolidation' (Mell, 2017).

The current phase (2010-onwards) of GI research and its practical connotation in urban planning can be considered as one of 'consolidation', in the sense that we have now established a relatively common consensus relating to what GIs are and how they should be developed (Mell, 2014; Mell, 2017). This has been supported by the continuous growth of specific GI investment strategies, as well as an increasing awareness of its value to a number of thematic planning agendas e.g. adaptation strategies for climate change (Mell, 2017). Therefore, whilst the 'expansion' period looked to assess *how, where* and *why* GIs could be seen as a relevant form of investment, the transition towards 'consolidation' in the last decade aimed to develop a more detailed, grounded and robust evidence base to support this (Mell, 2017). As a result, in 2013, the European Commission presented its GI strategy in order to enhance its implementation and to become an integral part of urban planning development in all its member states (Monteiro et al., 2020). The EU strategy defines GI as "*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*" (European Commission, 2013).

Despite the ecological functions being often the main focus of GI planning, social benefits are also very important criteria in the planning interventions (Monteiro et al., 2020). Recently, GI investments are seen as a more appropriate approach to the delivery of multifunctional landscapes compared to other forms of development and is thus being linked to greener, smarter and more efficient methods of urban development (Hansen & Pauleit, 2014; Mell, 2017). Not only do green spaces allow several recreational activities, which have a positive impact on people's health and well-being, but they also contribute to an increase in the connectivity between urban and rural areas, and, therefore, local

distinctiveness, social inclusion and sense of community (Wright, 2011). Furthermore, GIs can promote economic growth in urban areas, due to a decrease in health expenses, the capacity of attracting skilled workers and tourist, and the increase in property value (Tzoulas et al., 2007; Wright, 2011; Matthews et al., 2015). However, to achieve these multifunctional purposes of GIs, both the quantity and quality of urban green spaces must be addressed in planning processes (Tzoulas et al., 2007). GI principles are in fact underlying grounds that guide and facilitate the planning procedures of GIs in order to ensure that they contribute to a network of quality and functional green spaces, capable of meeting the needs of an urban area, contributing in the best way to its resilience by climate adaptation strategies (Monteiro et al., 2020). Still, further aspects of GI thinking remains crucial to the understanding of its functions, regardless what form of investment GIs take, one must consider it to be context specific (Mell, 2017).

#### 2.4.1 An urban planning perspective on climate resilience

Even though we can identify a consensus of which GI principles are considered to be accepted in each of the major GI planning principles (Mell, 2016), studies on urban climate resilience often overlook the multidisciplinary and complex nature of the notion of resilience and use the term with limited understanding (Jabareen, 2013).

In fact, urban climate resilience and infrastructural networks and services are inherently intertwined and awareness of urban vulnerabilities to technical infrastructure failures has grown steadily during recent years (Graham, 2010; Monstadt & Schmidt, 2019). However, in practice, policymakers and practitioners often interpret urban climate resilience according to their own interests and expertise. This presents difficulties in applying resilience as a new paradigm to planning practices (Lu & Stead, 2013). Additionally, Hommels (2018) shows that linking social and technical aspects of resilience poses major challenges in policymaking and planning practices because different groups of actors dealing with each dimension seldom integrate their work. Nevertheless, the statement below by Coaffee and Lee (2016) is exemplary for a discourse in urban planning literature on the need to modify planning procedures and infrastructural design techniques in order to enhance urban climate resilience:

*“From the perspective of urban and regional planning practice, [...] attaining urban resilience requires an enhancement of planning and designing techniques and the development of new repertoires of ‘doing’ planning in order to make cities and their associated critical infrastructures and communities more resistant and adaptable to a complex combination of endogenous and exogenous climate change shocks and stresses” (Coaffee and Lee, 2016, p. 5–6).*

In line with this, Porter and Davoudi (2012) argue that there is great potential for urban climate resilience by reframing urban planning. A major focus of this view in literature lies either on the inclusion of different sectoral perspectives in the formulation of policy objectives (Hommels, 2018), or on the compatibility of policy objectives across different policy fields (Chmutina et al., 2016). In addition, urban planning literature points to the need for active engagement of diverse actor groups in planning processes (Huck, 2020). This does not mean less governmental involvement in planning and decision-making process. On the contrary, municipal governments often take the lead in institutionalising urban resilience. However, it does mean that (local) governments cannot govern for urban climate resilience by itself, independently from other actors and solely by introducing top-down regulation (Huck, 2020). Bottom-up regulation is needed, this calls for a better cooperation between planners, climate scientists, disaster risk managers, citizens and other relevant actors (Coafee and Clarke, 2015).

#### 2.4.2 The challenges of implementing urban Green infrastructure

Although several studies have pointed out GI planning principles to follow in planning procedures (Mell, 2017), some of those principles are too theoretical and do not entirely capture the execution and implementation of GIs in the practice of urban planning (Monteiro et al., 2020.) Despite growing interest in the potential of GIs to positively contribute to urban resilience (Staddon et al., 2018), climate adaptation and public health (Monteiro et al., 2020), there is growing recognition that there are considerable challenges and trade-offs associated with the implementation of GIs and its outcomes (Staddon et al., 2018). The evidence for the socially positive effects from GIs are still relatively weak. In fact, recent studies show that poorly planned GIs can lead to greater social inequalities (Staddon et al., 2017; Staddon et al., 2018). Nevertheless, cities are increasingly focussing on the effective contribution of GIs to socioeconomic resilience, citizens' empowerment and improving decision-making processes through active engagement of citizens with GIs. Urban resilience is no longer just about GI structures, but also how GIs are implemented, conceived by its citizens and integrated within the socio-political-ecological systems (Staddon et al., 2017).

With these issues in mind, Staddon et al. (2017) explored the lack of knowledge and appreciation of the multidisciplinary challenges of implementing GI approaches to urban resilience around the world. Their analysis indicated that there are five main challenges for the effective implementation of GIs: Operation standards, regulatory, socioeconomic, financeability and innovation challenges (Staddon et al., 2018). These five key challenges are, together with additional academic literature on challenges of GIs, described below:

1. **Operation standards challenges:** The first challenge concerns difficulties concerning clear and applicable operation standards of GIs. The operation standards reflect the significant uncertainty around how to best plan, design, implement, and maintain GIs (Baptiste et al., 2015; Campbell et al., 2016). Standard guidelines that are tailored to local conditions of cities are essential for the successful planning, design, implementation, operation, maintenance, and evaluation of urban GIs (Li et al., 2017). Zuniga-Teran et al (2020) argue that cities must follow a standardized operation process in which they devise their own context-specific technical guidelines based on performance data while considering people's needs and beliefs. However, a range of factors have contributed to a current absence of a globally acknowledged operation standard for GIs (Staddon et al., 2018). A lack of sufficient performance data and operation standards is a major challenge for the widespread implementation of GIs (Baptiste et al., 2015; Campbell et al., 2016). In addition, the inadequate evaluation of GIs and lack of maintenance has caused a negative perception of the usefulness of GIs (Charlesworth et al., 2014). Therefore, there is a need to develop operation standards for GIs that are backed up by empirical evidence (Staddon et al., 2018).
2. **Regulatory challenges:** The second challenge is related to legal frameworks of rules and laws for GIs. Further mainstreaming and implementing of urban GIs face the challenge of finding a suitable regulatory environment (Zuniga-Teran et al., 2020). Legal arrangements need to have clarity in the distribution of responsibilities and the sustained maintenance commitment of GIs in the long term (Gersonius et al., 2016). Still, relatively poor integration of regulatory bodies into a system that fully appreciates the multidimensional benefits of urban GIs remains a key challenge (Kremer et al., 2016). Even though bottom-up approaches may lead to policy and action, top-down regulation is critical for the widespread adoption of GIs in practice (Staddon et al., 2017). A combination of top-down and bottom-up approaches seems to ensure greater

success for coordination of GIs across multiple policy domains and private sectors (Staddon et al., 2018).

3. **Socioeconomic challenges:** The third challenge is associated to the socioeconomic status of residents. Although promoting social equity is present in most resilience initiatives, in practice, it is a different story (Zuniga-Teran et al., 2020). There are many issues related to the tendency for good GIs to be located in richer areas in cities, or to be planned in a non-inclusive way. In most cities, therefore, low-income communities have disproportionately limited access to green space (Hoang & Fenner, 2016). Besides, wealthier areas are usually the first areas to receive the benefits of GIs, while poor areas lag behind (Parr et al., 2016). In GI projects, public participation has been identified as a critical aspect for implementing decisions that could affect urban residents. However, in some cases, people may not associate GIs with climate adaptation (Zuniga-Teran et al., 2020). A study by Derkzen et al. (2017) in Rotterdam shows that residents recognise the impacts of climate change, but do not associate GIs with an adaptation strategy. Nevertheless, people's needs and beliefs in relation to GI benefits need to be considered in any GI project to achieve legitimate adaptation, behavioural change, and public support (Derkzen et al., 2017). Therefore, inclusive public participation of all citizens in public deliberation processes, especially those of minority group, and co-creation of design and implementation processes becomes crucial to successful implementation and critical functioning of GIs—as does the production of appropriate GIs, which should be custom-made to local needs and capacities (Baptiste et al., 2015; Gould and Lewis 2016; Staddon et al. 2017). Although essential for effective GI implementation, public engagement may also be more difficult for low-income residents, who may not have leisure time to participate in community projects. Some people may even have negative views of green interventions, which may hinder GI implementation, particularly on private land (Furlong et al., 2018). Hence, in the promotion of GIs, there needs to be awareness of the local context and a perception of place, as well as socioeconomic factors, when establishing the value of benefits of ecosystem services to citizens (Kremer et al. 2016).
4. **Financeability challenges:** The fourth challenge is related to the costs and finances of GIs. The costs of not investing in resilience initiatives, like GIs, is increasing as climate change unfolds. Cities face significant economic challenges after events caused by climate change because of damage to the urban infrastructure (Zuniga-Teran et al., 2020). Therefore, the benefit of investing in GIs may be an economic incentive for cities (Li et al., 2017). However, it remains unclear how to estimate the costs and benefits of GIs reliably, and how to translate these cost/benefits calculations into financing models (Zuniga-Teran et al., 2020). Over the last years, several studies have found that GIs are actually cheaper than traditionally grey infrastructure (Levy et al., 2014; Tayouga & Gagné, 2015; Li et al., 2017) Although GIs may be cheaper to implement, regulations may offset this economic advantage (Levy et al., 2014). This might hamper the implementation of GIs. On the other hand, fines and economic incentives can help to implement GIs at household levels in cities. Fines for non-compliance of green quality standards or economic incentives from either the government (via subsidies, grants, loans or fees) or the private sector may promote the implementation of GIs (Vogel et al., 2015). Still, there is a challenge in the difficulty to quantify the multi-functionality of GIs (McRae, 2016). It is clear that GIs are a cost-effective solution for the greening of the city, but it is the wide array of ecosystem services that GIs provide that make it challenging to quantify. Therefore, it is critical to consider the benefits in any cost-analysis because they can offset the costs of GIs

(McRae, 2016). However there is not yet a market ready to support the economic valuation of ecosystem services. Empirical studies, data collection and monitoring of GIs are useful, but would require heavy investments from governments (Kremer et al., 2016). The final and perhaps most challenging issue regarding the financeability is the question: who should finance GIs? Because GIs are more effective when they are widely implemented, on public and private land, people's willingness to accept and pay for GIs is crucial (Parr et al., 2016). People are used to governments paying for GI implementation. However, GI projects shift the responsibility from the local government to property owners, which is something many people are not willing to accept since such changes will look like a new tax payment when there is no clear explanation of the underlying rationale (Parr et al., 2016). In addition, maintenance responsibilities and their associated costs, which go way beyond the completion of GIs, further discourages residents from investing in GI projects (Hoang & Fenner, 2016; Furlong et al., 2018). Still, even if the funding for maintenance challenges is addressed, there is a need to find the responsible party and this may require extra funding (Zuniga-Teran et al., 2020).

5. **Innovation challenges:** The final challenge concerns difficulties regarding the innovation of GIs. Resilience can be strengthened by harnessing innovation in infrastructures (ULI, 2018). Since urban GIs are a relatively new concept in terms of its relationship to urban resilience, it is necessary to find innovative mechanisms that combine grey, blue and green infrastructures to provide a wide collection of ecosystem services to urban residents (Zuniga-Teran et al., 2020). Learning from small scale pilot projects is essential for the successful implementation of GIs at a larger scale. It is critical to ensure that lessons from pilot projects are well documented and that these are periodically embedded as part of a standardised process, which is related to the first challenge (Zuniga-Teran et al., 2020). Therefore, the mainstreaming and implementing of GIs within organisations, institutions and governance processes requires significant innovation in frameworks from both top-down as well as bottom-up (Staddon et al., 2018). Besides, the successful implementation of GIs requires the collaboration of scientists, planners, developers and politicians to produce knowledge and power to successfully engage with citizens and stakeholders through extensive deliberative and participatory processes (Tayouga & Gagné, 2016).

Additional to the GI implementation challenges described above, according to scientific literature there are several other urban GI planning principles and approaches which should underpin any adaptive resilience strategy: (1) integration, GI planning must obtain to integrate and coordinate urban green spaces with other urban infrastructures in terms of physical and functional relations; (2) multifunctionality, GI planning should consider and seek to combine ecological, social, economic and cultural functions of green spaces; (3) Connectivity; GI planning must include physical and functional connections between green spaces at different scales and from different perspectives; (4) multi-scale approach, GI planning ought to function at multiple scales in the same. From individual parcels, to community, regional and state levels; (5) multi-object approach, GI planning should include all kinds of urban green and blue spaces, e.g. natural and semi-natural, public and private (Hansen & Pauleit, 2016; Coffey et al., 2020; Vaño et al., 2021). The absence of the GI planning principles above could each hinder the effective implementation of GIs for urban resilience. Therefore, this study considers these GI planning principles as challenges regarding the effective implementation of GIs. In this study, a new framework (table 1) has been formulated regarding the governance challenges of GI implementation. This framework is based on the GI challenges of Hansen & Pauleit (2016), Coffey et al., (2020) and Vaño

et al., (2021), which are combined to the two challenges of Integration and Multifunctionality, the five key GI implementation challenges of Staddon et al. (2017), and additional academic literature. This framework will serve as leading tool for this study on how to measure and quantify the governance challenges of effective GI implementation.

<b>Governance challenges</b>	<b>Features of the governance challenges (how to quantify them)</b>
<b>Integration challenges</b> (Hansen & Pauleit, 2016; Coffey et al., 2020; Vaño et al., 2021)	How to integrate urban green spaces with other urban grey infrastructure in terms of physical and functional GIs relations; How to connect physical and functional green spaces at different city scales to produce GIs.
<b>Multifunctional challenges</b> (Hansen & Pauleit, 2016; Coffey et al., 2020; Zuniga-Teran et al., 2020; Vaño et al., 2021)	How to strive for multifunctional GIs by combining ecological, social, economic and cultural functions of green spaces; How to strive for GI initiatives at multiple scales (individual, community, city, etc.) in the same time; How to include multiple GI objects (natural and semi-natural, public and private, etc.) in the same time.
<b>Operation standards challenges</b> (Charlesworth et al., 2014; Baptiste et al., 2015; Campbell et al., 2016; Li et al., 2017; Staddon et al., 2018; Zuniga-Teran et al., 2020)	How to develop operation standards for GIs that are backed up by empirical evidence; How to develop design guidelines; How to provide maintenance for GIs; How to evaluate the implementation of GIs.
<b>Institutional challenges</b> (Campbell et al., 2016; Dhakal & Chevalier, 2016; Hansen & Pauleit, 2016; Staddon et al., 2018; Coffey et al., 2020; Vaño et al., 2021)	How to deal with the lack of political support of GI projects; How to seek for interdisciplinary collaboration between key agents, disciplines, sectors and knowledge systems across different governance levels; How to include different stakeholders in the process of GI implementation; How to improve the coordination between top-down approaches and bottom-up approaches; How to connect between, and coordinate across, different governance levels; How to connect between, and coordinate across, organisations at the same level of governance; How to implement collaborative governance.

<p><b>Regulatory challenges</b> (Gersonius et al., 2016; Kremer et al., 2016; Staddon et al., 2017; Staddon et al., 2018; Zuniga-Teran et al., 2020)</p>	<p>Which legal mechanisms exist to guide GI intervention projects; How do these legal mechanisms translate into GI practice; What regulatory mechanisms can function as drivers for implementation of GIs; What regulatory mechanisms act as barriers for implementation of GIs.</p>
<p><b>Socioeconomic challenges</b> (Baptiste et al., 2015; Gould &amp; Lewis, 2016; Hansen &amp; Pauleit 2016; Hoang &amp; Fenner, 2016; Kremer et al., 2016; Parr et al., 2016; Derkzene et al., 2017; Staddon et al., 2017; Furlong et al., 2018; Coffey et al., 2020; Zuniga-Teran et al., 2020; Vaño et al., 2021)</p>	<p>How can GIs be inclusive for all citizens; How can underrepresented communities be included in the greening of the city; What challenges do poor neighbourhoods face that can be alleviated through GI projects; How to promote the active participation and citizenship of vulnerable communities in GI intervention projects; How to make sure to meet the local needs and capacities in producing appropriate GIs.</p>
<p><b>Financeability challenges</b> (Levy et al., 2014; Baptiste et al., 2015; Vogel et al., 2015; Hoang &amp; Fenner, 2016; McRae, 2016; Parr et al., 2016; Tayouga &amp; Gagné, 2016; Li et al., 2017; Staddon et al., 2017; Furlong et al., 2018; Zuniga-Teran et al., 2020)</p>	<p>What economic instruments exist for GI implementation; How do these instruments translate into action; How to consider whether the implementation of GIs is cheaper than grey infrastructures; How to quantify the economic benefit of GIs; How to examine the willingness of people, communities and governments to pay for GIs; How to influence the willingness of people to adopt GIs.</p>
<p><b>Innovation challenges</b> (Tayouga &amp; Gagné, 2016; Staddon et al., 2017; Staddon et al., 2018; ULI, 2018; Zuniga-Teran et al., 2020)</p>	<p>What types of innovations exist and can be developed around existing GIs that can guide the future planning of cities; What funding mechanisms can be used for long-term maintenance and for the monitoring of GI benefits and downsides; How wo make sure to keep innovate and collaborate on different stakeholder levels to produce enough knowledge and power; How to scale up small scale pilot projects.</p>

Table 1: Governance challenges of GI implementation.

### 2.4.3 Governing urban Green Infrastructures

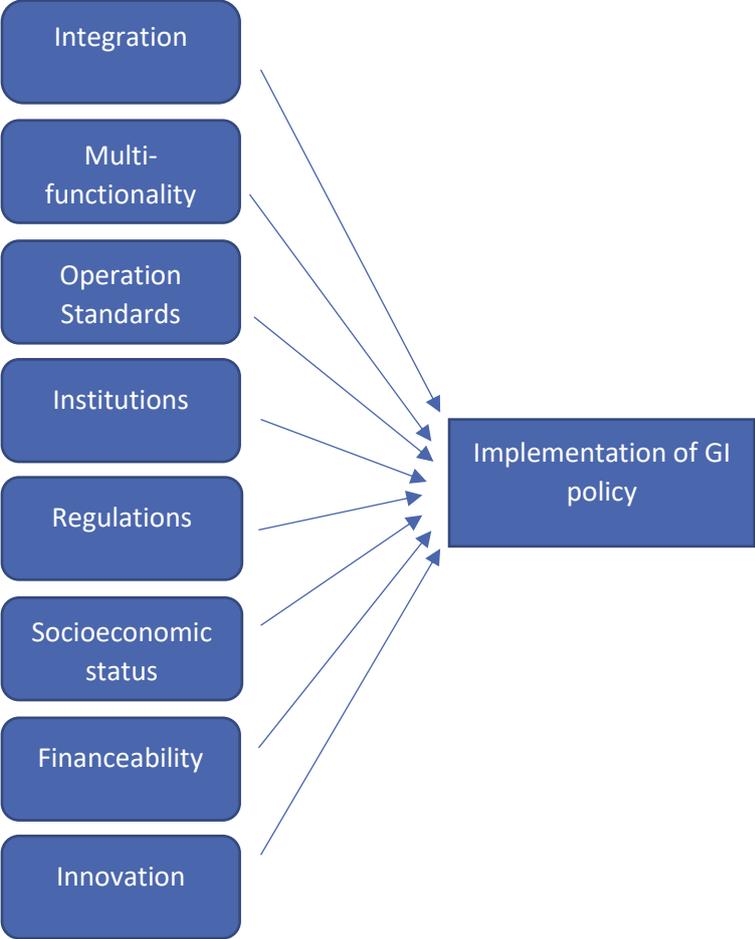
In order for the urban GI planning principles to be implemented in an effective way, a good regulating governance structure on city-level is needed. Governance refers to the structures and processes by which people in society make decisions and share power, within the context of dynamic relations between state, market and civil society actors (Schultz et al., 2015; Coffey et al., 2020). Urban GI initiatives and programs can involve different configurations of state, market and community actors, and may reflect to cooperation, conflict, shared interest and deliberation characteristic of the public (Coffey et al., 2020). As urban GI outcomes have implications at a household, local community, and broader society level, it is important to consider the associated governance structures in relation to those whose interest is being served. Particularly, considering that urban GI initiatives are often faced complexities and implementation challenges (Coffey et al., 2020). Therefore, urban GI governance contexts should include both formal governmental organisations and alliances, as well as diverse informal groups. These informal groups should be operating across different scales, managing natural resources across public, private or diverse land tenures, and including staff of government and non-government organisations, as well as individual community members of governance leaders (Coffey et al., 2020). In academic literature, there are several main approaches addressing urban GI governance principles. These GI governance principles are also related to the GI implementation challenges as discussed in the previous section.

First of all, urban GI governance should be *inclusive* for all citizens, also the ones at risk as a result of a minority group. There should be opportunities available to all citizens to participate in and influence decision-making processes and actions (Hansen & Pauleit, 2016; Staddon et al., 2017; Coffey et al., 2020; Vaño et al., 2021). Besides, urban GI governance stands for communicative and socially inclusive planning and management (Hansen & Pauleit, 2016). The inclusiveness of urban GI governance is strongly related to the socioeconomic challenges of GIs on how to make sure that GIs are inclusive for all citizens and include underrepresented communities in the implementation process of GIs (Zuniga-Teran et al., 2020). Besides, the inclusiveness of urban GI governance is also associated with the institutional challenges of GIs, because of the challenge to include different stakeholders in the implementation process of GIs (Staddon et al., 2018). Second, the *appropriateness* of urban GI governance should be aimed at the local needs and capacities (Staddon et al., 2017). The integration of both the appropriateness and inclusiveness in the implementation of GIs can foster a people-centered resilience approach in urban governance (Staddon et al., 2017). The appropriateness of GI governance is, same as the inclusiveness of GI governance, related to the socioeconomic challenges. However, not for including all citizens in the GI implementation process, but on how to meet and provide the local needs and capacities in producing and implementing appropriate GIs (Kremer et al., 2016; Staddon et al., 2017). Finally, urban GI governance must seek for *interdisciplinarity*. Collaboration between key agents, disciplines, sectors and knowledge systems across different governance levels is crucial for appropriate GIs (Hansen & Pauleit, 2016; Vaño et al., 2021). The interdisciplinarity of GI governance is related to multiple GI implementation challenges. First the operation standards challenge, because of the need to develop operation standards for GIs that are backed up by empirical evidence (Staddon et al., 2018) and interdisciplinary GI governance seeks to collaborate on knowledge systems. Second, institutional challenges, because these challenges are related to interdisciplinary collaboration between different stakeholders at different governance levels (Hansen & Pauleit, 2016; Vaño et al., 2021). Finally, the innovation challenges, since these challenges

are concerning in what way to innovate and collaborate between different stakeholder levels to produce enough knowledge and power for appropriate GIs (Tayouga & Gagné, 2016).

### 2.5 Conceptual Model

The conceptual model for this study is as follows:



The eight governance challenges listed above have a strong influence on the outcomes of how GI policy will be implemented in practice. Therefore the governance challenges are the independent variables and the implementation of GI policy is the dependent variable. By measuring the independent variables (governance challenges), this thesis has examined the independent variable (how well GI policy is implemented).

### 3. Methodology

This chapter will explain the research design and methodology used for the empirical research conducted in this study. First the research design and case selection will be explained and justified. Subsequently, the process of data collection and data analysis will be described. Finally, the limitations of this research methodology will be defined and several ethical considerations will be set out.

#### 3.1 Research design and case selection

The research approach adopted in this thesis can be best described as a multi-methods qualitative research, bringing together in person in-depth interviews, qualitative data analysis and secondary research. Since this study aims to examine how much Amsterdam's GI policy has learned from previous governance challenges regarding GI implementation and how they reflect on these challenges in their recent greening strategy, 'the truth', is constructed as a researcher (Bryman, 2012). Therefore this study has a qualitative research approach. Furthermore, this thesis is an in-depth study on a particular research problem, making this a *case study* (Bryman, 2012). Because the field of research conducted for this thesis focusses on one case, Amsterdam, this is a *single* case study (Bryman, 2012). A significant advantage of a single case study research design, is that a contemporary phenomenon (the 'case' of GIs in Amsterdam) is examined in depth and within its real-world context (Yin, 2014).

This single case study can be considered, moreover, as an *embedded* case study, meaning that it deals with multiple units of analysis at more than one level (Yin, 2014). The main unit of analysis in this study, how Amsterdam has learned from previous challenges of GI policy, has a number of subunits of analysis. These subunits include national and regional GI policy, policymakers, citizens, and rules and regulations regarding GI implementation. Furthermore, this case study can be considered as what Bryman (2012) and Yin (2014) refer to as an *extreme* or *unique* case. In the Netherlands, Amsterdam is one of the largest cities with the highest population, making it one of the most challenging cities to implement an integrated GI policy while also being one of the most ambitious cities to do so. Also, the rare shape of Amsterdam with its green wedges and city lobes, as further explained in the section on Promotion of GIs in Amsterdam (4.3), makes Amsterdam an unique case for GI implementation compared to other Dutch cities. However, compared to other cities in Europe and United States, Amsterdam can be seen as a *representative* or *common* case (Bryman, 2012; Yin, 2014). In the past, there has been several studies on the implications of urban GIs in Europe and United States (Curran & Hamilton, 2012; Anguelovski et al., 2018; De Sousa Silva et al., 2018; Goossens et al., 2020). Therefore, this study can also show important lessons for other cases. Bryman (2012) and Yin (2014) argue that both *extreme* and *representative* cases are relevant for single case study research. Considering this study's case selection, the combination between both types of cases makes the implementation of GIs in Amsterdam especially relevant to analyze. On the one hand, many cities around the world are dealing with the impacts of climate change, and the adoption of GIs is necessary for those cities to enhance their resilience (Staddon et al., 2017). On the other hand, in comparison to other Dutch cities, Amsterdam is a very significant case to analyse.

### 3.2 Data collection and data analysis

This thesis has used several techniques for data collection and is therefore a *multi-method* qualitative research. The different means of data collection is called *triangulation* and understood as a strength of a case study design. The convergence of data from different sources serves as a check to the consistency of the collected data (Bryman, 2012; Yin, 2014). The empirical data collection for this study is undertaken by a combination of semi-structured interviews, observations and qualitative data analysis.

First, observations have been made to gain a sense and image of what kind of GIs there are, and how GIs are used, in Amsterdam. The observations also contributed in the creation of self-made footage of several GIs in the city.

Second, the qualitative data analysis consists of a policy document analysis and a secondary analysis of qualitative data. A secondary analysis on qualitative data has allowed this study to examine other researches' data on GI implementation in Amsterdam. Although the number of studies was limited, some research made a significant contribution to this thesis. The document analysis deals with several national and local policy documents. The municipal policy documents primarily focus on urban greenery in Amsterdam, but also on urban development in general. Table 2 provides an overview of the policy documents examined in this thesis.

<b>Policy document (Dutch)</b>	<b>English translation</b>	<b>Level</b>	<b>Subject</b>
<b>Natuurlijk Verder: Rijksnatuurvisie (2014)</b>	National Vision for Nature	National	GIs
<b>Nederland Natuurpositief (2019)</b>	Netherlands Nature Positive	National	GIs
<b>Programma Natuurontwikkeling (2019)</b>	Agenda Nature Development	Provincial	GIs
<b>Structuurvisie Amsterdam 2040 (2011)</b>	Amsterdam Structural Vision	Municipal	Urban Development
<b>Agenda Groen 2015-2018 (2015)</b>	Green Agenda	Municipal	GIs
<b>Kwaliteitsimpuls Groen (2017)</b>	Quality Impulse Green	Municipal	GIs
<b>Natuurinclusief bouwen en ontwerpen (2018)</b>	Nature-inclusive Constructing and Designing	Municipal	GIs
<b>Groenvisie 2020-2050 (2020)</b>	Green Vision	Municipal	GIs
<b>Handboek Groen (2020)</b>	Green Handbook	Municipal	GIs
<b>Omgevingsvisie Amsterdam 2050 (2021)</b>	Amsterdam Comprehension Vision	Municipal	Urban Development

Table 2: An overview of policy documents analysed in this study.

Finally, semi-structured interviews were conducted with a number of respondents who are all currently or previously involved in the implementation of GIs in Amsterdam. A total of 10 interviews have been conducted. The number of interviews has been determined by the level of saturation (Bryman, 2012). For this thesis, people from various organisations involved in the implementation of GIs were interviewed to present the different aspects of GI implementation in Amsterdam from multiple perspectives. The aim of this sampling strategy was to produce a heterogenous sample of

people working for different organisations. The variety of samples is significant, with respondents working for the municipality of Amsterdam, green network organisations, a consultancy company or the national government. The majority of respondents were selected due to their knowledge and expertise of GI implementation within their own organisation. These respondents were chosen for their contributions to one of the (GI) policy documents, or for an interesting and relevant LinkedIn page. The other respondents were selected via the method of snow-ball sampling, which is proven to promote and stimulate the openness and trustworthiness of the respondents and is therefore a helpful sampling method (Bryman, 2012). All respondents were recruited by an e-mail, which were received via the internet or respondents' colleagues. The outline of the interview (appendix I) and an overview of the respondents and the organisation for which they work (appendix II) are included in the appendix; however, the function of some respondents is not provided because it would reveal who they are within their organisation.

All interviews were open conversations, however semi-structured because of the interview guideline. It is worth mentioning that all of the governance challenges associated with GI implementation, as presented in the framework in table 1, were individually discussed in the interviews. This study has been able to operationalise all GI implementation challenges because all features on how to measure and quantify the challenges of GI implementation were discussed in the interview. As a result, the framework in table 1 not only provides a useful overview of all governance challenges associated with GI implementation, but it also serves as the foundation for this study and shows how this research has quantified and operationalised all the GI implementation challenges specifically.

After all data was collected, the interviews have been transcribed and coded through the program of Atlas.ti. This programme has proved the effectiveness to segment data, assign quotations and associate answers to specific codes. By using *in vivo coding* and *open coding* all interviews were divided and organised into different *codes*, these are presented in appendix III (in Dutch). The codes were created based on the operationalisation of GI challenges (table 1). As a result, the process of analysing data in Atlas has been simplified, better structured and more transparent. This has met the requirements for the *reliability* of this study according to Bryman (2012). Furthermore, to meet the reliability this study has been descriptive on the methods and followed the case study protocol on how to deal with documentation problems discussed by Bryman (2012).

The analysis of data collected for this case study has dealt with inductive, or iterative, reasoning. Through an inductive process of going back and forth in the data, repeatedly associating and breaking down themes and elements, the findings have been structured by the complementation of data collection and data analysis (Bryman, 2012). It is significant to mention that the interviews have been conducted in Dutch, so the respondents' quotations have been translated using general translation standards. The qualitative interviews were a significant addition to the policy documents analysis since they were able to offer a more critical and less redacted version of what has been going on in terms of GI policy implementation in Amsterdam. Also, the interviews have provided an immense amount of information that could not have been provided by policy documents. On the other hand, because a significant part of the policy document analysis has been completed prior to conducting the interviews, the interviews were reinforced as a result of the knowledge gained during the policy analysis (Bowen, 2009). Furthermore, the document analysis has been used to verify several findings conducted from interviews. Therefore, the policy document analysis has been a contribution to the interview analysis as well (Bowen, 2009).

### 3.3 Limitations and ethical considerations

This single case study design faces certain limitations. First, a case study design does not entail *external validity* in the sense that it allows to generalise results of a single case to other comparable cases (Bryman, 2012). Since the aim of this single case study is to properly and comprehensively understand a single case in its real-world context, it is important to consider the fact that other cases have their own real-world contexts. Therefore this study, based on the case of GIs in Amsterdam, cannot be automatically aligned with analysis of other specific case studies. However, it is possible to make an analytical generalisation based on this study, by generalising a particular set of results to some broader theory (Bryman, 2012). So, the case itself cannot be generalised, but the theories and assumptions of this study can be tested with other cases.

Another limitation is related to the process of data collection by interviews. The process of interviewing comes with a number of obstacles (Bowen, 2009) For example, finding agreeable respondents, the extensive and time-consuming preparation and processing of the interviews, and costs of travelling are all proven to be problematic in the process of gathering data through interviewing (Bowen, 2012). However, these obstacles have not been too great for this study. The interviews were all conducted online because of the Covid-19 pandemic, which saved a significant amount of time. Also, as a researcher, I had easy access to this case because I live in Amsterdam and have worked for the Municipality of Amsterdam, thus the process of finding respondents was uncomplicated.

Concerning the ethical consideration of this thesis, all respondents were fully familiarised with the aims of this research by e-mail before being interviewed, and provided their consent. Prior to the interview, respondents were, once more, familiarised with the aim of the interview, informed about the intentions of this interview and asked whether it was possible to record the interview. All respondent have been fully anonymised during the whole process of doing this research. With this in mind, no ethical boundaries have been violated in conducting this research, according to Bryman (2012), because there has been no harm to participants, no lack of informed consent, and no invasion of privacy.

## 4. Results and Discussion

This chapter presents and discusses the findings of this study. To have a better understanding of GI policy in Amsterdam, it is important to understand how these policies are embedded in national or regional policies. Therefore, the first section of this chapter presents the context of green and nature policies of the Dutch government throughout the history. This is followed by a small section on the responsibilities of GIs within the municipality of Amsterdam. The third section gives an overview on how Amsterdam approached the promotion of GIs throughout the history, and what outcomes this have had to the greening strategy of Amsterdam. Finally, the fourth and last part will individually focus on the eight different governance challenges. For each challenge is presented and discussed to what extent Amsterdam has experienced these challenges in previous GI policy; to what extent these challenges are reflected in current GI policy; and, how Amsterdam could improve its greening strategy and overcome its shortcomings in the promotion of GIs.

### 4.1 The context of Green Infrastructures in The Netherlands

Nature and greenery are not restricted by any boundaries. Neither to the city, province or the Netherlands. That is why it is essential to have agreements at the local, national, and international levels in order to successfully address the cross-border aspects of nature and green policy (Provincie Noord-Holland, 2019).

The beginning of an active government role in greenery management started at the end of the nineteenth century, when the government founded State Forest Management (*Staatsbosbeheer*) to stimulate forest planting (Rijksoverheid, 2014). Various regulations and laws relating to the preservation of greenery and nature were established in the decades that followed. Because the demand for nature increased after Second World War, the national government became more involved in greening policy (Rijksoverheid, 2014). During the 1970s, environmental awareness increased in many Western countries, and the significance of a cross-border strategy became increasingly obvious. As a result, a series of agreements that had a significant impact on national green and nature policy were signed. These agreements, in addition to preserving animal and plant species, also intended to preserve habitats and areas (Rijksoverheid, 2014). When nature policy entered a new phase in the 1990s, a new strategy to establish a coherent network of existing and new nature reserves was formed, the Ecological Network (*Ecologische Hoofdstructuur*). The network includes, among others, all *Natura-2000* protected areas. These areas are designated protected nature reserves as part of the European 'nature network' (Rijksoverheid, 2014). At the same time, in both national and international nature and green policy, increased emphasis was placed on a newly introduced concept, biodiversity. With the introduction of various (inter-)national biodiversity agreements, there has been a greater emphasis on socioeconomic growth and inequality in combination with greenery and nature (Rijksoverheid, 2014). The significant importance of biodiversity and ecological values resulted in a widening nature policy. In 2000, the policy document *Nature for people, People for nature* (*Natuur voor mensen, Mensen voor natuur*) was established, with an increased emphasis placed on the experience and use values of greenery. The main thought was nature right outside one's front door (Rijksoverheid, 2014). Also, there were several goals for greenery in the city, such as a better living and working environment and more high-quality greenery. The new policy placed a greater emphasis on nature's contributions to citizens' well-being. However, a study in 2010 concluded that the comprehensive concept of nature had stayed in the background during the implementation of the

Ecological Network. The integration of nature and green policies with housing, business, and infrastructure policies has not yet taken shape (Rijksoverheid, 2014).

As a result, in 2014, the Ministry of Economic Affairs announced the Nature Vision. A national policy document outlining nature and green policy for the coming years, up to 2025, was presented (Rijksoverheid, 2014). The vision's key premise is a shift in thinking: nature belongs in the centre of society. Not just in designated natural areas. It has been clear that greenery in cities is beneficial in a variety of ways. Not only for residents' health and well-being, but also for cooling the city, absorbing water and pollutants, and making the living environment more attractive. Also, green environments are an attractive location for businesses and their employees (Rijksoverheid, 2014). This led to the result that the government is seeking to provide enough space in cities for the welfare qualities of greenery. Although it is primarily the responsibility of municipal and regional governments to deal with urban greenery, the national government has played a stimulating role by promoting the implementation of greenery (Rijksoverheid, 2014), by:

- Introducing a 'nature-inclusive' way of thinking in designing the city and constructing buildings, by promoting green roofs for example.
- Encouraging municipalities and provinces, as well as businesses and social partners, to collaborate on developing green living and working environments.
- Creating green-blue networks connect the city and its surrounding natural areas.
- Promoting the use of greenery by increasing citizens' knowledge and awareness.

With the introduction of a new policy document by the Ministry of Agriculture, Nature and Food Quality in 2019, Netherlands Nature Positive, the government's ambition for urban nature and green will be continuing (Rijksoverheid, 2019). In this policy document, the government aims to: (1) strengthen the agreements on the implementation of green spaces; (2) improve the quality of existing conditions of urban greenery; (3) expand the greening policy of urban development by including biodiversity and natural capital as a fundamental component of the vision of urban and infrastructure development, climate adaptation, and water and green management; (4) connect opportunities and challenges if the government encourages municipalities, provinces, regional water authorities, and social stakeholders to work more closely together (Rijksoverheid, 2019).

However, despite the fact that there is now a robust legal framework and national policy for the protection and implementation of greenery, public support for green policies has historically been weak (Buijs et al., 2012; Rijksoverheid, 2014). Different interests are certain to collide in a small, heavily populated country like the Netherlands, or that in particular cases, the protection regulations create a lot of societal pressure (Rijksoverheid, 2014). Furthermore, because of the strict focus on protection in the field, nature and green policy has taken on a sectoral character. When combined with the technical nature of green policy instruments, this neither contributes to a sustainable approach to nature nor to the effectiveness of green policy (Buijs et al., 2012). As a result, there has been misunderstanding, anger, and resistance, and the implementation of greenery and nature has been seen as a hindrance (Buijs et al., 2012; Rijksoverheid, 2014). In recent years, the governments have absorbed such frictions as far as possible within the legal possibilities and maintaining the core values for greenery. First of all, by involving as many stakeholders as possible in the process. But, more importantly, legal authority over green implementation is preferably assigned to governments that are most suited for this task (Rijksoverheid, 2014). These measure came into effect in 2012, when

numerous tasks related to nature and greenery were shifted to the province in order to bring nature and green policy closer to society. By delegating responsibility for the implementation of nature policy to the regional level, where there is also significant responsibility for the spatial domain, provinces and municipalities were given the opportunity to develop those policy areas in a coherent manner. This provided the opportunity for additional stakeholders and interests to play a role in the development of resilient nature and green implementation (Rijksoverheid, 2014). While provinces are responsible for implementing greenery around metropolitan areas, municipalities are in charge of implementing and maintaining greenery in urban public spaces.

## 4.2 Responsibilities for Green Infrastructures in Amsterdam

The approach in which green policy is implemented in Dutch municipalities differs per municipality. In Amsterdam, the municipal organisation is divided into five clusters, a management and board of directors, and seven City Districts (Bestuur en Organisatie, z.d.). Within the management and board of directors, the implementation of GIs is ultimately the responsibility of two aldermen. The alderman for Public Space and Green (*Openbare Ruimte en Groen*) is responsible for the implementation of greenery in the public space. The alderman for Spatial Development and Sustainability (*Ruimtelijke ontwikkeling en Duurzaamheid*) is responsible for the implementation of main green structures in Amsterdam (Interview 1, 2021). The aldermen, however, are not fully responsible for all GI implementation in Amsterdam (Bestuur en Organisatie, z.d.). The policy, construction and managing of GIs is divided by different clusters and departments within the municipality. Within the cluster of Space and Economy (*Ruimte en Economie*), the department of Space and Sustainability (*Ruimte en Duurzaamheid*) is most involved in the processes of GI implementation. This department, consisting of urban planners, landscape architects, designers, urban ecologists, green coaches and jurists, is accountable for the vision, strategic policy and design concerning GIs (Interview 1, 2021; Bestuur en Organisatie, z.d.). The other department concerned with GIs within the Space and Economy cluster is Traffic and Public Space (*Verkeer en Openbare Ruimte*). This department is responsible for the asset management of GIs (Interview 9, 2021). Furthermore, they are focused on policy implementation, resulting in more operational policy of GIs (Interview 1, 2021). The supervision and maintenance of GIs is provided by the department of City Works (*Stadswerken*) within the cluster of City Management (*Stadsbeheer*) (Interview 1, 2021; Bestuur en Organisatie, z.d.). This department is responsible for the daily maintenance of greenery in public space, but also for the maintenance of main green structures (Interview 9, 2021). Finally, the seven different City Districts are responsible for GIs on neighbourhood level, acting as liaisons between citizens and the government. More on the responsibility and management of GIs from the City Districts will be discussed in the section Institutional Challenges (4.4.4).

### 4.3 Promotion of Green Infrastructures in Amsterdam

Throughout Amsterdam's nearly 750-year history, green and cultural heritage have been strongly intertwined; almost all of the green in the city has been 'developed' as part of urban development projects (Gemeente Amsterdam, 2020). Over time, new sorts of green areas were added, such as public parks and allotment gardens. Its shape and design are strongly influenced by the time period in which it was created. The method it is utilised, as well as the setting in which it is employed, might be quite diverse. Various developments in the urban greenery may be witnessed through time in the history of the city's expansion (Gemeente Amsterdam, 2020).

(1) 17<sup>th</sup> century City-explanation (1585-1860); the famous seventeenth-century canal belt was developed and designed by the well-to-do bourgeoisie. The value of green was already evident throughout the canal belt, as seen by the systematic planting of trees and the greenery maintenance which was done by the city council (Gemeente Amsterdam, 2020; Interview 1, 2021). *"Amsterdam was one of the first cities in Europe to plant trees on the street, not only for the benefit of the wood, but also for the aesthetic reasons. Trees were planted for amusement when the canal belt was created, which was unprecedented"* (Interview 5, 2021).

(2) 19<sup>th</sup> century Ring (1860-1910); rapid population expansion, urbanisation, hygiene and public health were all major concerns in the nineteenth-century. The public greenery comprises of incidental tree plantings in working-class districts and as structural decoration along main roads. Green facilities and walking parks are acknowledged as essential elements of the future expansion areas for all layers of the population. It is a government duty to implement greenery in the city, however implementation is hampered by operations and land costs (Gemeente Amsterdam, 2020).

(3) City belt '20-'40 (1910-1945); in the first half of the twentieth-century, expansion occurred on all sides of the city. The Housing Act and the Health Act of 1901 both support the right to green for all citizens. Street profiles in the early-twentieth-century expansions invariably include tree planting. Many squares, parks and front gardens are included in the new districts (Gemeente Amsterdam, 2020). Views from the US and UK concerning the metropolitan landscape were first introduced in this period, including connections between urban greenery and the landscape immediately around the city, such as parkways, developed in America, and the garden city and greenbelt movements in the UK (Mell 2017; Gemeente Amsterdam, 2020; Monteiro et al., 2020).

(4) General Expansion Plan (1945-1970), from now on referred to as AUP (*Algemeen Uitbereidingsplan*); for the first time, a city-wide green system is established on the basis of statistical research in the AUP of 1934 (figure 6). Inspired by foreign norms, it was determined exactly how much and at what distance neighbourhood, park, school, allotment and sports greenery were required per inhabitant (Gemeente Amsterdam, 2020). The design of residential neighbourhoods was changing: open strips of allotment are replacing closed building blocks, with a gradual transition between the private greenery of the residences and the public greenery of green areas, public gardens and parks. The pervasive neighbourhood greenery connects to the collective and public greenery to form a cohesive network. This results in an explosion of green in the city. It also serves as the foundation of the current main green structure of Amsterdam, from now on referred to as HGS (*Hoofdgroenstructuur*), in which the green wedges project straight into the city (Gemeente Amsterdam, 2020). *"The AUP decided to transform the city into a wedge and lobed city. The reason was that all Amsterdammers had to be in green within 10 to 15 minutes. As a result, the lobes are the*

city's extension, and the wedges are patches of green in between. The pattern is still in use today" (Interview 5, 2021), as seen in figure 7.



Figure 6: AUP in 1934. Source: Stadsarchief Amsterdam.

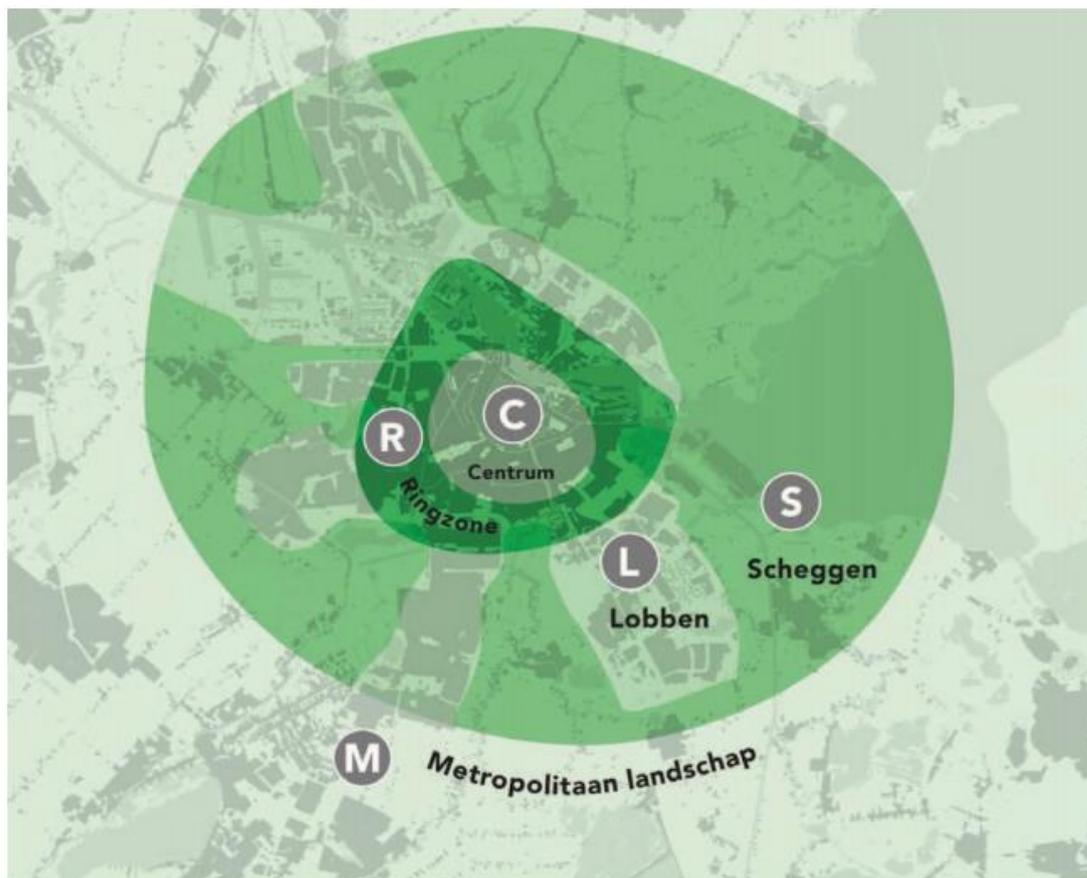


Figure 7: The spatial structure of Amsterdam, with its green wedges (scheggen) and grey lobes (lobben). Source: Green Agenda 2015-2018.

(5) Compact City (1970-1996); in the 1970s and 1980s there is less interest and awareness for urban green. The focus is on urban renewal and the 'compact city', urban development aimed at making the best use of available space in the city. However, the emergence of ecology does result in a different type of greenery management, with a strong emphasis on increasing biodiversity. Nature in Amsterdam is being recognised in and of itself, rather than just as a by-product of human experience. Still, a new vision of greenery in the city did not emerge within this period (Gemeente Amsterdam, 2020).

(6) Densified City (1996-2020); the establishment of the HGS in 1996 represents an acknowledgement of the ecological and cultural-historical values of greenery in Amsterdam (figure 8). The 2011 Amsterdam Structural Vision focuses on the HGS by preserving the city's green wedges and landscape around the city. Besides, new green areas are being developed as part of the city's core Ecological Network, which was formed in 2012. They are widely recognised as ecological linkages that connect the city and countryside (Gemeente Amsterdam, 2020). Both the HGS and Ecological Network were emphasised as key criteria for the development of greenery in Amsterdam (Gemeente Amsterdam, 2011). Various other greening activities were also taken in the Amsterdam Structural Vision in order to ensure the optimum green quality that is appropriate for a densifying city: investing in city parks, promoting the development of roof gardens and the use of green facades, maximising greenery in public space, and, paying more attention to designing with water and green in public space for the purposes of quality of life, water storage, and use (Gemeente Amsterdam, 2011). However, as a successor to the AUP, a city-wide urban vision on the importance of greenery for the city was still lacking.



Figure 8: The HGS of Amsterdam. Source: Green Agenda 2015-2018.

In 2015, Amsterdam's city council launched the Green Agenda 2015-2018. With rising market forces in housing construction, public and private greening is frequently put under strain. In the densely populated city of Amsterdam, more emphasis was being placed on reinforcing existing inner-city green spaces (Gemeente Amsterdam, 2020). Greenery began to appear in a variety of forms, including gardens, roadsides, embankments, parks, and greenery in city streets. City parks are being renovated, and more emphasis is being placed on enhancing the neighbourhoods' greenery through the creation of pocket parks, facade gardens, local vegetable gardens, and green roofs. These types of greenery also demonstrate that residents' involvement in the city's greenery is becoming increasingly important. Furthermore, green is increasingly being recognised as important for water management and as a heat buffer (Gemeente Amsterdam, 2020). The coalition agreement required that the municipality of Amsterdam should make the city a more attractive place to live, work, and visit by significantly greening its public space. Greenery is increasingly considered as a contributor to a pleasant living environment, and it is a significant location factor for people and businesses. As a result, € 20 million has been invested in green projects, which is double the amount invested in previous years (Gemeente Amsterdam, 2015). Addressing the challenges above, Amsterdam's Green Agenda 2015-2018 prioritises four themes with each several ambitious strategies for the accomplishment of strengthening the city's GI:

1. Urban parks: Parks should be better suited to heavy use and wet conditions. Also, the high amount of visitors must be dispersed around the city.
2. Climate and biodiversity: More and better greenery is needed in the city to combat the more extreme rainfall and higher temperatures.
3. Neighbourhood greenery: All citizens should have sufficient green facilities next door and engage in more sports and exercises.
4. Connections and accessibility: The city's existing greenery needs to be better utilised. There should be more routes into and out of green areas.

The successor of the Green Agenda 2015-2018, the Quality Impulse Green, further outlined the implementation approach of the city's GI strategy, additionally considering the pressures entailed by a growing population (Gemeente Amsterdam, 2017; Paulin et al., 2019). In 2019, the municipality of Amsterdam and the National Institute for Public Health and the Environment (RIVM) studied the potential impact of the implementation of green strategies envisioned in the Quality Impulse Green on natural capital and its contributions to human health and well-being. The aim of this study was to generate insights on the value that GIs generate for the city of Amsterdam (Paulin et al., 2019). Initially, the study would contribute to the achievement of GIs envisioned within Amsterdam's Structural Vision (Paulin et al., 2019), however, the study proved to be the motivating factor for the Green Vision (*Groenvisie*) (Interview 7, 2021). *"Our [RIVM] study has had a significant impact. The Green Vision was published by the Municipality of Amsterdam as a result of the study that we conducted. The Green Vision says, to put it succinctly, everything must be green unless there is no other option. And this is a consequence of our research. As a result, there is a much better awareness of the usefulness, necessity, and significance of greenery in Amsterdam"* (Interview 7, 2021).

In December 2020, a new city-wide urban vision on the importance of GIs was published. The Green Vision, which serves as a key element for the Amsterdam Comprehension Vision, portrays Amsterdam as a green city and shows the role of GIs and nature in the city, for now and in the future. The Vision outlines the main goals of what Amsterdam will do to become a more environmentally friendly and

green city between 2020 until 2050. These goals show that the ecological value, the value of climate adaptation and the social value of GIs will receive a lot of attention in the development of greenery in the city (Gemeente Amsterdam, 2020). The publication of a policy document of this size and intended impact, with a vision solely focused on green interventions in Amsterdam, demonstrate the increasing importance of promoting green infrastructures in the municipality of Amsterdam (Interview 4, 2021). *“I think, that if you literally look at the content of the Green Agenda and the new policy of the Green Vision, there are not many significant differences. However, there is a significant difference in the vision behind this new policy”* (Interview 9, 2021). The Green Vision is a vision until 2050, so it focusses on the implications of GIs in the future, while the Green Agenda 2015-2018 is more focussed on practical interventions on short term. As a result, the Green Vision was able to introduce several “revolutionary” greenery principles that will encourage its goals (Interview 10, 2021). *“In comparison to the former green policy, there is a revolutionary change in the Green Vision, which is that there will be a 'green unless' ('Groen tenzij') approach, although this always takes time to be applied in practise. But that is truly a revolution, because with every spatial intervention, the green answer is considered first, so that something can be done with greenery. Only then is the old-fashioned grey solution sought. I am really happy with this transition”* (Interview 2, 2021). Furthermore, in the new vision, urban greenery is seen as a way of life for not only people, but also for animals, plants, and trees. It is unusual that urban greenery will be developed for ecological purposes rather than for the use of citizens (Interview 10, 2021). *“This is part of the Green Visions’ rigorous greening, which is a new greening strategy and policy. Green was more of a decor green until recently. It was nice to plant some trees for decoration when designing the city. With the new vision, we begin the transition to green from start”* (Interview 10, 2021).

Despite the Green Vision's implementation in 2020, not every civil servant has or will instantly implement the new vision for greening the city. Some respondents relate the city's reluctance to green in the past and present to a generation gap (Interview, 2; 4; 6, 2021). However, the same respondents mention that a growing number of citizens and people in the municipality are becoming aware that a green city is inherently linked to a future-proof city (Interview 2; 4; 6 and 9, 2021). *“I got the idea that new generations realise, and are more aware of, the essentials of green in the city. You just feel that older generations are a little bit more reluctant to greening the city, but it is a matter of time. It is heading in the right direction (...) I think the reluctance to greening the city is slowly disappearing, and with that a major challenge is tackled. If you have been designing the city for more than 30 years and you always go with the grey options, and suddenly you have to go for the green option.. That will obviously take some time, but at least we started the transition by developing the Green Vision”* (Interview 2, 2021). So, the Green Vision is also the beginning of a cultural shift that must occur in the coming years. Still, the Vision has only been developed and must now proceed to the implementation and practical phase, this is not yet concrete and will face numerous challenges (Interview 2; 4, 2021).

## 4.4 Governance challenges of Green Infrastructures in Amsterdam

### 4.4.1 Integration challenges

Over the last decade, GI policy did not address the integration of GIs with grey infrastructures as much as it does today. Only a minor emphasis was placed in the Structural Vision on the physical integration of GIs in the city, by promoting the construction of green roofs and façade greening, focusing on greenery in public spaces and its underground growing space, and aiming for water-based design in public spaces (Gemeente Amsterdam, 2011). However, it was not until the Green Agenda in 2015 that the integration of GIs was elevated to a higher priority in green policy. In the Green Agenda, more concrete and ambitious plans on integrating grey infrastructures and GIs were included, namely: adding 50.000 m<sup>2</sup> of green roofs in the city, making more places suitable for rainwater collection, integrating more greenery in public spaces as a strategy for climate adaptation, and promoting nature-inclusive construction (Gemeente Amsterdam, 2015).

Still, previous policy documents such as the Structural Vision and Green Agenda emphasised the integration of GIs with grey infrastructures primarily for climate-adaptive reasons. With the introduction of the Green Vision, the vision on the integration of GIs shifted; the integration of GIs in public and private green spaces were introduced as a goal in and of itself, rather than solely for climate-adaptive purposes (Gemeente Amsterdam, 2020). *“As a result of the new policy, grey infrastructures are gradually becoming greener. Agenda Green provided the impetus for us to integrate more and more greenery with grey infrastructures. However, this has been made more concrete in the Green Vision”* (Interview 5, 2021). In the Green Vision, two groundbreaking initiatives were introduced that must stimulate the integration of GIs with grey infrastructures in the coming years. First, prioritising nature-inclusive construction for the renovation, transformation and new construction of buildings (Gemeente Amsterdam, 2020). Nature-inclusive construction ensures a healthy, future-proof living environment for both humans and animals by integrating GIs with grey infrastructures (Gemeente Amsterdam, 2018). In 2018, a handbook (Nature-inclusive Constructing and Designing) was introduced to compile ideas for the design and construction of nature-inclusive public space and buildings (Gemeente Amsterdam, 2018; Interview 5, 2021). This handbook emerged from an inventory on nature-inclusive construction in the 2015 Green Agenda, and it was first presented in GI policy by evolving in the Green Vision in 2020 (Interview 5, 2021). A second initiative from the Green Vision is the ‘Green unless’ approach; as a result of the new greening policy, public space is perceived as something that should be standardised as green. In previous greening policy, public space was often viewed as a paved grey space to which greenery was added if it fit (Gemeente Amsterdam, 2020; Interview 10, 2021). *“For a long time, greenery was at the bottom of the ladder”* (Interview 1, 2021). When constructing or redesigning public spaces in the future, the city will prioritise nature-inclusive banks, quays, verges, parks, forest, woodlands, grasslands, public gardens, streets and squares (Gemeente Amsterdam, 2020). This revolutionary shift in policy affects more than just the vision of greening the city. It also has an effect on the awareness of stakeholders who have never previously been involved in the greening process (Interview, 2; 9, 2021). *“With the ‘Green unless’ approach, we truly have something in our hands that allows other parties, who would otherwise never consider greening, to think along with us at the start of the process. We [pro-green] think along with the process from the start, and not at the end anymore, when there is often no more budget or no more room for greenery”* (Interview 9, 2021).

Nonetheless, despite the good intentions of the new greening policy to integrate GIs in the city with other grey infrastructures, it remains a challenge to achieve this integration in the public space due to

the city's underground infrastructure (Hennen & Mattijssen, 2018; Interview 2; 4; 9 and 7, 2021). *“The issue in public space is that there are a lot of wires and pipes in the underground infrastructure, also called the ‘Spaghetti Monster.’ As a result, there is no longer any space for GIs to be implemented “* (Interview 2, 2021). The green vision emphasises the need for more research into the requirements of integrating GIs with underground infrastructure (Gemeente Amsterdam, 2020), however, this subject will need to be given more priority in future green policies.

#### 4.4.2 Multifunctional challenges

Throughout Amsterdam's history, the multifunctionality of GIs has always been considered as important in the city's greening policy (Interview 5, 2021). To what extent Amsterdam has faced challenges related to the multifunctionality of GIs is determined by the principles of multifunctionality and the period in which the policy was implemented.

Amsterdam's greening policy has been recognising the multiple functions of greenery in the city for a long time and this is visible in various policy documents. In the Structural Vision, for example, the functions of GIs for cemeteries, sport parks and allotment gardens were prioritised (Gemeente Amsterdam, 2011). The Green Agenda elaborated on this, but also focused on multiple functions of neighbourhood's greenery (Gemeente Amsterdam, 2015). Despite this multifunctional vision of GIs, Amsterdam for a long time focused solely on the functions of GIs, rather than the multiple values of GIs, resulting in limited mixed functions of GIs at the same time (Interview 1, 2021). The Green Vision is trying to change this in the future by aiming for mixed values of GIs at the same time. *“With the introduction of the Green Vision, the ‘value approach’ of GIs has grown enormously. We used to have a ‘functional approach’ of GIs, which means that green had a specific function and we were trying to add as much different functions of green to the city as possible. However, now we let go of that mindset and attempt to look at the values of GIs, which is central in the Green Vision. By doing that, we try to combine as much values and functions of GIs at the same time from the start of the process. So, different values of GIs are already incorporated from the design phase”* (Interview 1, 2021). According to most respondents, Amsterdam is already progressing by combining the ecological, climate, cultural and social values of GIs in forms of local vegetable gardens, green recreation areas and ecological 'silence' zones (Interview 2; 3; 4; 5; 8 and 9, 2021).

Greening policy has also recognised the multiple scales of GIs for a long time now. The 1934 AUP formed the basis for a city-wide green system that encompassed multiple city scales. The 1996 HGS, which was included in the 2011 Structural Vision, is a legally-established vision that demonstrates which green areas are valuable for the city and its immediate surroundings in order to form a connected structure that covers different scales (Gemeente Amsterdam 2011; 2020). Various evaluations demonstrate that the HGS has done a good job in recent years (Gemeente Amsterdam, 2021). However, the HGS, as it was included in the Structural Vision, was not as effective for connecting multiple scales as had been hoped (Interview 1 and 8, 2021). Especially on neighbourhood level, the connection of greenery with higher city levels was missing. *“I have never heard a municipality official say, ‘If we are working on a project, we can immediately take this square or that street to implement green infrastructures.’ That is something I have never heard of. I am aware that the new Vision at city level includes a network of greenery, but at the neighbourhood level, this is lacking. Green interventions have been primarily recreational greenery”* (Interview 8, 2021). As a result, the HGS has been revised, and an updated vision of the HGS is incorporated in the Comprehension Vision (Gemeente Amsterdam, 2020; 2021). There are two major changes in the 'new' HGS compared to the HGS from

the Structural Vision; it will be a green-blue network rather than just a green network, and, the HGS will be more dynamic (Gemeente Amsterdam, 2021). *“The previous HGS was primarily focused on the protection of GIs. In the new vision, we want to allow the HGS to grow parallel with the city. That means that the HGS should be able to adjust itself. So, yes, the HGS should be protected and stay green, however, it should be possible to accept other functions in the HGS as well. We want to develop the HGS in a more active way, and previously the development of the HGS was quite defensive”* (Interview 1, 2021). Furthermore, the HGS will incorporate various greening structures such as the Ecological Network, the Main Tree Structure, the Green Bike Network, and the Green Street Map wherever possible (Gemeente Amsterdam, 2020). These revisions are all part of the so-called ‘HGS 2.0’, which demonstrates the progressiveness of new policy toward the implementation of GIs on multiple city scales at the same time to increase its multifunctionality (Interview 5, 2021).

#### 4.4.3 Operation standards challenges

Only in recent years operation standards have expanded significantly in Amsterdam’s greening policy, with new standards relating to the guidelines of implementation, maintenance, and evaluation of GIs. Over the last 10-15 years, there was no clear guideline for the operation standards of GIs in green policy yet (Interview 2; 5; 8 and 9, 2021). In 2018, the Green Puccini method was introduced. For the first time, a policy document focusing primarily on the guidelines for the qualitative design and management of GIs was developed (Gemeente Amsterdam, 2020b). Following that principle, the Green Handbook of 2020 elaborated on the Green Puccini method and improved the concept. The Green Handbook integrates GI policy ideas and standards into planting, technical details, regulations, design, properties, and examples of how to use them in the best way possible (Gemeente Amsterdam, 2020b). Also, in the 2020 Green Vision several greening standards are introduced like the nature-inclusive construction, as discussed in the section on Integration challenges (4.4.1), and the Green standard (Interview 1 and 5, 2021). The Green Standard is a set of standards that defines how much green space must exist in a neighbourhood in order for it to be liveable (Gemeente Amsterdam, 2020; Interview 5, 2021). However, even though Amsterdam recently introduced several operation standards in its GI policy, these standards are rarely followed yet, and it will most likely take a long time for the standards to become fully embedded in policy. *“Although there is a Green standard and a Green Handbook, no one is currently maintaining them. So, I believe we should revisit the green standard and make it clear to all parties that these standards must be based on actual facts. Because at the moment, we just don’t have a good system to implement and maintain these operation standards”* (Interview 10, 2021). To strengthen its GI policy in the future, Amsterdam must provide sufficient performance data and empirical evidence to its operation standards, as stated by the studies of Baptiste et al. (2015), Campbell et al. (2016), and Staddon et al. (2018).

The maintenance of GIs has also only recently received a lot of policy attention. For a long period of time, the maintenance of greenery has been challenging due to the various structures within the municipality (Interview 4, 2021). As mentioned in the section on Responsibilities for GIs in Amsterdam (4.3), within the governmental structures of Amsterdam, different departments are responsible for various parts of GI implementation. However, this has caused some difficulties with GI maintenance due to a lack of knowledge across different departments on how to manage and maintain GIs (Interview 4, 2021). Furthermore, in the past, there has frequently been a lack of money for the maintenance of GIs. *“As a result, the green solution is frequently unpayable because management and maintenance of green are not refundable. So, it is actually critical that more money is invested in the management and maintenance of GIs, but that is a less ‘catchy’ theme for managers to invest in”*

(Interview 2, 2021). The management of GIs was initially addressed in the 2015 Green Agenda, but it was not until the Green Vision that the maintenance of GIs became a sufficient part of the greening policy (Gemeente Amsterdam, 2015; 2020). *“Especially the maintenance of GIs managed by the municipality, the HGS and other big green structures like parks, has been improved last years,”* (Interview 8, 2021). Still, same as for the operation standards of GIs, the new policy is not always implemented in practise yet (Interview 5, 2021). The evaluation of GIs in particular, is lacking and producing additional maintenance issues. *“Recently, GIs maintenance has been making a lot of progression. However, evaluating and monitoring the GIs in order to make progress in maintenance is still not our greatest strength”* (Interview 1, 2021). Even though new GI policy introduced several standards for GIs, these standards have not been implemented, monitored and evaluated on a structural level so far (Interview 1; 8 and 9, 2021). The Green Vision aims to improve GI maintenance and evaluation (Gemeente Amsterdam, 2020), indicating a promising approach for these underappreciated aspects of GI implementation. However, as mentioned by Charlesworth et al. (2014), inadequate evaluation and lack of maintenance is causing a negative perception of the usefulness of GIs; therefore, in future greening policy, GI maintenance and evaluation should become a more promising aspect on the greening agenda and more structural funds should be invested.

#### 4.4.4 Institutional challenges

In Amsterdam, the implementation of GIs is coordinated through several governance structures at various levels, both by governmental institutions and in cooperation with other stakeholders. As mentioned in the section on Responsibilities for GIs in Amsterdam (4.3), the policy, construction and management of GIs is divided by different clusters and departments within the municipality. The coordination of GI implementation between different governance levels within the municipality has caused some difficulties in the past (Interview 1; 2; 5; 8; 9 and 10, 2021). According to a number of respondents, the communication and cooperation across different departments within the municipality has been lacking in recent years (Interview 2; 5; 8; 9 and 10, 2021). *“The municipality has a lot of knowledge on GIs, but not all departments communicate effectively or collaborate enough. For instance, not every department is informed of what is happening in the Green Vision”* (Interview 2, 2021). Furthermore, a lack of communication and coordination among municipal departments has resulted in a decline of green space during the last decade (Interview 8, 2021). Recently, a study by Giezen et al. (2018) revealed conflicting policy goals in Amsterdam between policy to densify the city on the one hand and goals of protecting and improving urban green space on the other. The results show a decrease of green space and an increase in the built-up ‘grey’ environment between 2003 and 2016 (Giezen et al., 2018). The results illustrate that the urban green space policies of the municipality appear insufficient to mitigate the negative outcomes of the city’s densification on urban green space (Giezen et al., 2018). According to several respondents, this is also a consequence of the differences in interests that exist between municipal departments, where the importance of green is frequently overlooked (Interview 5; 9; 8 and 10, 2021). *“When considerations are made, you can see that green frequently ends up at the bottom of the ladder. GIs are simply not a priority right now. There is no money, and houses are valued more important than trees. All those different departments, with each different stakes, try to push GIs through that...”* (Interview 10, 2021). Aside from the fact that a lack of coordination between different departments has hindered GI implementation, cooperation between City Districts (*Stadsdelen*) has also been inefficient over recent years (Interview 1; 2; 4; 6 and 9, 2021). The municipality of Amsterdam has been restructured since January 2015. The majority of the responsibilities of City Districts have been delegated to municipal policy (Gemeente Amsterdam,

2015). Ever since, City Districts have become more responsible for GIs on neighbourhood level, acting as liaisons between citizens and the government: *“They are the eyes and ears of the municipality”* (Interview 1, 2021). However, the rules and regulations for neighbourhood GIs to be implemented in one City District differ from other City Districts. According to several respondents, this has hampered the implementation of GIs on local level and also made implementing a unified GI policy on a city-wide scale for neighbourhood initiatives difficult (Interview 1; 2; 4; 6 and 9, 2021). Therefore, to improve the coordination and cooperation within the municipal organisation, Amsterdam should aim to implement a more comprehensive and unambiguous greening policy in the upcoming years (Interview 2, 2021). Besides, Amsterdam’s greening strategy should be consolidating the city’s responsibility for GI implementation under one alderman rather than two (Interview 5, 2021).

However, the municipality has recently made progress in terms of coordination and cooperation across departments and City Districts at the governmental level (Interview 1, 2021). For example, by developing an e-learning module, which is an easy accessible way to include all civil servants from different departments in the city’s greening process (Interview 2, 2021). Moreover, new policy in the 2020 Green Vision emphasises explicit collaborations on the policy, construction, and management of GI implementation between both departments within the municipality, as well as stakeholders outside municipal structures (Gemeente Amsterdam, 2020).

Nevertheless, collaboration and coordination within the municipality is still experiencing many challenges regarding the responsibility and management of GIs. According to a number of respondents, the municipality’s complex structure not only result in poor coordination between departments and City Districts, but also in a lack of clarity about who is accountable for managing and implementing GIs throughout the city (Interview 2; 4; 5; 9 and 10, 2021). Agreements between municipalities and residents, in particular, on the management and responsibility of GIs in both public and private spaces, cause uncertainty. (Interview 4; 5; 9 and 10) . *“The relationship between residents and the municipality, i.e. to what extent should residents manage their own green spaces and when green contracts will be signed. Then you suggest new management methods, which creates plenty of questions. (...) From a legal standpoint, you cannot place responsibility for GI implementation in public spaces with residents; the municipality is in charge of it. However, that does not mean that we cannot learn from new norms and look for ways to collaborate in order to create a strong local network of residents who manage the neighbourhood’s greenery. So, there is still a lot of room for improvement in terms of green management in both public and private spaces”* (Interview 4, 2021). The Green Vision will focus on assisting residents, businesses and green organisations in implementing green initiatives and managing green spaces in the future years (Gemeente Amsterdam, 2020). Also in previous years, there has already been good collaboration and coordination between the municipality and stakeholders outside of governmental organisations: *“What I have seen so far, is that top-down policy is absolutely necessary. But at the same time, bottom-up movements are essential for the creativity and ideas of GI implementation as well. In Amsterdam, the coordination of these two structures is very strong”* (Interview 8, 2021). According to Staddon et al. (2018) a combination of top-down and bottom-up approaches ensure greater success for coordination of GIs across multiple policy domains. Residents’ active participation in the greening process of Amsterdam has been a main pillar for many years and has been well organised within previous policies (Interview 1; 2; 5 and 8, 2021); in fact, this has only improved in recent years with the introduction of new participation methods (Interview 1 and 9, 2021).

Furthermore, there are numerous public-private collaborations in Amsterdam between municipalities and other stakeholders on which GIs rely (Interview, 2; 4; 5; 6; 8; 9 and 10, 2021). Housing corporations, real estate companies, green organisations, and private investors are all heavily involved in GI policy, particularly in the 2020 Green Vision (Gemeente Amsterdam, 2020; Interview 8, 2021). There is a Groen Platform Amsterdam (GPA), for example, which is an autonomous cooperation of (urban and local) green organisations, initiators, entrepreneurs, and residents' groups. The GPA's goal is to share knowledge and insights, hence increasing societal involvement in greenery in Amsterdam (Hennen & Mattijssen, 2020; Interview 2 and 9, 2021). Despite the support for public-private partnerships in Amsterdam's greening process, there are still stakeholders, particularly green organisations, who would like to have a greater influence on green policy (Interview 4 and 6; 2021). *“When it comes to greening policy, we would like to have a greater say. We do participate, but primarily as a result of our own initiative. If I were the municipality, I would make a greater effort to seek advice from us [Rooftop Revolution] and other green organisations on how to best use GIs”* (Interview 6, 2021). Therefore, in future GI policy, the municipality should be more proactive in involving green organisations.

#### 4.4.5 Regulatory challenges

Throughout history, there has been a strong emphasis on the preservation and protection of greenery in Amsterdam, which has been a driving force behind the implementation of GIs (Interview 1 and 5, 2021). Historically, Amsterdam contains a lot of protected monumental vegetation, like the UNESCO World Heritage Canal belt. Still, over the last 10 to 20 years, the number of policy frameworks and legislative regulations to protect and preserve green spaces has expanded significantly (Interview 5, 2021). The introduction of policy and regulatory frameworks like the HGS, Amsterdam Rainproof and the Green Handbook, have been driving forces for the development of GIs (Gemeente Amsterdam, 2015; 2020; Interview 1 and 5, 2021).

However, the rules for the implementation of GIs have tightened with the introduction of new policy frameworks; in fact, implementing neighbourhood greenery in particular was easier a few years ago than it is today (Interview 8, 2021). *“The new policy frameworks have led to a significant amount of uniformity in Amsterdam. For example, Handbook Puccini and the HGS have established a kind of norm that prevents you from simply developing green. So there are a lot of complexities in the agreements we have formed. When it comes to implementing green, the rules actually work against us..”* (Interview 10, 2021). Furthermore, increased safety norms and standards have proven to be a barrier for GI implementation. The main reason for this is a lack of space caused by the underground infrastructure, as mentioned in the section on Integration challenges (4.4.1), which creates a barrier to the implementation of GIs (Hennen & Mattijssen, 2018; Interview 2; 4; 7 and 9, 2021). The 2015 Green Agenda established the foundation for new GIs policies to effectively handle norms and procedures. The municipality intended to compile a list of regulations that operated as barriers to GI implementation and remove them when possible (Gemeente Amsterdam, 2015). Nonetheless, according to respondents there are numerous opportunities for current GI policy to ease regulations. It is possible, for example, to create rules that will accelerate the greening process (Interview 1, 2021). Also, it is essential to create rules, besides subsidies, that stimulate and encourage the implementation of GIs: *“It would be fantastic if there was some sort of incentive regulation that allowed people to instal greenery when they wanted to invest in their roof. Roof terraces are usually categorically rejected at the moment, despite the possibility of using the roof for greenery. If people want a roof terrace, for example, they should be required to integrate greenery. If they do not obtain that space, however, the*

*incentive to grow greenery is significantly reduced”* (Interview 6, 2021). So, future GI policy should aim to introduce new regulations that support and promote GI implementation.

#### 4.4.6 Socioeconomic challenges

The city of Amsterdam's inclusive character is under attack. The city's growth has a downside: it is becoming less inclusive, and citizens with low socioeconomic status are suffering as a result (Gemeente Amsterdam, 2021). This has spatial consequences for GIs in Amsterdam. As a result, the inclusiveness of GIs has been pushed to a much higher priority in recent GI policy (Interview 1; 5; 8 and 9, 2021). Inclusion of GIs has already been a priority in previous greening strategies; however, current policies, like the Green Vision, apply new innovative participatory methods to make GIs even more inclusive (Interview 5 and 9, 2021). For example, certain minority groups, who are normally not as involved as other groups of people, are becoming more involved in greening initiatives by multimedia methods rather than only through participation evenings (Interview 9, 2021). Also, the number of neighbourhood green coaches and area managers, who operate as a connection between the municipality and residents, has increased (Interview 5 and 9, 2021). Furthermore, the new greening policy places more emphasis on local needs and capacities in the implementation of GIs (Interview 2; 3 and 10, 2021). *“It is important to be aware of the social issues affecting the neighbourhood. Residents with a low socioeconomic status who live in a poorer neighbourhood are less likely to invest in GIs. So, it is important to approach those neighbourhoods from a different perspective to actively involve these residents in the greening process as well”* (Interview 2, 2021). Most respondents agree that the municipality should be responsible for the inclusiveness of residents with a low socioeconomic status (Interview 1; 2; 3; 4; 6 and 10, 2021). The municipality has recently started exploring various funding options, such as those provided by a housing corporations, in order to implement GIs in low-income areas and include underrepresented communities in the greening of the city (Interview 4, 2021). Resilio is one of these projects, which introduces the construction of GIs on the roofs of housing corporations in particular (Interview 6, 2021). *“As a result of initiatives like these, residents who do not have any money or control are involved in greening the city* (Interview 6, 2021).

However, a number of respondents mention that despite having a progressive greening policy towards inclusiveness of all residents, in practise, the policy's outcomes are not always accomplished (Interview 1; 2; 4 and 8, 2021). *“We have been primarily focused on providing more opportunities for people and businesses to develop greenery. However, we are less concerned with how to ensure that greenery is not only accessible to everybody, but also satisfies everyone's needs. That, in my opinion, is a huge challenge for coming years. Because, at the moment, the people involved in greening the city are far too often the same: well-educated, elderly, white residents. This is not a bad thing, but it is the responsibility of the municipality to ensure that the voices of those who are underrepresented are heard”* (Interview 1, 2021). Most residents with a low socioeconomic status do not have the time, money or capacity to get involved in the greening process (Interview 8, 2021). According to Furlong et al. (2018), a lack of participation by minority groups may hinder GI implementation. So, despite the inclusive intentions of Amsterdam's GI policy, there are still far too little people from lower socioeconomic backgrounds involved in the greening process (Interview 1; 2; 4 and 8, 2021). As a result, in the coming years, the municipality should place a greater emphasis on including underrepresented residents in the greening process.

#### 4.4.7 Financeability challenges

Amsterdam has always been, and continues to be, reliant on government funding for the investment of GIs (Interview 1, 2021). For a long time, green investments depended only on the funds made available per coalition agreement, which was strongly influenced by the board's vision on greenery (Interview 2 and 8, 2021). The number of options for funding GI implementation has grown over the last decade; for example, under the 2015 Green Agenda's policy, the coalition agreement has made 20 million euro available to invest in GIs (Gemeente Amsterdam, 2015). The municipality has also made more funds available for subsidies, for both private investors and residents, as well as green network organisations (Interview 2 and 3, 2021). More recently, alternative ways of investing in GIs have been introduced; taxes for green investments, for example, can now be deducted by companies (Interview 2 and 6, 2021). As a result, budgetary concerns for GIs are becoming less of an issue than they once were, both for neighbourhood initiatives (Interview 8, 2021) and for city-wide programmes (Interview 2, 2021).

However, many respondents still perceive that government funding is insufficiently structured, which hinders the implementation of GIs (Interview 1; 2; 8 and 9, 2021). *"There have been a lot of investments in GIs recently, so the funding is not a major problem. However, the government funding is often inconsistent. Transforming investment funds to something structural is still challenging"* (Interview 2, 2021). Management and maintenance of GIs, in particular, do not yet get sufficient funding on a structural basis (Interview 1; 2 and 9, 2021), as discussed in the section on Operation Standards challenges. This has caused several issues with the practical implementation of GIs (Interview 2, 2021). As a result, the Green Vision seeks for more structural funding for GIs, particularly for management and maintenance of greenery (Gemeente Amsterdam, 2020).

Furthermore, the number of private investors in GIs have been insufficient in recent years (Interview 10, 2021). This has partly to do with the inconsistent funding, but also because the financial benefits of GIs are insignificant (Interview 6 and 9, 2021). For this reason, many respondents agree that it is important to have a tool to quantify the economic benefits of GIs, unfortunately this does not exist yet (Interview 3; 6; 8; 9 and 10, 2021). *"If the benefits of greenery, i.e. biodiversity, health, and so on, can be represented in financial terms, they will receive much more attention and will be much better substantiated, which will support in GI decision-making"* (Interview 7, 2021). However, there are two recent studies that have quantified the (economic) benefits of GIs for residents in Amsterdam. The first study, by Bos and Vogelzang (2018), shows it is possible to quantify the value of GIs in financial terms. Another study, by Paulin et al. (2019), quantified the benefits that GIs generate for human health and well-being, as well as for mitigating the impacts of climate change. The study indicates that the benefits of GIs in Amsterdam are considerable, between 1 and 5 euro per m<sup>2</sup> additional green per year (Paulin et al., 2019). However, despite these studies, no definitive tool that permanently quantifies the economic benefits of GI has been developed. In new greening policy, more emphasis is placed on research to get private parties and stakeholders more financially involved in the implementation of GIs (Gemeente Amsterdam, 2020). Nonetheless, new GI policy should aim for both more structural funding for GIs as well as a reliable instrument to quantify the economic benefits of GIs.

#### 4.4.8 Innovation challenges

When it comes to the innovations of green interventions, Amsterdam has traditionally been a very innovative city. Throughout history, many innovative greening projects, such as the AUP and the HGS, have been implemented (Gemeente Amsterdam, 2011; 2020). The number of innovative projects has only increased in previous and recent GI policy documents. The following projects have been considered as innovative by several respondents: the 'Green unless' approach (Interview 2, 2021); Nature-inclusive construction (Interview 1; 5; 9 and 10, 2021); climate adaptive designing regarding projects like Amsterdam Rainproof (interview 1 and 9, 2021); ecological projects like the Ecological Network (Interview 1; 5 and 10); and the projects of vertical and urban farming (Interview 10, 2021). However, the majority of these innovative projects are still in the pilot phase and have not yet been fully integrated into city-wide policy. This is due to the fact that previous GI policy has lacked the potential to scale up small scale pilot projects (Interview 4; 9 and 10). *"No, it is not easy to scale up innovative projects. It is much easier to run pilots. So, yes.. this will definitely be a challenge for us the upcoming years"* (Interview 9, 2021). According to Zuniga-Teran et al. (2020), it is crucial to ensure that lessons from pilot projects are well documented and embedded as part of the standardised process, because learning from small scale pilot projects is essential for successful implementation of GIs at a larger scale. However, this is still lacking in Amsterdam's GI policy, therefore future GI policy should prioritise documenting and upscaling of pilot projects. Nevertheless, the Green Vision aims to do more research and monitoring to see what innovations are possible in combining GIs in public and private spaces (Gemeente Amsterdam, 2020).

## 5. Conclusion

In this final chapter, the findings of this study will be presented. First, the sub-questions will be answered, followed by a general answer on the research question. Subsequently, the thesis will provide a recommendation for the planning practice on GI implementation. Finally, the limitations of this study will be highlighted, together with some suggestions for future research.

*How does the city of Amsterdam promote Green Infrastructures?*

Throughout the history, Amsterdam has been very active in the promotion of GIs. This all began approximately 500 years ago, when Amsterdam was already a leading city in greening the public spaces for aesthetic and design purposes. Since the last century, greening the city has become more of a government responsibility. Several policies concerning the implementation of GIs have been presented since the second World War. The number of GI policy documents has increased rapidly over the last 20 years, boosted by national government incentives. The policies concerning the implementation of green follow one another in rapid succession, and there are often multiple policy documents at the same time. As a result, this study concludes that Amsterdam actively encourages the implementation of GIs, and that in recent years, GI implementation has acquired a significant role in urban development strategy.

*What have been the governance challenges of Green Infrastructure policy until today?*

Despite the introduction of multiple GI policy documents over the last two decades, Amsterdam has faced numerous governance challenges in the past regarding the implementation of GIs. Until the introduction of the Green Vision, Amsterdam has faced all eight governance challenges in implementing GIs to different degrees. In terms of Integration, Regulatory, and Innovation challenges, Amsterdam has experienced some minor issues with the implementation of GIs. Especially within the Multifunctional, Operation Standards, Institutional, Socioeconomic and Financeability challenges Amsterdam has faced major problems regarding GI implementation. Furthermore, the decrease in green spaces in Amsterdam between 2003 and 2016, as examined by Giezen et al. (2018), demonstrates that the city has faced many governance challenges in the implementation of GI policy. As a result, this study concludes that GI policy has been inefficient over the previous two decades since all eight governance challenges have had a detrimental impact on GI implementation.

*To what extent are these governance challenges reflected in the current Green Infrastructure policy?*

Since the introduction of Amsterdam's new greening policy, the Green Vision, in 2020, the city has made significant improvements in GI policy in comparison to previous policy. Many difficulties related to previous GI implementation governance challenges have been addressed in the new GI policy. The new GI policy has mainly emphasized and reflected on the Integration, Multifunctional, Socioeconomic, Financeability, and Innovation challenges. The challenges concerning Operation Standards, Institutional, and Regulatory issues have also been reflected in new GI policy, but to a lesser extent than the first challenges. As a result, this study concludes that Amsterdam does have a very powerful instrument for GI implementation in the form of the Green Vision, in which many governance challenges from the past have been reflected. The extent to which the Green Vision will be adopted in practice will determine the level to which GIs will be implemented in the coming years.

*How could Amsterdam improve its greening strategy and overcome its shortcomings in promoting green infrastructures?*

A number of aspects of the governance challenges can be improved in future GI policy. Therefore, there are a number of improvements that could be implemented in Amsterdam's greening strategy in order to overcome its shortcomings regarding several governance challenges. Concerning the Integration challenges, Amsterdam could aim for a better integration between underground infrastructures and urban GIs, as discussed by Hennen & Mattijssen (2018). In terms of the Operation Standards challenges, Amsterdam could progress in a variety of ways. First, Amsterdam could improve its GI implementation operation standards by providing sufficient performance data and empirical evidence, which is mentioned by Baptiste et al. (2015), Campbell et al. (2016) and Staddon et al. (2018). Second, more emphasis and structural funds could be devoted toward maintenance and evaluation of GIs, as argued by Charlesworth et al. (2014). For the Institutional challenges, Amsterdam could strive for improved cooperation among municipal departments and a more proactive approach to including other stakeholders. Regarding the Regulatory challenges, future GI policy could aim to introduce new regulations that support and stimulate GI implementation. Concerning the Socioeconomic challenges, Amsterdam could aim to improve the involvement of underrepresented residents with a low socioeconomic status, as also discussed by Furlong et al. (2018). In terms of the Financeability challenges, Amsterdam could seek for more structural funding for GIs and should try to introduce a tool to quantify the economic benefits of GIs, which is possible according to the studies by Bos & Vogelzang (2018) and Paulin et al. (2019). Finally, concerning the Innovation challenges, future GI could aim to prioritise the documentation and upscaling of pilot projects, as mentioned by Zuniga-Teran et al. (2020).

*How does Amsterdam's recent greening strategy learn from previous governance challenges in promoting green infrastructures?*

To summarise this study, despite Amsterdam's active promotion of GIs in the past, Amsterdam struggled with many governance challenges of GI implementation prior to the introduction of the Green Vision. Many of these governance challenges have been reflected in Amsterdam's new GI strategy. As a result, Amsterdam now has a very powerful tool for GI implementation in the form of the Green Vision. However, future GI policy in Amsterdam could still solve a significant number of governance challenges, so the implementation of GIs in Amsterdam could definitely be improved. Nevertheless, based on how Amsterdam has previously reflected on GI governance challenges in new GI policy, it is reasonable to conclude that Amsterdam has made significant progress in their greening strategy and has learned a lot from previous GI governance challenges.

### 5.1 Recommendation for planning practice

Before highlighting the limitations of this thesis, I would like to make a recommendation for the planning practice in general. As mentioned in the introduction of this thesis, cities have become very vulnerable over the last decades and therefore the transition to green cities is essential and the most straightforward process in becoming more resilient for urban areas (Merk, 2012; Staddon et al. 2017). Over the last years, urban GIs are among the most widely applicable, economically viable and effective tools to combat the impact of climate change and help people adapt to the adverse of climate change. Hence, GIs have become a critical part of cities' approaches towards urban resilience and climate adaptation (Staddon et al., 2017). However, based on the empirical results of this study, I would strongly recommend for planners and policy makers to consider the challenges of GI implementation

seriously. Despite growing interest in the potential of GIs to tackle urban issues and positively contribute to urban resilience, there are limitations and challenges for their implementation and mainstreaming in practice (Staddon et al., 2018; Goossens et al., 2020). It seems that a lot of cities and local governments in the Netherlands and Europe do not realise the challenges and complications of implementing GIs, and focus solely on the promotion of GIs (Goossens & Van Gorp, 2017). By demonstrating how a green city like Amsterdam has faced governance challenges of GI implementation in the past, I hope this study raises awareness of the complications and challenges of GI implementation; and planners and policy makers realise they have to consider the challenges of GI implementation from the start of the planning process.

## 5.2 Limitations and suggestions for future research

This study, however, has a number of limitations. The study's initial aim was to assess the effectiveness of current GI policy implementation in Amsterdam. However, because the current policy on GIs has not yet been implemented, this could not have been studied. As a result, the aim of this research has shifted to the governance challenges of GI implementation in the past, and how these are reflected in current GI policy. A limitation of this study is that the conclusions drawn regarding current and future GI policy are mostly based on assumptions, as it has yet to be adopted and it is unclear to what extent it will be implemented in practice. However, there is a future research opportunity to assess the effectiveness of current GI policy implementation by applying the eight governance challenges to current GI policy.

Another limitation of this thesis refers to the framework of eight governance challenges of GI implementation that have been assessed in this study. This framework is based on a literature review on GI governance challenges. Although no additional insights were gained from asking all respondents if they have experienced any other governance challenges in implementing GIs, there may be more governance challenges of GI implementation in literature beyond the understanding of this study. Therefore, future research could build on the framework used in this study and introduce new governance challenges of GI implementation, if these exist.

A final limitation of this study is that the Covid-19 pandemic was not an ideal situation during this research. Initially, a target of this study for its data collection was to interview both aldermen responsible for GI implementation in Amsterdam. Because of the pandemic, the alderman were very limited available due to time constraints. Despite the fact that this study interviewed a number of people from the municipality involved in the implementation of GIs, there is an opportunity for future research to have less time constraints and conduct more interviews, especially with municipal experts like the alderman of Green, to collect data with possibly higher quantitative and qualitative results.

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## Appendix

### Appendix I: Outline Interview

#### Introductie

Mijn naam is Guido de Vries, ik ben 24 jaar en student Spatial Planning aan de Universiteit van Utrecht. Ik zit momenteel in de eindfase van mijn Master en ben bezig met mijn scriptie onderzoek. Voor mijn scriptie doe ik onderzoek naar de uitdagingen om Groene Infrastructuur te implementeren in Amsterdam en hoe de huidige groenstrategie van Amsterdam kan leren van eerder opgedane tekortkomingen bij het promoten van Groen Infrastructuur. Ik wil daar proberen achter te komen door in gesprek te gaan met verschillende partijen die betrokken zijn bij het implementeren van Groene Infrastructuur in Amsterdams beleid.

Dit interview ga ik transcriberen en zal ik geheel anoniem verwerken in mijn onderzoek. Als u het toestaat zou ik wel uw functietitel willen gebruiken in het onderzoek?

Dit gesprek zou ik graag willen opnemen zodat ik het later nog eens na kunnen luisteren. Gaat u hiermee akkoord?

(Interviewer : schakel de opname apparatuur in)

#### Introduction

Where do you work at the moment and what is your current function?

To what extent are you related to the decision-making process of Green Infrastructure policy of Amsterdam?

#### Greening strategy of Amsterdam

Which are the key instruments in promoting Green Infrastructure in Amsterdam?

What are the main innovations of the greening strategy of Amsterdam?

Where do you see the potential of green infrastructure in Amsterdam?

#### Contemporary policy

How did the greening strategy of Amsterdam develop over the last years?

Are there any differences between previous Green Infrastructure policy *from Agenda Groen 2015-2018* and *Sructuurvisie 2040* and contemporary GI policy *Groenvisie 2020-2050* and *Omgevingsvisie 2050*?

- What are the differences?
- How did this change over the years?

#### Challenges of Green infrastructure in the past

Are there any challenges experienced related to the **integration** of different forms of Green Infrastructures?

- How does Amsterdam integrate urban green spaces with other urban grey infrastructures related to the physical aspect of GIs?

- How does Amsterdam integrate urban green spaces with other urban grey infrastructures related to the function of GIs?
- How does Amsterdam connect physical and functional green spaces at different scales to produce GIs?
- How does new GI policy reflect to challenges related to integration of GI?
- In your opinion, do you see the need for a reform in the integration of different forms of Green Infrastructure?

Are there any challenges experienced related to the **multifunctionality** of Green Infrastructures?

- How does GI policy strive for multifunctional GIs by combining ecological, social, economic and cultural functions of green spaces?
- How does GI policy strive for GI initiatives at multiple scales in the same time?
- How does GI policy include multiple GI objects/goals in the same time?
- How does new GI policy reflect to challenges related to multifunctionality of GI?
- In your opinion, do you see the need for a reform in the multifunctionality of Green Infrastructure?

Are there any challenges experienced with Green Infrastructure **standards**?

- How does Amsterdam develop standards for GIs?
- Are they backed up by empirical evidence?
- How does Amsterdam provide maintenance for GIs?
- How does Amsterdam evaluate the implementation of GIs?
- How does new GI policy reflect to challenges related to standards of GI?
- In your opinion, do you see the need for stronger standards?

Are there any challenges experienced with **institutional** factors of Green Infrastructure?

- Who has the key responsibility for the GI policy development?
- How does this responsibility align or differ from the responsibilities for its implementation?
- How does policy include different stakeholders in the process of GI implementation?
- Does the greening policy of **name department** receive sufficient political, financial and institutional support in promoting GI projects?
  - o Why (not)?
- How does Amsterdam organize collaboration between different stakeholders on different levels?
  - o How does Amsterdam organize the coordination between governmental agencies and non-profit organisations?
  - o What about the private sector?
  - o And what about participation of civil society?
- Which collaboration are seen as the most important?
- How does new GI policy reflect to institutional challenges?
- In your opinion, where do you see the needs for institutional reform?

Are there any challenges experienced with the **regulation** of Green Infrastructure:

- Do you think the regulatory framework sufficiently supports the development of GI

- Which are legal frameworks and instruments that enhance (drivers) the implementation of GIs?
- And which legal frameworks restrict (barriers) the implementation of GIs?
- How do these mechanisms translate GI projects into practice?
- How does new GI policy reflect to challenges related to regulation of GI?
- In your opinion, where do you see the needs for regulatory reform?

Are there any challenges experienced with **socioeconomic status** processes of Green Infrastructure?

- How does Amsterdam make sure to make GIs inclusive for all citizens?
- What challenges do poor neighbourhoods face that can be improved through GI projects?
- How can underrepresented communities be better included in the greening strategy of the city?
- How to promote the active participation and citizenship of all citizens, especially vulnerable communities, in GI intervention projects?
- How to make sure to meet the local needs and capacities in producing appropriate GI?
- How does new GI policy reflect to social challenges?
- In your opinion, where do you see the needs for social-economic reform?

Are there any challenges experienced related to **financeability**?

- What economic instruments exist for GI implementation?
- How do these instruments translate into practice?
- Is there an economic market for GI? Is there any economic interest?
- Is there any consideration whether the implementation of GIs is cheaper than grey infrastructure?
- How does the city of Amsterdam quantify the economic benefit of GIs? And how do they examine the willingness of people, communities and governments to pay for GIs?
- How does Amsterdam influence the willingness of people to adopt GIs?
- How does new GI policy reflect to challenges related to financeability of GI?
- In your opinion, where do you see the needs for financeable reform?

Are there any challenges experienced with the **innovation** of Green Infrastructures?

- What type of innovations exist and can be developed around existing GI in Amsterdam?
- What funding mechanism can be used for long-term maintenance and for the monitoring of GI benefits and downsides?
- How do we make sure to keep innovate and collaborate on different stakeholder levels to produce enough knowledge and power?
- How can Amsterdam scale-up innovative projects (living-labs, experiments)?
- How does new GI policy reflect to challenges related to the innovation of GI?
- In your opinion, where do you see the needs for innovative reform?

To sum up:

- In your opinion, are there any other challenges experienced in implementing Green Infrastructure I did not discuss yet?
- In your opinion, what do you see as the key challenge for implementing Green Infrastructure over the last 10 years in Amsterdam?

## Improvements

Is there something Amsterdam could have done differently in the greening strategy of implementing GIs?

How could Amsterdam improve its greening strategy in the future?

How could Amsterdam overcome its shortcomings in promoting GI in the future?

## Appendix II: Overview respondents

<b>Respondent</b>	<b>Organisation (and function)</b>
<b>Interview 1</b>	Senior Planner at the Municipality of Amsterdam
<b>Interview 2</b>	Buurtgroen 020 and Green Platform Amsterdam (Both Green Network Organisations)
<b>Interview 3</b>	De Gezonde Stad (Green Network Organisation)
<b>Interview 4</b>	Rainproof Amsterdam
<b>Interview 5</b>	Urban ecologist and landscape architect at the Municipality of Amsterdam
<b>Interview 6</b>	Rooftop Revolution
<b>Interview 7</b>	Project coordinator at National Institute for Public Health and the Environment (RIVM)
<b>Interview 8</b>	Groeizaam (consultancy firm in GIs) and former Green coach at the municipality of Amsterdam
<b>Interview 9</b>	Senior Policy Advisor Green at the municipality of Amsterdam
<b>Interview 10</b>	Project Green and Healthy City at the municipality of Amsterdam

### Appendix 3: Code Manager from Atlas.Ti

Code	Code Group
Belangrijkste uitdagingen	Uitdagingen van GI
Benadering Amsterdam van Groen	Groenstrategie
Financierbaarheid: economische instrumenten	Uitdagingen van GI
Financierbaarheid: kwantificeerbaarheid van economische voordelen	Uitdagingen van GI
Financierbaarheid: tekortkomingen/uitdagingen	Uitdagingen van GI
Fysieke Integratie: groenstructuren met grijsstructuren	Uitdagingen van GI
Fysieke Integratie: nieuw beleid	Uitdagingen van GI
Groenvisie/Omgevingsvisie	Huidig groenbeleid
Innovatie: belemmering	Uitdagingen van GI
Innovatie: nieuw beleid	Uitdagingen van GI
Innovatie: type GI	Uitdagingen van GI
Institutionele factoren: Beheer verantwoordelijk voor groen	Uitdagingen van GI
Institutionele factoren: samenwerking tussen verschillende stakeholders	Uitdagingen van GI
Institutionele factoren: samenwerkingen binnen gemeente	Uitdagingen van GI
Multifunctionaliteit: nieuw beleid	Uitdagingen van GI
Multifunctionaliteit: privaat/publiek	Uitdagingen van GI
Multifunctionaliteit: stadsniveaus	Uitdagingen van GI
Multifunctionaliteit: waarden benadering	Uitdagingen van GI
Overige uitdagingen	Uitdagingen van GI
Potentie voor groen	Groenstrategie
Regelgeving: barrière of drijfveer	Uitdagingen van GI
Sociaaleconomische status: actieve participatie	Uitdagingen van GI
Sociaaleconomische status: capaciteit van bewoners	Uitdagingen van GI
Sociaaleconomische status: inclusiviteit	Uitdagingen van GI
Sociaaleconomische status: nieuw beleid	Uitdagingen van GI
Standaard eigenschappen: evaluatie	Uitdagingen van GI
Standaard eigenschappen: onderhoud	Uitdagingen van GI
Standaard eigenschappen: standaard norm van groen	Uitdagingen van GI
Verandering in het Besef rondom GI	Huidig groenbeleid
Verbeteringen beleid	Toekomst groenbeleid